



REPUBLIC OF KENYA

Technical, Industrial, Vocational and
Entrepreneurship Training

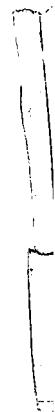
**DIPLOMA IN ELECTRICAL AND
ELECTRONIC ENGINEERING
POWER OPTION**

SYLLABUS AND REGULATIONS



KENYA INSTITUTE OF EDUCATION
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NAIROBI

July, 2009



**TECHNICAL, INDUSTRIAL,
VOCATIONAL AND
ENTREPRENEURSHIP TRAINING**

**DIPLOMA IN ELECTRICAL AND
ELECTRONIC ENGINEERING**

POWER OPTION

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Foreword

The Technical Industrial Vocational and Entrepreneurship Training (TIVET) programmes have been revised to cater for new technology, issues and trends that have emerged since early '90s when the syllabi were developed under the Technical Education Project (TEP) programme. The content has been revised and new areas included to help the graduates of the programme acquire knowledge, practical skills, attitudes and competence relating to occupations in various sectors of economic and social life.

The syllabus is designed and organised to guide the trainer in the depth of teaching, with a clear outline of the general objectives, specific objectives, teaching/learning activities and suggested methods of evaluating the trainee's achievement.

The curriculum is modular and competency based allowing for trainees' exit to the world of work and easy re-entry to the course.

I am grateful to the staff of Kenya Institute of Education, subject and course panel members at the Kenya Institute of Education, the KIE academic board, the staff of the MoHEST and all those who participated in the development and the production of this syllabus.

**Director Technical Education
Ministry of Higher Education Science and Technology**

vii) **Promote international consciousness and foster positive attitudes towards other nations**

Kenya is part of the international community. It is part of the complicated and interdependent network of peoples and nations. Education should, therefore, lead the youth of the country to accept membership in this international community with all the obligations and responsibilities, rights and benefits that this membership entails.

viii) **Promote positive attitudes towards good health and environmental protection**

Education should inculcate in the youth the value for good health in order to avoid indulging in activities that will lead to physical or mental ill health. It should foster positive attitudes towards environmental development and conservation. It should lead the youth to appreciate the need for a healthy environment.

1.2 National Aims of Technical Training Programmes

The aims of the technical training at both post primary and post secondary levels should be to:

- a) provide training opportunities for the increasing number of school leavers to enable them to be self-supporting
- b) develop practical skills and attitudes which will lead to income generating activities in the urban and rural areas through self-employment
- c) provide practical education and training skills which are responsive and relevant to Kenya's agricultural, industrial, commercial and economic needs
- d) provide the technical knowledge and vocational skills necessary to enhance the pace of this nation's development
- e) encourage self-employment while at the same time producing skilled artisans, technicians and technologists for both formal and informal sectors at the ratio of one technologist to five technicians to 30 craftsmen/artisans (1:5:30).

1.3 Objectives of the Technician Training Programmes

The general objectives of the technician training programmes are to:

- a) Develop skills which will be responsive and relevant to the country's human resources required at the middle level;
- b) Prepare the trainees so that they can enter the world of work with confidence for either salaried employment or self-employment;
- c) Impart adequate skills which will enable the trainee to perform middle supervisory functions.

2.0 Introduction to Diploma in Electrical and Electronic Engineering, Power Option

The Diploma in Electrical Engineering Power Option course is designed for Kenya Certificate of Secondary Education graduates (or equivalent qualifications), to provide trainees with skills, knowledge and attitudes that will enable them perform and manage tasks in Electrical Engineering and related fields or progress in further training.

The course is in three modules and is competency based, designed with multiple skills to enhance trainees' adaptability in the formal and the informal employment. Each module prepares the trainee to perform specific tasks and jobs whose total value combined will impart the desired competence, which will produce the required graduate at the end of the course.

The course puts emphasis on practical work and competence acquisition, thus, the trainee is required to spend adequate time on practical lessons.

The graduate of the course will be able to design, install test, and maintain electrical systems to the specified professional standards.

The trainers are encouraged to continuously carry out research to establish the emerging trends and issues in each area and integrate them in the teaching. The trainers are further encouraged to take into considerations the interests of persons with disability as prescribed in the Persons with Disability Act of 2003.

■ Economic Needs

Education in Kenya should produce citizens with skills, knowledge, expertise and personal qualities that are required to support a growing economy. Kenya is building up a modern and independent economy, which is in need of adequate domestic manpower.

■ Technological and Industrial Needs

Education in Kenya should provide the learners with the necessary skills and attitudes for Industrial development. Kenya recognizes the rapid industrial and technological changes taking place, especially in the developed world. We can only be part of this development if our education system deliberately focused on knowledge, skills and attitudes that will prepare the youth for these changing global trends.

iii) Promote individual development and self-fulfilment

Education should provide opportunities for the fullest development of individual talents and personality. It should help children to develop their potential, interests and abilities. A vital aspect of individual development is character building.

iv) Promote sound moral and religious values

Education should provide for the development of knowledge, skills and attitudes that will enhance acquisition of sound moral values and help children to grow up into self-disciplined, self-reliant and integrated citizens.

v) Promote social equality and responsibility

Education should promote social equality and foster a sense of social responsibility within an education system, which provides equal education opportunities for all. It should give all children varied and challenging opportunities for collective activities and corporate social service, irrespective of gender, ability or geographical environment.

vi) Promote respect for and development of Kenya's rich and varied cultures

Education should instil in the youth of Kenya an understanding of past and present cultures and their valid place in contemporary society.

The children should be able to blend the best of traditional values with the changed requirements that, must follow rapid development in order to build a stable and modern society.

1.0 General Introduction

1.1 National Goals of Education

The overall education policy goal of the Government of Kenya is to achieve the Millennium Development Goals (MDGs) and Education for all (EFA) goals by 2015 in tandem with the national and international commitments. The vision of the Ministry of Education, is “to have a globally competitive education, training and research for Kenya’s sustainable development” while the mission is “to provide, promote, coordinate the provision of quality education, training and research for the empowerment of individuals to become responsible and competent citizens who value education as a lifelong process” as envisaged by Kenya Vision 2030. The national goals of education are given below:

i) Foster nationalism, patriotism and promote national unity

Kenya’s people belong to different ethnic groups, races and religions, but these differences need not divide them. They must be able to live and interact as Kenyans. It is a paramount duty of education to help the youth acquire this sense of nationhood, by removing conflicts and by promoting positive attitudes of mutual respect, which enable them to live together in harmony, and foster patriotism in order to make a positive contribution to the life of the Nation.

ii) Promote the social economic, technological and industrial needs for national development

Education should prepare the youth of the country to play an effective and productive role in the life of the nation.

■ Social Needs

Education in Kenya must prepare children for the changes in attitudes and relationships, which are necessary for the smooth process of a rapidly developing modern economy. There is bound to be a silent social revolution following in the wake of rapid modernization. Education should assist our youth to adapt to this change.

| | | |
|--------|--|-----------------------|
| 21.2.0 | Engineering Drawing and Design | - Practice |
| 22.2.0 | Industrial Programmable Logic Controllers | - Theory and Practice |
| 23.2.0 | Business Plan | - Theory and Practice |
| 24.2.0 | Electric Circuit Analysis | - Theory |
| 25.2.0 | Electrical Protection and Services for Buildings | - Theory and Practice |
| 26.2.0 | Electrical Power Generation and Transmission | - Theory and Practice |

Module III – Industrial Machines and Controls

| | | |
|--------|--|-----------------------|
| 27.3.0 | Engineering Mathematics III | - Theory |
| 28.3.0 | Microcontroller Technology | - Theory and Practice |
| 29.3.0 | Industrial Organization and Management | - Theory |
| 30.3.0 | Microprocessor Systems | - Theory and Practice |
| 31.3.0 | Estimating, Tendering and Engineering Services Contracts | - Theory and Practice |
| 32.3.0 | Trade Project | - Practice |
| 33.3.0 | Electromagnetic Fields Theory | - Theory and Practice |
| 34.3.0 | Machines and Utilization | - Theory and Practice |
| 35.3.0 | Electrical Power Transmission and Distribution | - Theory and Practice |
| 36.3.0 | Power Electronics | - Theory and Practice |

Candidates do not have to take all the papers of a module at the same sitting

2.4 Attendance and Course Work Requirements

The candidates are expected to register for training at an institution approved for the course for the theoretical and practical studies.

2.4.1 Coursework Marks

Continuous assessment marks for the course work must be kept by the institution and details must be submitted to the Kenya National Examinations Council (KNEC) in respect of each candidate entered for the examinations at least two weeks before the external examination is taken.

2.4.2 Coursework Assessment

Continuous assessment will be given a weighting of 30% and the external examinations by KNEC will be given a weighting of 70% in the determination of the final grade.

2.4.3 Compulsory Industrial Attachment/Internship for Trainees

Before the end of the course, every trainee shall undergo industrial attachment/internship of 660 hours which shall be taken in two phases. Industrial attachment shall be an integral part of training and its assessment shall form part of the final grade and certification.

The training institutions in collaboration with the organization where the trainee is attached shall supervise the trainee during the Industrial Attachment. The KNEC shall provide the modalities for the assessment of industrial attachment.

2.4.4 Project Work

A project in this context means a piece of work carried out by an individual trainee. It may be practical, mathematical, evaluative, and descriptive or research based project. The project must have well defined objectives so that the trainee has something definite to aim at, without inhibiting his/her initiative. The aim of the project is to give trainees an opportunity to carry out an independent work. The management and the assessment methods of project work shall be determined by KNEC and the training institutions.

2.5 Examinations and Award of Certificates

2.5.1 Assessment

The assessment of all the modules shall be competency based.

2.5.2 Internal Examinations

The training institutions will conduct course work and/or project work assessments based on the competences acquired during the training. The institutions will offer internal examinations at the end of each module and keep these records for use at the end of the course to determine the final grade. The course work or project work and/or assessments shall also be used during the re-entry to the course or for the award of credit transfer.

2.5.3 External Examinations

The Kenya National Examinations Council (KNEC) will offer external examinations to trainees in all modules covered during the training.

2.5.4 Eligibility for Candidates Entering Into External Examinations

Candidates for external examinations must at the time of entry to the examinations, have successfully completed the required competences in each course modules.

2.5.5 Coursework/continuous Assessment

Coursework/continuous Assessment will be prepared and marked by the institutions.-

The institutions will issue statement of results while the examining body will award a certificate after completion of the relevant modules.

2.5.6 Examination Results

In order to qualify for the award of Diploma in Electrical and Electronic engineering Power Option, the candidate must pass all the modules of the course. Results of the examination as a whole will be issued in five classes and for the individual papers will be in eight grades. Each candidate will receive all records of performance, giving the result in terms of class and grade.

The relationship between classes and grades is:

| | | |
|-----------------------|---|---------------|
| Pass with distinction | - | Grade 1 and 2 |
| Pass with credit | - | Grade 3 and 4 |
| Pass | - | Grade 5 and 6 |
| Referred | - | Grade 7 |
| Fail | - | Grade 8 |

Candidates, who fail any paper (module unit) in a particular module, will be REFERRED in the failed paper and will be allowed to re-sit three (3) times and pass within a period of five (5) years after the date of the first sitting. Thereafter the candidate will be discontinued from further re-sitting the paper(s).

2.5.7 Award of Certificate

The KNEC will issue the candidates with result slips for Modules passed and a final certificate in Diploma in Electrical and Electronic Technology Engineering Power Option.

2.5.8 General Examination Regulation

In the event of any inconsistency arising between the regulations as set out in this syllabus and the General Regulations published by the examining body, the General Regulations of the KNEC shall prevail.

2.6 Course Coding and Time Allocation

Diploma in Electrical and Electronic Engineering, Power Option

| Module I - Electrical Installations Systems | | |
|--|--|-----------------|
| Code | Module Unit | Time Hrs |
| 3.1.0 | Communication Skills | 66 |
| 4.1.0 | Life Skills | 66 |
| 5.1.0 | Information and Communication Technology (ICT) | 99 |
| 6.1.0 | Entrepreneurship | 66 |
| 7.1.0 | Engineering Mathematics I | 66 |
| 8.1.0 | Physical Science | 48 |
| 9.1.0 | Mechanical Science | 66 |
| 10.1.0 | Materials, Processes and Workshop Practice | 66 |
| 11.1.0 | Engineering Drawing | 66 |
| 12.1.0 | Electrical Engineering Principles | 66 |
| 13.1.0 | Electrical Installation Technology | 117 |
| 14.1.0 | Solar Installation Systems | 66 |
| 15.1.0 | Analogue Electronics I | 66 |
| 16.1.0 | Electrical Measurements and Fault Diagnosis | 66 |
| Tuition hours for module I | | 990 |
| Industrial attachment for module I | | 330 |
| Total Time for Module I | | 1320 |

| Module II – Electrical Power Generation and Transmission | | |
|---|--|-------------|
| 17.2.0 | Control Systems | 66 |
| 18.2.0 | Analogue Electronics II | 88 |
| 19.2.0 | Engineering Mathematics II | 66 |
| 20.2.0 | Digital Electronics | 66 |
| 21.2.0 | Engineering Drawing and Design | 44 |
| 22.2.0 | Industrial Programmable Logic Controllers | 66 |
| 23.2.0 | Business Plan | 44 |
| 24.2.0 | Electric Circuit Analysis I | 66 |
| 25.2.0 | Building Services and Protection | 66 |
| 26.2.0 | Electrical Power Generation and Transmission | 88 |
| | Total tuition time for module I | 660 |
| | Time for Industrial Attachment for Module I | 330 |
| | Total Time for Module II | 990 |
| Module III – Industrial Machines and Controls | | |
| 27.3.0 | Engineering Mathematics III | 88 |
| 28.3.0 | Microcontroller Technology | 44 |
| 29.3.0 | Industrial Organization And Management | 66 |
| 30.3.0 | Microprocessor Systems | 66 |
| 31.3.0 | Estimating, Tendering And Engineering Services Contracts | 66 |
| 32.3.0 | Trade Project | 44 |
| 33.3.0 | Electromagnetic Fields Theory | 44 |
| 34.3.0 | Machines and Utilisation | 88 |
| 35.3.0 | Electrical Power Transmission and Distribution | 88 |
| 36.3.10 | Power Electronics | 66 |
| | Total tuition time for module III | 660 |
| | Total Time for Module III | 660 |
| | Total Time for the Course | 2970 |

**DIPLOMA IN ELECTRICAL AND
ELECTRONIC ENGINEERING**

POWER OPTION

MODULE I

MODULE I - ELECTRICAL INSTALLATION SYSTEMS

Introduction

This module is designed to enable the trainee acquire necessary knowledge, skills, attitudes and Competence that can be utilized in Electrical , Electronics and Instrumentation works, carry out domestic wiring, repair and maintain electrical and electronics equipments

The module also includes life skills and the related general education subjects.

The graduate of this module has the necessary skills for the world of work in an Electrical, Electronics and Instrumentation workshop.

General Objectives

At the end of the module the trainee should be able to:

- a) Understand the general engineering concepts
- b) Understand electrical and electronics equipments, and their applications
- c) Install, test and maintain electrical and electronic systems
- d) Apply acquired knowledge in ICT in electrical installations design
- e) Demonstrate entrepreneurial skills in electrical engineering field
- f) Observe safety regulations and standards when performing tasks

Key Competence

At the end of the module, the trainee should be able to:

- i) Perform electrical installations in domestic and commercial premises
- ii) Repair and maintain electrical and electronics equipment
- iii) Operate on low voltage single-phase loads
- iv) Construct basic electronic circuits
- v) Perform workshop processes

The units covered in this module are:

- 3.1.0 Communication Skills
- 4.1.0 Life Skills
- 5.1.0 Information and Communication Technology (ICT)
- 6.1.0 Entrepreneurship
- 7.1.0 Engineering Mathematics I
- 8.1.0 Physical Science
- 9.1.0 Mechanical Science
- 10.1.0 Materials, Processes And Workshop Practice
- 11.1.0 Engineering Drawing
- 12.1.0 Electrical Engineering Principles
- 13.1.0 Electrical Installation Technology
- 14.1.0 Analogue Electronics I
- 15.1.0 Solar Installation
- 16.1.0 Electrical Measurements and Fault Diagnosis

3.1.0 COMMUNICATION SKILLS

3.1.01

Introduction

The module unit is intended to equip the trainee with knowledge, skills and attitudes to enable him/her to perform duties, process information from a variety of sources and apply communication skills at the work place.

At the end of the unit is a list of teaching/learning activities, teaching/learning resources and evaluation methods that may be applied in the implementation of the syllabus unit. The list is not exhaustive and the instructor is encouraged to explore other suitable methods.

3.1.02

General Objectives

At the end of this module unit, the trainee should be able to:

- a) Appreciate the importance of communication in the work place
- b) Develop necessary skills for effective communication
- c) Appreciate the use of different modes and forms of communication
- d) Appreciate the role of information and communication technology in communication
- e) Develop the necessary writing skills for various documents
- f) Appreciate official etiquette, protocol and diplomacy at the work place
- g) Appreciate emerging issues in communication

3.103

Module Summary and Time Allocation

Communication Skills

| Code | Sub-Module Unit | Content | Time Hrs |
|-------------|-------------------------------|---|-----------------|
| 3.1.1 | Introduction to Communication | <ul style="list-style-type: none">• Terms and concept used• Essentials to effective communication• Role of ICT in communication | 4 |
| 3.1.2 | Communication Process | <ul style="list-style-type: none">• Stages of communication process• Barriers to effective communication• Ways of overcoming barriers• Basic concepts of transmission and receipt of a message | |

| | | | |
|--------|--|--|----|
| | | <ul style="list-style-type: none"> • Feedback mechanism • Ethical issues in communication | 2 |
| 3.1.3 | Classification of Communication | <ul style="list-style-type: none"> • Types of communication • Use of various types of communication | 4 |
| 3.1.4 | Forms of Communication | <ul style="list-style-type: none"> • Forms of communication • Advantages and disadvantages of | 4 |
| 3.1.5 | Channels of Communication | <ul style="list-style-type: none"> • Communication channels • Advantages and disadvantages | 5 |
| 3.1.6 | Official Etiquette, Protocol and Diplomacy | <ul style="list-style-type: none"> • Meaning of etiquette, protocol and diplomacy | 5 |
| 3.1.7 | Writing Skills | <ul style="list-style-type: none"> • Punctuation marks • Courtesy in writing • Paragraph development • Essay writing • Functional writing | 10 |
| 3.1.8 | Summary | <ul style="list-style-type: none"> • Importance of summary writing • Essential steps in summary writing | 4 |
| 3.1.9 | Report Writing Skills | <ul style="list-style-type: none"> • Definition of a report • Role of reports • Formats of reports • Preparation for report writing • Report writing , editing and dissemination • Referencing styles • Preparation of power point slides | 8 |
| 3.1.10 | Conducting Meetings and Minute Writing | <ul style="list-style-type: none"> • Definition of terms • Role of meetings and minutes • Types of meetings • Planning and conducting meetings • Minute writing • Challenges in conducting meetings | 8 |

| | | | |
|--------------|------------------------------------|---|-----------|
| 3.1.11 | Interviews | <ul style="list-style-type: none"> • Meaning of the term interview • Purpose of interviews • Types of interviews • Preparation for an interview • Interviewing skills | 4 |
| 3.1.12 | Public Relations and Customer Care | <ul style="list-style-type: none"> • Definition of term • Types of customers • Role of public relations and customer care • Interpersonal and public relation skills • Quality management • Customer care skills • Challenges faces in public relation and customer care | 4 |
| 3.1.13 | Emerging Issues in Communication | <ul style="list-style-type: none"> • Emerging trends and issues in communication • Challenges posed by emerging issues and trends • Ways of coping with emerging issues and trends | 4 |
| Total | | | 66 |

| | | |
|---------|--|---|
| 3.1.1 | INTRODUCTION TO COMMUNICATION | |
| | Theory | |
| 3.1.1T0 | <i>Specific objectives</i> | <p><i>Content</i></p> <p>3.1.1P1 Effective use of terms and concepts in communication</p> <p>3.1.1P2 Application of essentials of communication</p> |
| | <p>By the end of the sub-module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) define terms and concepts used in communication b) explain the purpose of communication c) explain the essential steps to effective communication d) explain the role of Information and Communication Technology e) (I.C.T.) in communication | <p>3.1.1C Competence</p> <p>The trainee should have the ability to:</p> <ul style="list-style-type: none"> i) use the terms and concepts in communication effectively in different situations. |
| | <i>Content</i> | |
| 3.1.1T1 | Terms and concepts used in communication | <p>3.1.2T0 <i>Specific Objectives</i></p> <p>By the end of the sub-module unit, the trainee should be able to:</p> |
| 3.1.1T2 | Purpose of communication | <ul style="list-style-type: none"> a) describe the stages of the communication process b) identify barriers to effective communication c) explain ways of overcoming barriers to effective communication |
| 3.1.1T3 | Essentials to effective communication | <ul style="list-style-type: none"> a) identify basic concepts of transmission and receipt of a message b) describe feedback mechanism c) explain ethical issues in communication |
| 3.1.1T4 | Role of I.C.T. in communication | |
| | Practice | <p><i>Content</i></p> <p>3.1.2T1 Stages of communication process</p> |
| 3.1.1P0 | <i>Specific Objectives</i> | <p>3.1.2T2 Barriers to effective communication</p> <ul style="list-style-type: none"> i) Age difference ii) Social economic factors |
| | <p>By the end of the sub-module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) use terms and concepts in communication effectively b) apply essentials of communication in a given situation | |

| | | |
|---------|--|--|
| | iii) Language | 3.1.2P2 Encoding and decoding messages |
| | iv) Competition for attention | 3.1.2P3 Demonstration of ethical issues in communication |
| | v) Noise | |
| | vi) Environment | |
| | vii) Attitude of sender/receiver and others | |
| 3.1.2T3 | Ways of overcoming barriers to effective communication | |
| 3.1.2T4 | Basic concepts of transmission and receipt of a message <ul style="list-style-type: none"> i) Encoding of message by the sender ii) Transmission of message through a channel iii) Decoding a message by receiver iv) Decoding of feedback by the sender | 3.1.2C Competence The trainee should have the ability to: <ul style="list-style-type: none"> i) Apply communication process in a given situation ii) Overcome barriers to effective communication |
| 3.1.2T5 | Feedback mechanism | |
| 3.1.2T6 | Ethical issues in communication | |
| | Practice | |
| 3.1.2P0 | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: a) apply the communication process in a given situation b) encode and decode messages c) demonstrate ethical issues in communication | 3.1.3 CLASSIFICATION OF COMMUNICATION Theory 3.1.3T0 <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: a) explain the various types of communication b) explain the use of various types of communication Content 3.1.3T1 Types of communication <ul style="list-style-type: none"> i) Formal ii) Informal iii) Internal iv) External v) Inter personal vi) Intra-personal |
| 3.1.2P1 | Application of the process of communication | 3.1.3T2 Use of various types of communication |

| Practice | |
|-------------------------------------|--|
| 3.1.3P0 | <p><i>Specific Objective</i> By the end of the sub-module unit, the trainee should be able to apply the various types of communication in given situations</p> <p><i>Content</i> Application of various types of communication</p> <p>Competence The trainee should have the ability to: apply the various types of communication in a given situation</p> |
| 3.1.4 FORMS OF COMMUNICATION | |
| | <p>Theory</p> <p>3.1.4T0 <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) explain the various forms of communication b) discuss the advantages and disadvantages of each form of communication c) communication <p><i>Content</i></p> <p>3.1.4T1 Forms of communication</p> <ul style="list-style-type: none"> i) Oral ii) Written iii) Visual iv) Audio-visual <p>3.1.4T2 Advantages and disadvantages of each form of communication</p> |
| | <p>Practice</p> <p>3.1.4P0 <i>Specific Objective</i> By the end of the sub-module unit, the trainee should be able to use the various forms of communication.</p> <p><i>Content</i></p> <p>3.1.4P Using various forms of communication</p> <p>3.1.4C Competence The trainee should have the ability to: use various forms of communication effectively</p> <p>3.1.5 CHANNELS OF COMMUNICATION</p> <p>Theory</p> <p>3.1.5T0 <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) outline the various channels of communication in an organization b) discuss the advantages and disadvantages of each channel of communication c) communication <p><i>Content</i></p> <p>3.1.5T1 Channels of communication</p> <ul style="list-style-type: none"> i) Vertical ii) Upwards iii) Downwards iv) Lateral/Horizontal v) Diagonal <p>3.1.5T2 Advantages and disadvantages</p> |

of each channel of communication

Practice

3.1.5P0 Specific Objective

By the end of the sub-module, the trainee should be able to role play the use of different channels of communication

Content

3.1.5P1 Role play of use of different channels of communication

3.1.5C Competence

The trainee should have the ability to: apply various channels of communication in a given situation

3.1.6T0 OFFICIAL ETIQUETTE, PROTOCOL AND DIPLOMACY

Theory

3.1.6T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) explain the meaning of etiquette, protocol and diplomacy
- b) explain the importance of official etiquette
- c) explain the accepted protocol and diplomacy

Content

3.1.6T1 Meaning of etiquette, protocol and diplomacy

3.1.6T2 Official etiquette

3.1.6T3 Accepted protocol and

vi) diplomacy

Practice

3.1.6P0 *Specific objectives*

By the end of the sub-module unit, the trainee should be able to practice the accepted official etiquette

Content

3.1.6P1 Demonstration of accepted official etiquette

3.1.6C Competence

The trainee should have the ability to Interact with others without offending

- i) Observe protocol requirements
- ii) Exercise diplomacy in daily interactions
- iii) Adhere to official etiquette requirements

3.1.7 WRITING SKILLS

Theory

3.1.7T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) determine how to use punctuation marks in a written document
- b) explain the importance of courtesy in writing
- c) develop well constructed paragraphs

- d) explain how to write different types of essays
 - e) determine how to write different functional writing
- Content*
- 3.1.7P1 Punctuating correctly
 - 3.1.7P2 Demonstrating courtesy in writing
 - 3.1.7P3 Writing different types of essays
 - 3.1.7P4 Writing different functional writing

- 3.1.7C Competence**
- The trainee will have the ability to: Punctuate correctly Prepare business documents
- 3.1.8 SUMMARY**
- Theory**
- 3.1.8T0 Specific Objectives**
- By the end of the sub-module unit, the trainee should be able to:
- a) explain the importance of summarizing passages/information
 - b) determine the steps in note taking when summarizing passages,
 - c) reports and conversations
- Content**
- 3.1.8T1 Importance of summary writing
 - 3.1.8T2 Essential steps in summary writing
- Practice**
- 3.1.8P0 Specific Objective**
- By the end of the sub-module unit, the trainee should be able to take notes and summarize passages, reports and conversations

Content

3.1.8P1 Summarizing passages,

- b) Passed National Vocational Certificate of Education and Training (NVCET) Electrical and Electronic Technology Level II Option II, or;
- c) Equivalent qualifications as shall be determined by Kenya National Examinations Council (KNEC).

2.3.4 Examinable Units

All the units in each module of the course are examinable.

The examinations shall include Theory and Practical phase tests for the core competency areas in each Module which shall include:

| Code | Module Unit | Recommended Mode of Assessment and Evaluation |
|--|--|--|
| Module I - Electrical Installation Systems | | |
| 3.1.0 | Communication Skills | - Theory |
| 4.1.0 | Life Skills | - Theory |
| 5.1.0 | Information and Communication Technology (ICT) | - Theory and Practice |
| 6.1.0 | Entrepreneurship | - Theory |
| 7.1.0 | Engineering Mathematics I | - Theory |
| 8.1.0 | Physical Science | - Theory and Practice |
| 9.1.0 | Mechanical Science | - Theory and Practice |
| 10.1.0 | Materials, Processes and Workshop Practice | - Theory and Practice |
| 11.1.0 | Engineering Drawing | - Practice |
| 12.1.0 | Electrical Engineering Principles | - Theory and Practice |
| 13.1.0 | Electrical Installation Technology | - Theory and Practice |
| 14.1.0 | Solar Installation Systems | - Theory and Practice |
| 15.1.0 | Analogue Electronics I | - Theory and Practice |
| 16.1.0 | Electrical Measurements and Fault Diagnosis | - Theory and Practice |
| Module II -Electrical Power Generation and Transmission | | |
| 17.2.0 | Control Systems | - Theory |
| 18.2.0 | Analogue Electronics II | - Theory and Practice |
| 19.2.0 | Engineering Mathematics II | - Theory |
| 20.2.0 | Digital Electronics | - Theory and Practice |

2.1 General Objectives of the Course

At the end of the course, the trainee should be able to:

- a) Maintain electrical and electronic equipment and devices
- b) Interpret technical information/data for electrical installations and industrial machines
- c) Design, install, test and maintain electrical installations
- d) Apply Information Communication Technology (ICT) in electronics and instrumentation system design and networking
- e) Observe environment, health and safety in electrical installation work
- f) Create a firm foundation for further training.
- g) Demonstrate creativity and innovation

2.3 General Regulations

2.3.1 Approval of the Training Institutions

Institutions offering this course should be recognized and approved by the Ministry responsible for Training.

2.3.2 Course Duration

The course is designed to have 2970 hours. The trainee spends 2310 hours in the institution and 660 hours in industrial attachment. The course is structured in **THREE** Modules as outlined below:

| | Institution Time (Hours) | Industrial Attachment Time (Hours) | Total Time (Hours) |
|-------------------|---------------------------------|---|---------------------------|
| Module I | 990 | 330 | 1320 |
| Module II | 660 | 330 | 990 |
| Module III | 660 | - | 660 |
| Total | 2310 | 660 | 2970 |

2.3.3 Entry Requirements

Trainees entering this course should have any of the following minimum requirements:

- a) Passed Kenya Certificate of Secondary Education (KCSE) with a Mean grade of C (plain) and with C plain in cluster subjects, i.e. Mathematics, English and Physics/Physical science. or;

| | | |
|------------------------------------|---|--|
| | reports and conversations | vi) Maintenance, breakdown and accident reports vii) Entrepreneurship and trade reports viii) Internal memos |
| 3.1.8C Competence | The trainee should have the ability to: summarize passages, reports and conversations | |
| 3.1.9 REPORT WRITING SKILLS | | |
| | Theory | |
| 3.1.9T0 Specific Objectives | By the end of the sub-module unit, the trainee should be able to: | |
| a) | define the term report | 3.1.9T4 Formats of reports |
| b) | explain the role of reports in an organization | 3.1.9T5 Preparation for report writing |
| c) | name different types of reports | i) Audience analysis ii) Reading skills iii) Data collection iv) Data analysis |
| d) | explain the formats of reports | 3.1.9T6 Report writing, editing and dissemination |
| e) | explain the steps to take in preparation for report writing in engineering | 3.1.9T7 Referencing styles |
| f) | explain how to write, edit and disseminate reports | 3.1.9T8 Preparation of power point slides |
| g) | explain the referencing styles used in engineering reports | |
| h) | prepare power point presentations | |
| | Content | |
| 3.1.9T1 | Definition of a report | 3.1.9P0 <i>Specific Objectives</i> |
| 3.1.9T2 | Role of reports in an organization | By the end of the sub-module unit, the trainee should be able to: |
| 3.1.9T3 | Types of reports | a) prepare different types of reports b) edit and disseminate reports c) present a report through power point slides |
| i) | Oral | |
| ii) | Written | |
| iii) | Management reports | Content |
| iv) | Operations procedures | 3.1.9P1 Preparation of different types of reports |
| v) | Production schedules | 3.1.9P2 Editing and dissemination of reports |
| | | 3.1.9P3 Presenting a report |
| | Competence | |
| | The trainee should have the ability to: | |
| i) | Prepare effective reports | |
| ii) | Adapt reports to various audiences | |

- iii) Apply I.C.T. in report writing, editing and dissemination
- iv) Present reports using power point presentations
- v) Select appropriate referencing styles in engineering

3.1.10 CONDUCTING MEETINGS AND MINUTE WRITING

Theory

3.1.10T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) define the terms meetings and minutes
- b) explain the role of meetings and minutes in an organization
- c) identify types of meetings
- d) discuss how to plan and conduct meetings
- e) highlight the challenges faced in the conduct of meetings and minute writing
- f) discuss the advantages and disadvantages of meetings

Content

3.1.10T1 Definition of the terms meetings and minutes

3.1.10T2 Role of meetings and minutes in an organization

3.1.10T3 Types of meetings

3.1.10T4 Planning and conducting Meetings

3.1.10T5 Challenges in conduct of meetings and minute writing

3.1.10T6 Advantages and disadvantages of meetings

Practice

3.1.10P0 Specific Objective

By the end of the sub-module unit, the trainee should be able to write minutes correctly

Content

3.1.10P1 Writing minutes

3.1.10C Competence

The trainee should have the ability to: Plan and conduct meetings Write minutes effectively

3.1.11 INTERVIEWS

Theory

3.1.11T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) explain the meaning of the term ‘interview’
- b) explain the purpose of interviews in an organization
- c) discuss the various types of interviews
- d) explain how to prepare for an interview
- e) explain the skills for interviewing
- f) interviewing

Content

3.1.11T1 Meaning of the term ‘interview’

3.1.11T2 Purpose of an interviews in an organization

3.1.11T3 Types of interviews

3.1.11T4 Preparation for an interview

- i) Dressing and grooming
- ii) Role of interviewer

- 3.1.11T5 Interviewing skills
- i) Briefing skills
 - ii) Conducting the interview
 - iii) Debriefing skills
- c) explain the role of public relations and customer care in an organization
- d) explain interpersonal and public relations skills
- e) define quality management
- f) explain the skills in customer care
- g) explain the challenges faced in public relations and customer care

Practice

3.1.11P0 Specific Objective

By the end of the sub-module unit, the trainee should be able to role play as an interviewer and as an interviewee

Content

3.1.11P1 Role playing the interviewer and interviewee

3.1.11C Competence

The trainee should have the ability to:

- i) Conduct interviews
- ii) Prepare for an interview as an interviewee
- iii) Prepare for an interview as an interviewer

3.1.12 PUBLIC RELATIONS AND CUSTOMER CARE

Theory

3.1.12T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) define the terms public, customer and public relations
- b) name different types of customers

- 3.1.12T1 Definition of the terms public, customer and public relations
- 3.1.12T2 Types of customers
- 3.1.12T3 Role of public relations and customer care in an organization
- 3.1.12T4 Interpersonal and public relations skills
- 3.1.12T5 Quality management
- 3.1.12T6 Customer care skills
- 3.1.12T7 Challenges faced in public relations and customer care

Practice

3.1.12P0 Specific Objective

By the end of the sub-module unit, the trainee should be able to apply public relation skills in dealing with the various people

Content

3.1.12P1 Application of public relation skills

3.1.12C Competence

The trainee should have the ability to:

- i) Demonstrate proper public relations

- ii) Interact with different types of people
- iii) Care for customers appropriately

3.1.13 EMERGING ISSUES IN COMMUNICATION

Theory

3.1.13T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) state emerging trends and issues in communication
- b) outline challenges posed by emerging issues
- c) explain ways of coping with emerging trends and issues in
- d) communication

Content

3.1.13T1 Emerging trends and issues in communication

3.1.13T2 Challenges posed by emerging trends and issues

3.1.13T3 Ways of coping with the emerging trends and issues

3.1.13C Competence

The trainee should have the Ability to cope with emerging trends and issues

Suggested Teaching/Learning Activities

- i) Group work/presentations
- ii) Debating
- iii) Observations
- iv) Listening to lecturers/resource persons
- v) Drama/role playing
- vi) Excursions

Suggested Teaching/Learning Resources

- Boards
- Charts
- Language laboratory
- Machines and equipment
- Power point
- Projectors
- Audio tapes
- Telephone/fax
- E-mail
- Internet
- Lecturers and resource persons
- Library
- Newspapers/magazines/journals

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments

- 4.1.0 LIFE SKILLS**
- 4.1.01 Introduction**
The youth face many challenges due to their physiological, psychological, social and economic circumstances. This makes them a particularly vulnerable group.

This module unit is intended to equip them with knowledge, skills, attitudes and values that empower them to face realities of life. It is hoped that this will enable them to take responsibility for their individual actions.
- At the end of the unit is a list of teaching/learning activities, teaching/learning resources and evaluation methods that may be applied in the implementation of the syllabus unit. The list is not exhaustive and the instructor is encouraged to explore other suitable methods.
- 4.1.02 General Objectives**
By the end of the sub module unit, the trainee should be able to:
- a) Develop an awareness and understanding of every day demands and challenges
 - b) Understand and deal with their health problems, fears and anxieties about growing up, sexuality and relationships
 - c) Enhance self-esteem and assertiveness in their relationships with peers and adults
 - d) Develop an appreciation of females and males as equal partners in society
 - e) Make optimum use of available resources in order to improve the quality of life
 - f) Develop attitudes, values and skills that promote positive responsible and healthy life styles
 - g) Develop an understanding support and a sense of care and responsibility for disadvantaged groups in the community

4.1.03 Module Unit Summary and Time Allocation

Life Skills

| Code | Sub Module Unit | Content | Time Hrs |
|-------|---|--|----------|
| 4.1.1 | Introduction to Life skills | <ul style="list-style-type: none"> • Define the term life skills • Categories • Benefits • Living values and our lives • Relationship between life skills and living values | 2 |
| 4.1.2 | Knowing and Living With Oneself: Self Awareness | <ul style="list-style-type: none"> • Self description • Self assessment • Challenges that hinder the attainment of life goals • Strategies of overcoming challenges • Values associated with self awareness skill | 4 |
| 4.1.3 | Self Esteem | <ul style="list-style-type: none"> • Definition of self esteem • Signs of high and low self esteem in an individual • Signs of low self esteem • Effects of low self esteem • Factors that enhance high and low esteem • Importance of high self esteem • Values associated with high self esteem • How to boost self esteem | 2 |
| 4.1.4 | Stress Management | <ul style="list-style-type: none"> • Definition of emotion • Definition of stress • Causes of stress • Effects of stress • Coping with stress • Forms of positive stress • Values associated to positive stress management | 2 |
| 4.1.5 | Coping With Emotion | <ul style="list-style-type: none"> • Definition of emotion • Good and bad feelings • Causes of good and bad feelings • Meaning of emotional intelligence | 2 |

| | | | |
|--------|---------------------------------|--|---|
| | | <ul style="list-style-type: none"> • Feelings which can lead to risky behaviour • Ways of coping with negative emotions • Values associated with emotional intelligence | |
| 4.1.6 | Empathy | <ul style="list-style-type: none"> • Definition of empathy • Importance • Difference between empathy and sympathy • Situations requiring empathy • Values associated with empathy | 4 |
| 4.1.7 | Assertiveness | <ul style="list-style-type: none"> • Definition of assertiveness • Characteristics of an assertive person • Steps to being assertive • Difference between assertiveness and aggression • Difference between peer pressure and influence • Values associated with assertiveness | 4 |
| 4.1.8 | Negotiation | <ul style="list-style-type: none"> • Definition of negotiation • Importance • Situations that require negotiating • Negotiating techniques • Values associated with negotiations | 4 |
| 4.1.9 | Non-Violent Conflict Resolution | <ul style="list-style-type: none"> • Definition of conflict • Causes of conflict • Consequences • Types of conflict • Ways of dealing with conflict • Skills for conflict management • Institutions that resolve conflict in community • Values related to conflict resolution | 2 |
| 4.1.10 | Effective Decision Making | <ul style="list-style-type: none"> • Situations that require decision making • Challenges facing youth in decision making • Factors influencing decisions | 4 |

| | | | |
|--------|-------------------|---|---|
| | | <p>making</p> <ul style="list-style-type: none"> • Steps to effective decision making • Consequences • Decision making institutions within community • Steps to effective decision making • Values associated with effective decision making | |
| 4.1.11 | Critical Thinking | <ul style="list-style-type: none"> • Meaning of critical thinking • Risky situations • Evaluating ideas or issues objectively • Consequences of making decisions before critical thinking • Values associated with critical thinking | 4 |
| 4.1.12 | Creative Thinking | <ul style="list-style-type: none"> • Definition • Situations that require creative thinking • Importance • Consequences • Associated values | 4 |
| 4.1.13 | Problem Solving | <ul style="list-style-type: none"> • Problem areas • Causes of problems • Tools • Problem solving process • Values necessary for solving problems | 3 |
| 4.1.14 | Leisure | <ul style="list-style-type: none"> • Definition of leisure • Effects of misuse of leisure • Activities for positive leisure • Life skills for positive use of leisure • Values | 3 |
| 4.1.15 | Time Management | <ul style="list-style-type: none"> • Definition • Work schedule • Time management chart • Importance • Time robbers • Values and associated life skills | 2 |
| 4.1.16 | Gender | <ul style="list-style-type: none"> • Definition | 2 |

| | | | |
|--------|--------------------------|---|---|
| | Education | <ul style="list-style-type: none"> • Agents perpetuating gender • Gender stereotyping • Effects of gender • Strategies to eliminate gender discrimination • Associated values | |
| 4.1.17 | Drug and Substance Abuse | <ul style="list-style-type: none"> • Definition of terms • Commonly abused drugs • Causes • Symptoms • Effects • Relationship between drug abuse and HIV and AIDS • Prevention • Management • Life skills and values necessary | 4 |
| 4.1.18 | HIV and Aids | <ul style="list-style-type: none"> • Definition of terms • Transmission • Signs and symptoms • Catalysts • Prevention • Interventions • Misconceptions • Care and support | 3 |
| 4.1.19 | Child Labour | <ul style="list-style-type: none"> • Definition of terms • Difference between child labour and work • Forms of child labour • Factors leading to child labour • Awareness on child labour • Interventions • Appropriate life skills | 4 |
| 4.1.20 | Child Rights | <ul style="list-style-type: none"> • Definition of terms • Types of human needs • UN Conventions • Categories of child rights • Importance of child rights • Responsibilities • Principles in right of child • Life skills and values | 3 |
| 4.1.21 | Relationships | <ul style="list-style-type: none"> • Types of relationships • Developing healthy relationships • Factors that influence healthy | 4 |

| | | | |
|-------------------|--|---|-----------|
| | | <p>relationships</p> <ul style="list-style-type: none"> ● Maintaining healthy relationships ● Influence of relationships on behaviour ● Values associated with relationship ● Life skills | |
| Total Time | | | 66 |

4.1.1 INTRODUCTION TO LIFE SKILLS

Theory

4.1.1T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) define life skills
- b) identify the categories of life skills
- c) explain the benefits of life skills education to the society
- d) identify living values and how they relate to our lives
- e) relate values and life skills

Content

4.1.1T1 Meaning of life skills

4.1.1T2 Categories of life skills

- i) Skills of knowing and living with oneself
- ii) Skills of knowing and living with others
- iii) Skills of making effective decisions

4.1.1T3 Benefits of life skills education to the society in the following sectors

- i) Education
- ii) Social
- iii) Health

4.1.1T4 Living values and our lives

4.1.1T5 Relationship between life skills and living values

4.1.1C Competence

The trainee should have the ability to:

- i) Face the day to day challenges
- ii) Relate well with oneself
- iii) Relate well with others
- iv) Make effective decisions in life
- v) Solve problems

4.1.2 KNOWING AND LIVING ONE SELF: SELF AWARENESS

Theory

4.1.2T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) describe him/herself
- b) identify his/her strengths and weaknesses
- c) explain what he/she likes and does not like about him/herself
- d) explain limitations/challenges that hinder one from attaining one's goals in life
- e) identify ways of overcoming the challenges

Content

4.1.2T1 Who Am I?

4.1.2T2 Physical attributes

4.1.2T3 Personal values, beliefs, goals and ambitions

4.1.2T4 Strengths and weaknesses

4.1.2T5 Challenges that hinder the attainment of life goals

4.1.2T6 Strategies of overcoming challenges

4.1.2T7 Values associated

with the self awareness skill

Practice

4.1.2P0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) describe oneself
- b) demonstrate one's strengths and weaknesses

Content

4.1.2P1 Description of oneself

4.1.2P2 Demonstration of one's strengths and weaknesses

4.1.2C Competence

The trainee should have the ability to:

- i) Identify one's strengths and weaknesses
- ii) Identify one's talents
- iii) Set realistic goals

4.1.3 SELF ESTEEM

Theory

4.1.3T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) identify signs of high and low self esteem in an individual
- b) explain factors that enhance high and low self esteem
- c) state the importance of having high self esteem
- d) describe the effects of low self esteem

- f) identify values associated with high self esteem
- g) suggest ways of boosting self esteem

Content

4.1.3T1 Signs of high self esteem

- i) Self confidence
- ii) Self discipline
- iii) Relating well with others
- iv) Self care

4.1.3T2 Signs of low esteem

- i) isolation
- ii) self doubt
- iii) self neglect
- iv) vulnerability
- v) aggressiveness
- vi) low performance of tasks

4.1.3T3 Factors that enhance high self esteem

- i) good health habits
- ii) goal setting
- iii) good grooming

4.1.3T4 Importance of high self esteem

4.1.3T5 Effects of low self esteem

- i) unhappiness
- ii) vulnerability to HIV infection
- iii) drug abuse
- iv) physical and emotional abuse

4.1.3T6 Values associated with high self esteem humility self respect happiness

4.1.3T7 How to boost self-esteem Praise/acknowledging effort

Practice

4.1.3P0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) express one's feelings of self hate and self acceptance
- b) demonstrate self pride and confidence

Content

- 4.1.3P1 Expressing one's feelings of self hate and self acceptance
- 4.1.3P2 Demonstrating self pride and confidence

4.1.3C Competence

The trainee should have the ability to:

- i) Have a feeling of self worth
- ii) Relate well with others
- iii) Be confident
- iv) Have positive self
- v) pride
- vi) Feel good about oneself

4.1.4 COPING WITH STRESS

Theory

4.1.4T Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) define the term 'emotion'
- b) define stress
- c) describe situations that lead to stress
- d) discuss effects of stress
- e) suggest ways of coping with stress
- f) identify forms of positive stress

- g) give values associated to positive stress management

Content

- 4.1.4T1 Meaning of stress
- 4.1.4T2 Causes of stress
 - i) growth and development (biological, physical and mental)
 - ii) peer pressure
 - iii) communication within families
 - iv) need to belong
 - v) lack of positive time management
 - vi) Displacement
 - vii) Conflicts
- 4.1.4T3 Effects of stress
 - i) displacement
 - ii) aggression
 - iii) social maladjustment
 - iv) drug and substance abuse
 - v) immorality
 - vi) diseases such as HIV and Aids
 - vii) Post traumatic stress disorders
- 4.1.4T4 Coping with stress
 - i) organize work in order of priority/work within possible working schedules
 - ii) take a break/relax/exercise
 - iii) share feelings with others
 - iv) Forms of positive stress
- 4.1.4T5 Values associated to positive stress management
 - i) peace
 - ii) tolerance
 - iii) co-operation

- iv) unity
- 4.1.4T6 Avoid stressors
- 4.1.4T7 Cope / manage stress
- 4.1.4T8 Apply values to manage stress
- e) discuss feelings which can lead to risky behaviour
- f) suggest ways of coping with emotions
- g) state values associated with emotional intelligence

Practice

4.1.4P0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) Identify stressors
- b) Demonstrate ways of stress management

Content

- 4.1.4P1 identifying stressors
- 4.1.4P2 demonstrating ways of stress management

4.1.4C Competence

The trainee should have the ability to:

- i) Identify stressors
- ii) Avoid stressors
- iii) Manage stress

4.1.5 COPING WITH EMOTIONS

Theory

4.1.5T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) define the term ‘emotion’
- b) identify good and bad feelings
- c) explain causes of each feeling
- d) explain the meaning of emotional intelligence

- 4.1.5T1 *Content*
Meaning of the term ‘emotion’
- 4.1.5T2 Good and bad feelings
- 4.1.5T3 Causes of good/bad feelings
- 4.1.5T4 Feelings which can lead to risky behaviour
 - i) Bitterness
 - ii) Sadness
 - iii) Excitement
 - iv) Hurt
- 4.1.5T5 Meaning of emotional intelligence
- 4.1.5T6 How to control negative emotions
 - i) Talk to somebody
 - ii) Take a break/sleep/rest/walk
 - iii) Do exercises
- 4.1.5T7 Values associated with emotional intelligence
 - i) Peace
 - ii) Humility
 - iii) Tolerance
 - iv) Respect

Practice

- 4.1.5P0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
 - a) express different kinds of emotions

- b) demonstrate emotional intelligence

Content

- 4.1.5P0 different kinds of emotions
- 4.1.5P0 emotional intelligence

4.1.5C Competence

- The trainee should have the ability to:
- i) be calm
 - ii) be patient
 - iii) take time before acting

4.1.6 EMPATHY

Theory

4.1.6T Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) define empathy
- b) explain the importance of empathizing
- c) explain the difference between empathy and sympathy
- d) identify situations that require empathy
- e) identify values associated with empathy

Content

- 4.1.6T1 Definition of empathy
- 4.1.6T2 Importance of empathising Examples of times of empathizing
 - i) Death
 - ii) HIV/aids infected or affected
 - iii) Joblessness
 - iv) Sickness
- 4.1.6T3 Difference between

- empathy and sympathy
- 4.1.6T4 Values associated with empathy
- i) Responsibility
 - ii) Respect
 - iii) Love
 - iv) Kindness
 - v) Co-operation
 - vi) Tolerance

Practice

4.1.6P0 Specific Objective

By the end of the sub-module unit, the trainee should be able to:

- i) demonstrate pathetic situations
- ii) differentiate empathy from empathy
- iii) demonstrate ways to show empathy

Content

- 4.1.6P1 Pathetic situations
- 4.1.6P2 Empathy form empathy
- 4.1.6P3 Ways to show empathy

4.1.6C Competence

The trainee should have the ability:

- i) Empathize with people in need
- ii) Demonstrate positive values in situations that require empathy

4.1.7 ASSERTIVENESS

Theory

4.1.7T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) define assertiveness

| | |
|--|---|
| b) identify characteristics of assertive behaviour | assertiveness, passiveness and aggression |
| c) describe steps to being assertive | |
| d) explain the importance of being assertive | |
| e) differentiate being assertiveness from being aggressive and passive | |
| f) explain the difference between peer pressure and peer influence | |
| g) apply values associated with assertiveness | |

Content

- 4.1.7T1 Meaning of assertiveness
- 4.1.7T2 Identify characteristics of an assertive person
- 4.1.7T3 Steps to being assertive
- 4.1.7T4 Importance of being assertive achieving ones goals
Avoiding getting into trouble
- 4.1.7T5 Differentiate between aggressiveness and passiveness
- 4.1.7T6 Differentiate peer pressure from peer influence
- 4.1.7T7 Values associated with assertiveness
 - i) honesty
 - ii) love
 - iii) cooperation
 - iv) simplicity

Practice

- 4.1.7P0 *Specific Objective*
By the end of the sub-module unit, the trainee should be able to illustrate

Content

Illustrating assertiveness, passiveness and aggression

Competence

The trainee should have the ability to:

- v) Be firm without being influenced by others
- vi) Be positively principled
- vii) Say no to negative influence or yes to positive behaviour

4.1.8 NEGOTIATION

Theory

4.1.8T0 *Specific Objectives*

By the end of the sub-module unit, the trainee should be able to:

- a) define the term negotiation
- b) explain the importance of negotiation
- c) identify situations that require negotiation
- d) discuss possible negotiating techniques
- e) identify values that are associated with negotiation

Content

- 4.1.8T1 Meaning of negotiation
- 4.1.8T2 Importance of negotiation
- 4.1.8T3 Situations that require negotiations
- 4.1.8T4 Negotiating techniques
- 4.1.8T5 Values related to negotiation

- i) tolerance
- ii) responsibility
- iii) co-operation
- iv) honesty
- v) respect

Practice

4.1.8P0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) demonstrate situations that would require negotiation
- b) apply various negotiation techniques

Content

4.1.8P1 Demonstrate situations that would require negotiation

4.1.8P1 Apply various negotiation techniques

4.1.8C Competence

The trainee should have the ability to:

- a) Get out of difficult situations
- b) Come up with alternatives

4.1.9 NON-VIOLENT CONFLICT RESOLUTION

Theory

4.1.9T0 Specific Objectives

By the end of this module sub-unit the trainee should be able to:

- a) define conflicts
- b) explain causes of conflicts
- c) explain consequences of conflicts

- d) state the different types of conflicts
- e) explain constructive ways of dealing with conflicts
- f) state skills for peaceful conflicts
- g) identify institutions that resolve conflicts in the community
- h) apply values in resolving conflicts

Content

4.1.9T1 Meaning of conflicts

4.1.9T2 Causes of conflicts

4.1.9T3 Consequences of conflicts

4.1.9T4 Types of conflicts (siblings, parents, relatives, Communities or clans)

4.1.9T5 Ways of dealing with conflicts

4.1.9T6 Conflict resolution skills

- i) empathy
- ii) seeking assistance
- iii) respect others
- iv) assertiveness
- v) negotiation

4.1.9T7 Institutions that resolve conflicts in the community

- i) courts
- ii) religious institutions
- iii) committees
- iv) council of elders

4.1.9T8 Values related to conflict resolution

- i) co-operation
- ii) humility
- iii) tolerance
- iv) responsibility

4.1.9T9 Peace as a core value in conflict resolution

Practice

- 4.1.9P0 Specific Objectives**
- By the end of the sub-module unit, the trainee should be able to:
- a) demonstrate conflict situations
 - b) carry out mock peace deals
 - c) illustrate ways of preventing conflicts
- Content*
- 4.1.9P0 Demonstrate conflict situations
 - 4.1.9P0 Carry out mock peace deals
 - 4.1.9P0 Illustrate ways of preventing conflicts
- 4.1.9C Competence**
- The trainee should have the ability to:
- ability to:
- i) Make effective decisions
 - ii) Resolve conflicts peacefully
- 4.1.10 EFFECTIVE DECISION MAKING**
- Theory**
- 4.1.10T0 Specific Objectives**
- By the end of the sub-module unit, the trainee should be able to:
- a) identify situations that require decision making
 - b) state everyday challenges facing the youth that would require effective decision making
 - c) give factors that influence decision making
 - d) discuss the steps to effective decision making
- e) discuss consequences of not making effective decisions
 - f) suggest values associated with effective decision making
- Content*
- 4.1.10T1 Situations that require decision making
 - 4.1.10T1 Challenges facing the youth such as:
 - iii) unplanned pregnancies
 - iv) peer pressure/peer influence
 - v) drug abuse
 - vi) HIV and other Sexually Transmitted Infections
 - vii) orphaned
 - viii) relationships
 - ix) career choices
 - 4.1.10T1 Factors that influence decision making
 - i) experiences
 - ii) uniqueness
 - 4.1.10T1 Consequences of not making effective decisions
 - 4.1.10T1 Decision making institutions within the community
 - i) family
 - ii) schools /colleges
 - iii) courts
 - iv) peer arbitrators
 - v) religious bodies
 - 4.1.10T1 Steps to effective decision making
 - 4.1.10T1 Values associated with effective decision making
 - i) honesty
 - ii) integrity
 - iii) peace
 - iv) kindness
- Practice**

| | |
|---|---|
| <p>4.1.10P0 <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) demonstrate challenges facing the youth b) discuss ways in which youth can make effective decisions in life | <p>4.1.11T1Risky situations what constitutes the risk pleasurable activities without risks</p> <p>4.1.11T1Evaluating ideas/issues Objectively weighing options making rational choices</p> <p>4.1.11T1Consequences of making decisions before thinking critically</p> <p>4.1.11TPossibility of falling victim to:</p> <ul style="list-style-type: none"> i) HIV infection ii) drug and substance abuse iii) unplanned pregnancy iv) early marriage v) physical and psychological abuse <p>4.1.11T1Values associated with critical thinking</p> |
| <p>4.1.10C Competence The trainee should have the ability to:</p> <ul style="list-style-type: none"> i) Make effective decisions ii) Weight options before making decisions | |
| <p>4.1.11 CRITICAL THINKING</p> | <p>Practice</p> |
| <p>Theory</p> <p>4.1.11T0 <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) explain the meaning of critical thinking b) describe risky situations c) discuss possible ways of evaluating ideas or issues objectively d) give the consequences of making decisions before thinking critically e) suggest values associated with critical thinking | <p>4.1.11P0 <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) analyse of risky situations b) demonstrate effective decision making |
| <p>Content</p> <p>4.1.11T1 Meaning of critical thinking</p> | <p>Content</p> <p>4.1.11P1 Analysis of risky situations</p> <p>4.1.11P2 Effective decision making</p> <p>4.1.11C Competence The trainee should have the ability to:</p> <ul style="list-style-type: none"> i) Think fast and analyze situations before acting ii) Anticipate consequences |

4.1.12 CREATIVE THINKING

Theory

4.1.12T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) give the meaning of the term creative thinking
- b) discuss situations that require creative thinking
- c) discuss the importance of being creative
- d) give the consequences of not being creative
- e) state values required in creative thinking

Content

4.1.12T1 Meaning of creative thinking

4.1.12T1 Situations/issues that require creative thinking

4.1.12T1 Importance of being creative

4.1.12T1 Consequences of not being creative

4.1.12T1 Associated values Association values

Practice

4.1.12P0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) think creatively
- b) explore possible options

Content

4.1.12P1 Thinking creatively

4.1.12P2 Exploring possible options

4.1.12C Competence

The trainee should have the ability to: make alternative choices

4.1.13 PROBLEM SOLVING

Theory

4.1.13T0 Specific Objectives

By the end of the sub-unit, the trainee should be able to:

- a) identify problem areas that require solutions
- b) identify causes of problems
- c) identify tools used in problem solving
- d) explain the problem solving process
- e) state values necessary solving problems

Content

4.1.13T1 Problem areas

- i) In school
- ii) At home
- iii) With peers
- iv) In relationships

4.1.13T1 Cause of the problem

4.1.13T1 Problem solving process

4.1.13T1 Tools available for solving problems

4.1.13T1 Problem solving process

- i) Identify alternative choices
- ii) Weighing options Action

4.1.13T1 Values required in the problem solving process

- i) Responsibility
- ii) Honesty
- iii) Kindness
- iv) Love

Practice

4.1.13P0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) Identify and analyzing problems
- b) Participate in a problem solving process

Content

4.1.13P1 Identifying and analyzing problems

4.1.13P2 The problem solving process

4.1.13C Competence

The trainee should have the ability to: effectively solve problems

4.1.14 LEISURE TIME

Theory

4.1.14T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) define leisure and related concepts
- b) explain the effects of wrong use/misuse of leisure time
- c) list activities for positive leisure
- d) identify life skills for positive use of leisure
- e) identify values associated with leisure

Content

4.1.14T1 Meaning of leisure and related concepts

- i) Leisure

- ii) leisure time
- iii) active leisure
- iv) passive leisure

4.1.14T2 Effects of wrong

- i) use/misuse of leisure time
- ii) drug and substance abuse
- iii) HIV and AIDS infection
- iv) STDs
- v) criminal activities

4.1.14T3 Activities for positive leisure

- i) ball games
- ii) athletics
- iii) swimming
- iv) reading
- v) singing

4.1.14T4 Life skills for positive use of leisure time

- i) empathy
- ii) problem solving
- iii) creative thinking
- iv) critical thinking
- v) assertiveness
- vi) negotiation

4.1.14T5 Values associated with

- i) leisure
- ii) freedom
- iii) tolerance
- iv) humility
- v) honesty

Practice

4.1.14P0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) demonstrate every day's activities
- b) identify leisure time
- c) choose leisure time activities

Content

| | | |
|-------------------------------|---|---|
| 4.1.14P1 | Demonstrating every day's activities | vii) rest |
| 4.1.14P2 | Identifying leisure time | 4.1.15T4 Importance of managing time |
| 4.1.14P3 | Leisure time activities | i) focus on priorities ii) sense of direction iii) attain goals iv) reduce/avoid stress v) satisfy others/clients |
| 4.1.14C Competence | The trainee should have the ability to: | |
| | i) Use leisure time positively and constructively | 4.1.15T5 Time robbers |
| | | i) procrastination ii) talking too long iii) lack of priorities iv) day dreaming v) excessive playing vi) Indecisiveness vii) disorganization viii) uncontrolled media influence |
| 4.1.15 TIME MANAGEMENT | | 4.1.15T6 Values associated |
| | Theory | Effective decision making |
| 4.1.15T0 | <i>Specific Objectives</i> | i) honesty simplicity ii) responsibility |
| | By the end of the sub-module unit, the trainee should be able to: | 4.1.15T7 Associated Life Skills |
| a) | define the concepts of time management | i) assertiveness ii) self awareness iii) self esteem iv) communication v) decision making |
| b) | give an analysis of own working schedule | |
| c) | draw a time management chart | |
| d) | explain the importance of managing time | |
| e) | analyze aspects of time robbers | |
| f) | state associated values and life skills | |
| | <i>Content</i> | Practice |
| 4.1.15T1 | Meaning of the concepts 'time management' | 4.1.15P0 <i>Specific Objectives</i> |
| 4.1.15T2 | Work schedule | By the end of the sub-module unit, the trainee should be able to: |
| 4.1.15T3 | Time management chart to include for example | a) identify time robbers b) strategise of time management |
| | i) leisure time ii) working time iii) exercise and games iv) helping the needy v) meal times vi) cleaning time | <i>Content</i> |
| | | 4.1.15P1 Identifying time robbers |
| | | 4.1.15P2 Strategies of time management |

4.1.15C Competence

The trainee should have ability to:

- i) Manage time effectively
- ii) Be organized and focused
- iii) Achieve set goals
- iv) Meet others / clientele's satisfaction

4.1.16 DRUG AND UBSTANCE ABUSE

Theory

4.1.16T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) define drug and substance abuse and drug misuse
- b) identify drugs and substances of abuse
- c) state commonly abused drugs
- d) explain the causes of drug and substance abuse
- e) identify signs and symptoms of drug and substance abuse
- f) explain the effects of drugs and substance abuse
- g) explain the relationship between drug and substance abuse and HIV and aids
- h) explain ways of preventing drug and substance abuse

- i) explain ways of managing drug and substance abuse cases
- j) identify life skills and values necessary in the prevention and management of drug and substance abuse

Content

- 4.1.16T1 Meaning of drug and substance abuse
- 4.1.16T2 Drugs and substances of abuse
- 4.1.16T3 Distinction between drugs and substance abuse and drug misuse
- 4.1.16T4 Causes of drug and substance abuse
- 4.1.16T5 Commonly abused drugs and substances
 - i) Alcohol
 - ii) Tobacco
 - iii) Bhang
 - iv) Miraa
 - v) Glue
- 4.1.16T6 Signs and symptoms of drug and substance abuse
- 4.1.16T7 Effects of drug and substance abuse
- 4.1.16T8 Relationship between drug abuse and HIV and AIDS
- 4.1.16T9 Preventive measures to drug and substance abuse
- 4.1.16T10 Management of drug and substance abuse
 - i) Treatment
 - ii) Rehabilitation
 - iii) Re-integration
- 4.1.16T11 Life skills and values necessary in the prevention of drug and substance abuse
- 4.1.16T12 Life skills
 - i) assertiveness

- ii) Self awareness
 - iii) self esteem
 - iv) communication
 - v) decision making
- 4.1.16T13 Values
- i) Integrity
 - ii) Love
 - iii) Freedom
 - iv) Responsibility

Practice

- 4.1.16P0 *Specific Objectives*
- By the end of the sub-module unit, the trainee should be able to:
- a) identify commonly abuses drugs and their street names.
 - b) apply preventive and management strategies

Content

- 4.1.16P1 Identification of commonly abuses drugs and their street names.
- 4.1.16P2 application of Preventive and management strategies

4.1.16C Competence

The trainee should have the ability to:

- i) Live a drug free life
- ii) Advocate for a drug free society
- iii) Assist in rehabilitating drug and substance abusers
- iv) Be a role model

4.1.17 HIV AND AIDS

Theory

- 4.1.17T0 *Specific Objectives*
- By the end of the sub-module unit, the trainee should be able to:
- c) give the meaning of HIV and AIDS
 - d) state ways through which HIV is transmitted
 - e) describe signs and symptoms of AIDS
 - f) explain ways of preventing HIV infection
 - g) identify life skills and values that help in the prevention of HIV and AIDS
 - h) explain the misconceptions about AIDS
 - i) explain ways of taking care and supporting the affected and infected
 - j) discuss factors that facilitate the spread of HIV and AIDS

Content

- 4.1.17T1 Meaning of HIV and AIDS
- 4.1.17T2 Ways in which HIV is transmitted
- 4.1.17T3 Signs and symptoms of AIDS
- 4.1.17T4 Factors that facilitate the spread of HIV and AIDS
- 4.1.17T5 Myths and misconception about HIV and AIDS
- 4.1.17T6 Ways of preventing spread of HIV and AIDS
- i) life skills education
 - ii) values
 - iii) counseling

| | | |
|-----------------|---|---|
| 4.1.17T7 | Care and support of the infected and affected | 4.1.18T0 <i>Specific objectives</i> By the end of the sub-module unit, the trainee should be able to: |
| Practice | | |
| 4.1.17P0 | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: | a) define terms relating to child labour b) explain the difference between child labour and child work c) identify forms of child labour d) analyze factors that lead children to labour e) examine the level of awareness on child labour in the community f) suggest interventions possible to eliminate child labour g) apply appropriate life skills in saying “NO” to child labour |
| <i>Content</i> | | |
| 4.1.17P1 | Identification of HIV transmission mode | 4.1.18T1 Definition of terms i) Child ii) Child labour iii) Child work |
| 4.1.17P2 | Differentiation facts from myths | 4.1.18T2 Difference between child labour and child work |
| 4.1.17P3 | Care and support for HIV and AIDS infected and affected | 4.1.18T3 Identification of forms of child labour i) Herding ii) Selling/peddling drugs iii) Farm hand iv) Hawking v) Transport operators |
| 4.1.17P4 | Building resilience | 4.1.18T4 Analyzing factors leading to child labour i) Poverty ii) Negligence of parents iii) Ignorance of child rights |
| 4.1.17C | Competence The trainee should have the ability to: | |
| | a) Live a HIV free life b) Care for an infected person c) Protect him / herself from infection d) Advocate for HIV and Aids free society e) Be a morally upright person | |
| 4.1.18 | CHILD LABOUR | |
| | Theory | |

| | | |
|----------|---|--|
| 4.1.18T5 | iv) Orphaned Examining community's level of awareness on child labour i) Are they many or few? ii) How many are aware? iii) What are their views in child labour iv) What are their views about children being engaged in work | By the end of the sub- module unit, the trainee should be able to: vii) Identify forms of child labour a) Identify factors promoting worst forms of child labour b) Apply worst forms of child labour intervention strategies |
| 4.1.18T6 | Suggesting possible interventions to eliminate child labour i) Enforcing laws on child rights ii) rents, children, teachers, employers and communities iii) Educating children through curriculum iv) Empowering community leaders and local administration v) Organizing lobby groups at community levels vi) Setting help/ reporting desks at community levels | <i>Content</i> 4.1.18P1 Forms of child labour 4.1.18P2 Factors promoting worst forms of child labour 4.1.18P3 Intervention strategies |
| 4.1.18T7 | Associated life skills include: i) Negotiation ii) Assertive iii) Communication iv) Decision making v) Empathy vi) Practice | 4.1.18C Competence The trainee should have the ability to: i) Differentiate child work from child labour ii) Put appropriate interventions to worst forms of child labour iii) Work responsibly |
| 4.1.18P0 | <i>Specific Objectives</i> | 4.1.19 HUMAN RIGHTS Theory 4.1.19T0 <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: a) define terms b) identify types of needs c) describe UN conventions on rights of the child |

| | | |
|----------|--|--|
| | d) describe the categories of human rights e) explain the responsibilities relating to child rights f) principles in the right of a child g) appreciate the importance of child protection and rights | By the end of the sub-module unit, the trainee should be able to identify human rights/child rights |
| | <i>Content</i> | |
| 4.1.19T0 | Meaning of terms i) Human rights ii) Abuse iii) Neglect iv) Labour v) Needs vi) Ratification | 4.1.19P1 Identifying human rights/child rights |
| 4.1.19T0 | Types of needs i) Physical ii) Psychological | 4.1.19C Competence The trainee should have the ability to: i) advocate for human rights and protection ii) intervene in case of child abuse or child neglect defend own self in case of abuse |
| 4.1.19T0 | UN conventions on the rights of the child | 4.1.20 RELATIONSHIPS |
| 4.1.19T0 | Categories of child rights | Theory |
| 4.1.19T0 | Importance of child rights and child protection | 4.1.20T0 <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: |
| 4.1.19T0 | Principles of child rights i) Best interests of the child ii) Rights apply to every child without discrimination on basis of gender race, age, ability, religion | a) identify different types of relationships b) explain ways of developing healthy relationships c) state factors that influence the maintenance of healthy relationships d) explain how to maintain a healthy relationship e) explain how relationships influence behaviour f) suggest values associated with relationships g) identify life skills associated with relationships |
| 4.1.19T0 | Life skills and values associated with child rights | <i>Content</i> |
| | Practice | 4.1.20T1 Types of relationships i) Peer/peer ii) Boy/girl; man/woman iii) Siblings relationships |
| 4.1.19P0 | <i>Specific Objectives</i> | |

- iv) Parent/child
 - v) Employee/ employer
 - vi) Client/service provider
 - vii) Husband/wife
- 4.1.20T1 Healthy relationships
- 4.1.20T1 Factors that influence healthy relationships
- i) Personality
 - ii) Generation gap
 - iii) Experiences in life
- 4.1.20T1 Relationship and behaviour
- 4.1.20T1 Maintain healthy relationships like waiting until marriage
- i) Upholding associated values and life skills
 - ii) Self sacrifice
- 4.1.20T1 Life skills associated with relationships
- i) Assertiveness
 - ii) Awareness
 - iii) Communication
 - iv) Negotiation
 - v) Peer resistance
 - vi) Friendship formation
 - vii) Coping with stress
 - viii) Coping with emotions
 - ix) Decision making
- 4.1.20T1 Influence of relationship on behaviour
- i) Negative influence
 - ii) Positive influence
- 4.1.20T1 Values associated with relationships
- i) Love
 - ii) Kindness
 - iii) Understanding
 - iv) Responsibility
 - v) Freedom
 - vi) Tolerance

Practice

4.1.20P0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) types of relationships
- b) strategies to maintain healthy relationships

Content

- 4.1.20P1 Types of relationships
- 4.1.20P2 Strategies to maintain healthy relationships

4.1.20C Competence

The trainee should have the ability to:

- i) Maintain healthy relationship respect each other in relationships.

Suggested teaching/Learning Activities

- i) Discussion
- ii) Illustration
- iii) Demonstration
- ii) Note taking
- iii) Role play

Suggested teaching/Learning Resources

- Text books
- Charts
- External resource persons

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Practical tests

5.1.0 INFORMATION AND COMMUNICATION TECHNOLOGY (ICT)

5.1.01 Introduction

This module unit is intended to equip the trainee with knowledge; skills and attitudes to enable him/her appreciate and apply Information and Communication Technology in the research, design, production and marketing of industrial components. Upon completion of the module unit, trainees will be able to use various computer packages in work places and in their daily life.

At the end of the unit is a list of teaching/learning activities, teaching/learning resources and evaluation methods that may be applied in the implementation of the syllabus unit. The list is not exhaustive and the instructor is encouraged to explore other suitable methods.

5.1.02 General Objectives

At the end of the module unit, the trainee should be able to:

- a) Understand Information Communication Technology Operating Systems
- b) Understand techniques of data processing
- c) Appreciate the role of Information Communication Technology (ICT) in organizations and life in general
- d) Understand the principles of operation of a computer and operating systems
- e) Adapt to emerging trends in Information Communication Technology (ICT)

5.1.03 Module Unit Summary and Time Allocation

Information Communication Technology

| Code | Sub Module Units | Content | Time Hrs |
|-------------|-------------------------|---|-----------------|
| 5.1.1 | Introduction to ICT | <ul style="list-style-type: none">• Concept of ICT• Functions of ICT• History of computers• Classification of computers• Components of a computer | 7 |
| 5.1.2 | Computer Hardware | <ul style="list-style-type: none">• Input devices• Output devices• Central Processing Unit | 6 |

| | | | |
|-------|---------------------------|--|----|
| | | (CPU) • Peripherals • Storage Media | |
| 5.1.3 | Computer Software | • Software concept • Types of software • Functions of computer software | 6 |
| 5.1.4 | Operating System | • Operating systems • Function of operating systems • Operating system commands • Managing disks | 6 |
| 5.1.5 | Data Security and Control | • Definition of data security and privacy • Security threats and control measures • Computer crimes • Detection and protection against computer crimes • Laws governing protection of ICT | 8 |
| 5.1.6 | Word Processing | • Concepts of word processing • Functions of word processing • Document creation and manipulation • Tables creation and manipulation • Mail merging • Apply word processing utilities | 14 |
| 5.1.7 | Spread Sheets | • Meaning of spread sheet • Uses of spread sheets • Preparing worksheet layout • Building worksheet • Manipulating data on worksheet • Data application to cells • Formulae and function • Charts | 12 |
| 5.1.8 | Database | • Meaning of database | 12 |

| | | | |
|-------------------|-----------------------------------|--|-----------|
| | | <ul style="list-style-type: none"> • Database design • Data manipulation • Data sorting and indexing • Data storage • Data retrieval • Data security | |
| 5.1.9 | Networking and Internet | <ul style="list-style-type: none"> • Meaning of networks • Functions of networks • Networks configuration • Meaning and uses of internet • Electronic Mail (e-mail) | 8 |
| 5.1.10 | Desktop Publishing | <ul style="list-style-type: none"> • Functions of • Tools used • Manipulations • Enhancements of typeset work • Printing of documents | 10 |
| 5.1.11 | Presentation Packages | <ul style="list-style-type: none"> • Types of presentation packages • Creating slides • Formatting slides • Running slides • Editing objects • Printing slides and handouts | 6 |
| 5.1.12 | Emerging Trends and Issues in ICT | <ul style="list-style-type: none"> • Emerging trends and issues in Information Communication Technology • Challenges posed by the emerging trends and issues in Information and Communication Technology • Coping with challenges posed by emerging trends and issues in Information and Communication Technology | 4 |
| Total time | | | 99 |

5.1.1 INTRODUCTION TO INFORMATION COMMUNICATION TECHNOLOGY (ICT)

Theory

5.1.1T1 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) describe the concept of ICT
- b) describe the functions of ICT
- c) discuss the history of computers
- d) classify computers
- e) identify components of a computer

Content

5.1.1T1 Concept of ICT

5.1.1T2 Functions of ICT

5.1.1T3 History of computers

5.1.1T4 Classification of computers

- i) super computers
- ii) main frames
- iii) mini computers
- iv) micro computers
- v) desktops
- vi) laptops
- vii) palm top

5.1.1T5 Components of computers

- i) computer hardware
- ii) computer software

Practice

5.1.1P1 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) discuss types of computers
- b) identify components of a

computer

Content

5.1.1P1 Group discussion on types of computers

5.1.1P2 Identification of computer components and parts

5.1.1C Competence

The trainee should have the ability to:

- i) Identify the various types of computers
- ii) Identify parts of a computer
- iii) Connect computer peripherals
- iv) Maintain the computer system

5.1.2 COMPUTER HARDWARE

Theory

5.1.2T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) identify hardware components of a computer
- b) describe input devices
- c) describe output devices
- d) describe central processing unit (CPU)
- e) identify storage media
- f) describe peripherals

Content

5.1.2T1 Computer hardware components

5.1.2T2 Input devices

- i) keyboard
- ii) mouse
- iii) scanner

- iv) bar code reader
 - v) magnetic card input
 - vi) voice input devices
- 5.1.2T3 Output devices**
- i) monitor (visual display unit)
 - ii) printer
 - iii) sound output device
- 5.1.2T4 Central Processing Unit (CPU)**
- i) electronic components of CPU
 - ii) computer bases
- 5.1.2T5 Storage media**
- i) primary (main) memory
 - ii) R.A.M.
 - iii) R.O.M.
 - iv) secondary storage device
 - v) tapes
 - vi) cassettes
 - vii) diskette
 - viii) flash disks
 - ix) optic media
 - x) compact disks (CDs)
 - xi) video Compact disks (VCD)
 - xii) digital Video Disks (DVD)
- 5.1.2T6 Computer peripherals**

Practice

- 5.1.2P0 Specific Objectives**
- By the end of the sub module unit, the trainee should be able to:
- a) identify input and output devices of a computer
 - b) identify storage media of a computer
 - c) start and restart the computer
 - d) demonstrate Competence in keyboard skills

- e) demonstrate Competence in mouse skills

Content

- 5.1.2P1** Identification of input and output devices
- 5.1.2P2** Identification of storage media of a computer
- 5.1.2P3** Starting and restarting the computer
 - i) cold booting
 - ii) warm booting
- 5.1.2P4** Keyboard skills
 - i) functional keys
 - ii) alphanumeric keys
 - iii) special keys
 - iv) cursor movement keys
 - v) numeric keypad
- 5.1.2P5** Mouse skills
 - i) clicking
 - ii) double clicking
 - iii) dragging
 - iv) right clicking
 - v) scrolling

5.1.2C Competence

The trainee should have the ability to:

- i) Identify computer hardware
- ii) Classify memory
- iii) Select computer hardware
- iv) Test hardware
- v) Install hardware
- vi) Maintain hardware

5.1.3 COMPUTER SOFTWARE

Theory

5.1.3T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) explain the concept of software
- b) classify computer software
- c) describe functions of computer software

Content

- 5.1.3T1 Software concept
- 5.1.3T2 Classification of computer software
 - i) system software
 - ii) application software
 - iii) programming language
- 5.1.3T3 Functions of computer software

Practice

5.1.3P0 Specific Objectives

By the end of the sub module unit, the trainee should be able to install basic computer software.

Content

- 5.1.3P1 Installation of basic computer software

5.1.3C Competence

The trainee should have the ability to:

- i) Identify type of computer software
- ii) Select computer software
- iii) Utilize computer system
- iv) Maintain software
- v) Install software
- vi) Launch software
- vii) Upgrade software

5.1.4 OPERATING SYSTEMS

Theory

5.1.4T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) explain how operating systems work
- b) explain how operating systems commands work
- c) explain how to manage disks

Content

- 5.1.4T1 Working of an operating system
 - i) Starting
 - ii) Shutting
 - iii) Customizing
- 5.1.4T2 Operating systems commands
 - i) Directories/folders management
 - ii) Creating
 - iii) Moving and copying
 - iv) Renaming
 - v) Selecting
 - vi) Opening folder
 - vii) File management
 - viii) Creating
 - ix) Moving and copying
 - x) Renaming and deleting
 - xi) Opening and closing
 - xii) Searching
- 5.1.4T3 Managing disks
 - i) Assigning a volume label
 - ii) Checking disk storage state
 - iii) Formatting
 - iv) Copying
 - v) Scanning

Practice

5.1.4P0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) demonstrate Competence in the use of an operating system
- b) apply various operating system commands
- c) manage disks

Content

- 5.1.4P1 Using an operating system
 - i) starting an operating system
 - ii) shutting down an operating system
 - iii) customizing an operating system
- 5.1.4P2 Operating system commands
 - i) Directories/folders management
 - ii) Creating a folders
 - iii) Moving and copying folders
 - iv) Renaming and selecting a folder
 - v) Opening a folder
 - vi) File management
 - vii) Creating a file
 - viii) Moving and copying
 - ix) Renaming and deleting
 - x) Opening and closing a file
 - xi) Searching and sorting files
- 5.1.4P3 Managing disks
 - i) Assigning a volume label
 - ii) Checking disk storage status
 - iii) Formatting a disk
 - iv) Copying a diskette (disk copy)
 - v) Scanning of disks

5.1.4C Competence

The trainee should have the ability to:

- a) Identify an Operating System (OS)
- b) Describe an operating system
- c) Compare an operating systems
- d) Select an operating system
- e) Utilize OS systems
- f) Install OS
- g) Maintain an operating

5.1.5 DATA SECURITY AND CONTROL

Theory

5.1.5T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) define data security and privacy
- b) identify security threats on ICT and possible control measures
- c) identify types of computer crimes
- d) explain how to detect and protect identified computer crimes
- e) discuss laws governing protection of Information and Communication Technology

Content

- 5.1.5 T 1 Definition of data security and privacy
- 5.1.5 T 2 Security threats and control measures
- 5.1.5 T 3 Computer crimes
- 5.1.5 T 4 Detection and protection against computer crimes
- 5.1.5 T 5 Laws governing protection of ICT

Practice

5.1.11T0 Specific Objectives

By the end of this sub-module the trainee should be able to:

- a) identify security threats on ICT and possible control measures
- b) identify types of computer crimes
- c) detect and protect identified computer crimes

Content

5.1.5P 1 Security threats and control measures

5.1.5P 2 Computer crimes

5.1.5P 3 Detection and protection against computer crimes

5.1.6 WORD PROCESSING

Theory

5.1.6T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) explain concepts in word processing
- b) describe the procedure of creating and manipulating documents
- c) explain how to create and manipulate tables
- d) explain mail merging techniques
- e) describe word processing utilities

Content

5.1.6T1 Concepts in word processing
i) File

- ii) Save
- iii) Word wrap
- iv) Delete

5.1.6T2 Document creation and manipulation

- i) Create a document
- ii) Save a document
- iii) Format a document
- iv) Retrieve a document
- v) Delete a document
- vi) Edit a document
- vii) Print a document

5.1.6T3 Tables creation and manipulation

- i) Tables
- ii) Insert rows and columns
- iii) Create cells
- iv) Sizing
- v) Entering texts and formatting
- vi) Borders and shading
- vii) Lines
- viii) Drawing
- ix) Editing
- x) Entering
- xi) Print

5.1.6T4 Mail merge

- i) Create a main document
- ii) Create a data resource document
- iii) Merging process
- iv) Merge the information to a file
- v) Print individualized documents

5.1.6T5 Application of word processing utilities

- i) Search and replace
- ii) Grammar checker
- iii) The sources
- iv) Book marks
- v) Sorting and selecting
- vi) Line sort
- vii) Paragraph sort
- viii) Merge sort
- ix) Table sort

- x) Spell check

Practice

5.1.6P0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- i) start a word processing package
- ii) create a document
- iii) format and style documents
- iv) create multi columned documents
- v) create and edit tables
- vi) apply word processing graphics
- vii) print documents

Content

5.1.6P1 Starting a word processing package

- i) Parts of a word processing window
- ii) Exiting a word processing package

5.1.6P2 Document creation

- i) Creating a new document
- ii) Editing a document
- iii) Saving, closing and opening a document
- iv) Formatting a document

5.1.6P3 Formatting

- i) Character formatting
- ii) Bold
- iii) Italics
- iv) Underline
- v) Fonts (size, style, colour)
- vi) Paragraph formatting
- vii) Alignment
- viii) Indentation
- ix) Spacing
- x) Page breaks
- xi) Bullet and numbering
- xii) Change case

- xiii) Page formatting
- xiv) Page layout
- xv) Page set up
- xvi) Page numbering
- xvii) Headers and footers
- xviii) Foot notes and end notes

5.1.6P4 Creation of multicolumn document

- i) Create columns
- ii) Manipulate columns
- iii) Column width
- iv) Column spacing
- v) Column lines
- vi) Column breaks
- vii) Balancing columns
- xix) Converting columns

5.1.6P5 Creating and editing tables

- i) Ways of creating a table
- ii) Entering data
- iii) Resizing
- iv) Editing tables
- v) Inserting rows and columns
- vi) Merging and splitting cells
- vii) Deleting rows, columns and table
- viii) Enhancing tables
- ix) Borders and shading
- x) Performing calculations

5.1.6P6 Word processing graphics

- i) Inserting pictures
- ii) Drawing objects
- iii) Creating and editing text boxes

5.1.6P7 Printing

- i) Printer set up
- ii) Selecting a printer
- iii) Print settings
- iv) Printer connection
- v) Print options
- vi) Printer status
- vii) Print range

- viii) Multiple pages
- ix) Copies
- x) Print preview
- xi) Display
- xii) One page
- xiii) Full screen
- xiv) Multiple pages
- xv) Magnify
- xvi) Ruler
- xvii) Print
- xviii) Close
- xix) Printing a document

5.1.6C Competence

The trainee should have the ability to:

- i) Create a word document
- ii) Edit a word document
- iii) Format a document
- iv) Print a document
- v) Create:
 - Letter
 - Memo
 - Poster
 - Advert
 - Menu
- vi) Merge documents
- vii) Save / Open a document

5.1.7 SPREAD SHEETS

Theory

5.1.7T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- i) explain the meaning of a spread sheet
- ii) identify areas where spreadsheets are applied
- iii) explain worksheets layout
- iv) explain how to build and save a worksheet

- v) manipulate data in a worksheet
- vi) explain how to apply cell data types
- vii) explain formulae and functions
- viii) explain use of charts

Content

- 5.1.7T1 Meaning of a spreadsheet
- 5.1.7T2 Areas where spreadsheets are applied
- 5.1.7T3 Demonstration of worksheet layouts
 - i) Columns
 - ii) Rows
 - iii) Cells
- 5.1.7T4 Building and saving a worksheet
 - i) Build/enter simple worksheets
 - ii) Save a worksheet file
 - iii) Exit a worksheet file
 - iv) Insert numbers
 - v) Insert text
 - vi) Insert simple formulae
- 5.1.7T5 Data manipulation on worksheet
- 5.1.7T6 Data application to cell
- 5.1.7T7 Formulae and function
- 5.1.7T8 Use charts

Practice

5.1.7P0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) start a spreadsheet package
- b) enter and edit data in a worksheet
- c) edit a worksheet
- d) format a worksheet
- e) apply formulae and functions

- f) apply spreadsheet charts
- g) print worksheet and charts

Content

- 5.1.7P1 Starting a spreadsheet package
 - i) Loading and running a spreadsheet package
 - ii) Parts of spreadsheet window
 - iii) Exiting a spreadsheets package
- 5.1.7P2 Entering and editing data
 - i) Entering numbers, text and formulae
 - ii) Editing data
 - iii) Selecting data in a worksheet
 - iv) Cancelling selected areas
 - v) Copying and moving data
 - vi) Deleting data
- 5.1.7P3 Editing a worksheet
 - i) inserting and deleting rows, columns and worksheets
 - ii) Naming worksheets
 - iii) Adjusting column width and row height
 - iv) Freezing rows and columns
- 5.1.7P4 Formatting a worksheet
 - i) formatting cells and worksheet data
 - ii) copying and deleting formats
 - iii) conditional formatting
- 5.1.7P5 Applying formulae and functions
 - i) Types of formulae
 - ii) Rules of entering formulae
 - iii) Copying and moving of formulae
 - iv) Cell references

- v) Parts and layout of a function
- vi) Entering a function

5.1.7P6 Working with charts

- i) creating charts
- ii) chart types
- iii) modifying/editing charts
- iv) formatting charts

5.1.7P7 Printing

- i) printing a worksheet
- ii) printing a selection

5.1.7C Competence

The trainee should have the ability to:

- i) Create a spreadsheet
- ii) Edit a spreadsheet
- iii) Format a spreadsheet
- iv) Save/open a spreadsheet
- v) Use formula
- vi) Use statistical functions/Analysis
- vii) Use macros in spreadsheet
- viii) Perform calculations
- ix) Print spreadsheet

5.1.8 DATABASE

Theory

5.1.8T0 *Specific Objectives*

By the end of the sub module unit, the trainee should be able to:

- a) explain the meaning of database
- b) describe the database design
- c) explain how to carry out data manipulation
- d) explain how to use various software for data sorting and indexing
- e) explain how to store data appropriately

- f) explain how to retrieve data
- g) discuss how to uphold data security

Content

5.1.8T1 Meaning of database

- i) Data
- ii) Database
- iii) Databank

5.1.8T2 Data base design

- i) Field name
- ii) Field type
- iii) Field width
- iv) Field table

5.1.8T3 Data manipulation

- editing

5.1.8T4 Data sorting

- i) Ascending order
- ii) Descending order
- iii) Selective sorting

5.1.8T5 Data storage

5.1.8T6 Data retrieval

- i) Meaning
- ii) Processes

5.1.8T7 Data security

- i) Threats/hazards
- ii) Data security controls
- iii) Ergonomics

Practice

5.1.8P0 *Specific Objectives*

By the end of the sub module unit, the trainee should be able to:

- a) apply database concepts
- b) design database structure
- c) apply queries
- d) use forms in entering data
- e) apply reporting and labelling
- f) print tables, forms, queries and reports

Content

5.1.8P1 Application of database concepts

- i) Field name
- ii) Records
- iii) Files
- iv) Database

5.1.8P2 Designing a database structure (table)

- i) Field name
- ii) Field type
- iii) Field width
- iv) Data entry
- v) Saving the table in the database
- vi) Editing the table
- vii) Appending records
- viii) Insertion
- ix) Deletion
- x) Altering the table
- xi) Sorting and indexing

5.1.8P3 Application of querying

- i) Single field condition
- ii) Multiple field condition
- iii) Logical operators
- iv) AND
- v) OR
- vi) NOT

5.1.8P4 Application of forms

- i) Form design layout
- ii) Using forms to enter data

5.1.8P5 Application of reporting and labelling

- i) Form design layouts
- ii) Tabular
- iii) Columnar
- iv) Modifying a report

5.1.8P6 Printing

- i) printing tables
- ii) printing queries
- iii) printing forms
- iv) printing reports

5.1.8C Competence

The trainee should have the ability to:

- i) Create a database
- ii) Enter data into a database
- iii) Manipulate in a database
- iv) Create tables, forms, queries and reports

5.1.9 NETWORKING AND INTERNET

Theory

5.1.9T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) explain the meaning of computer networks
- b) explain functions of networks
- c) describe types of networks
- d) explain how to carry out network configuration
- e) describe internet and internet uses
- f) explain the e-mail concept

Content

5.1.9T1 Meaning of computer networks

5.1.9T2 Functions of networks

5.1.9T3 Types of networks

- i) Local Area Network (L.A.N.)
- ii) Metropolitan Area Network (M.A.N.)
- iii) Wide Area Network (W.A.N.)
- iv) others

5.1.9T4 Configuration of networks

- i) tools
- ii) process

5.1.9T5 Internet and internet uses

- i) Internet browsing
 - ii) Searching techniques
- 5.1.9T6 Electronic mail (e-mail)
- i) Email address
 - ii) Creating email messages
 - iii) Sending and reading messages
 - iv) Using the address book
 - v) Organizing email messages

Practice

5.1.9P0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) connect to the internet
- b) browse the internet
- c) apply electronic mail concepts
- d) carryout network configurations

Content

5.1.9P1 Connecting to the internet

- i) Leased line
- ii) Dial up
- iii) Wireless

5.1.9P Browsing the internet

- i) Internet browsers
- ii) Website addresses
- iii) Search engines
- iv) Search techniques

5.1.9P3 Application of electronic mail

- i) E-mail address
- ii) Creating e-mail messages
- iii) Sending and reading messages
- iv) Attaching files to e-mail messages
- v) Using the address book
- vi) Organizing e-mail messages

5.1.9P4 Configurations of network

5.1.9C Competence

The trainee should have the ability to:

- i) Identify network resources
- ii) Share resources over the network
- iii) Identify network types
- iv) Differentiate between internet and www
- v) Identify internet addresses
- vi) Use browsers
- vii) Use search engines
- viii) Surf the net
- ix) Create e-mail accounts and their facilities
- x) Print documents

5.1.10 DESK TOP PUBLISHING

Theory

5.1.10T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) explain how to identify the different icons and tools used in DTP
- b) explain page layout
- c) explain how to open, save and close files
- d) explain how to draw various shapes using DTP
- e) explain application of colour pellets
- f) explain how to insert text from within
- g) explain how to import and export text
- h) explain object linking and embedding

- i) explain how knowledge is applied in design and output scenario

Content

- 5.1.10T1 Identification of various icons used in DTP
 - i) Concepts of desktop publishing
 - ii) Loading a DTP application
- 5.1.10T2 Explanation of page layout (margins, paper sizes, page)
 - i) Formatting
 - ii) Margins
 - iii) Paper size
 - iv) Page formatting
- 5.1.10T3 Starting a new page in DTP, saving the setup, retrieving it and
 - i) Closing files
 - ii) Start a new page
 - iii) Save a page
- 5.1.10T4 Drawing various shapes using DTP
 - i) Moving shapes
 - ii) Resizing shapes
 - iii) Cropping
- 5.1.10T5 Application of the use of colour pellets to enhance a document
 - i) Demonstration of colour pellete
 - ii) Style pellet
 - iii) Control pellete
- 5.1.10T6 How text is inserted from within
 - i) Procedures for insertion
 - ii) Locating the source
 - iii) Identifying the destination
- 5.1.10T7 Importing and exporting text from other sources

| | | |
|----------|---|---|
| | i) Identifying source and destination | 5.1.10P2 Determination of page layout (margins, paper sizes, page formatting) |
| 5.1.10T8 | Explanation of object linking and embedding. | <ul style="list-style-type: none"> i) Object linking ii) Embedding procedures |
| 5.1.10T9 | Knowledge application learned in design and output scenario | <ul style="list-style-type: none"> i) Designing functional items like: ii) Business cards iii) Posters and flyers iv) Wedding cards v) Calendars |

Practice

5.1.10P0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) identify the different icons and tools used in DTP
- b) determine page layout
- c) open, save and close files
- d) draw various shapes using DTP
- e) apply the use of colour pellets
- f) insert text from within
- g) import and export text
- h) link and embed object
- i) apply knowledge in design and output scenario

Content

| | |
|----------|--|
| 5.1.10P1 | Identification of various icons used in DTP |
| | <ul style="list-style-type: none"> i) Concepts of desktop publishing ii) Loading a DTP application |

| | | |
|--|--|--|
| | | 5.1.10P2 Determination of page layout (margins, paper sizes, page formatting) |
| | | <ul style="list-style-type: none"> i) Margins ii) Paper size iii) Page formatting |
| | | 5.1.10P3 Starting a new page in DTP, saving the setup, retrieving it and |
| | | <ul style="list-style-type: none"> i) Closing files ii) Start a new page iii) Save a page |
| | | 5.1.10P4 Drawing various shapes using DTP |
| | | <ul style="list-style-type: none"> i) Moving shapes ii) Resizing shapes iii) Cropping |
| | | 5.1.10P5 Application of the use of colour pellets to enhance a document |
| | | <ul style="list-style-type: none"> i) Demonstration of colour pellet ii) Style pellet iii) Control pellet |
| | | 5.1.10P6 Inserting text from within |
| | | <ul style="list-style-type: none"> i) Procedures for insertion ii) Locating the source iii) Identifying the destination |
| | | 5.1.10P7 Importing and exporting text from other sources |
| | | <ul style="list-style-type: none"> i) Identifying source and destination |
| | | 5.1.10P8 Object linking and embedding. |
| | | <ul style="list-style-type: none"> i) Object linking ii) Embedding procedures |
| | | 5.1.10P9 Application of the knowledge learned in design and output Scenario |
| | | <ul style="list-style-type: none"> i) Designing functional items like: ii) Business cards iii) Posters and flyers |

- iv) Wedding cards
- v) Calendars

5.1.10C Competence

The trainee should have the ability to: use

- Desk Top Publishing tools to produce a document

5.1.11 PRESENTATION PACKAGES

Theory

5.1.11T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) discuss various types of presentation packages
- b) explain how to create slides
- c) explain how to format slides
- d) explain how to run slides
- e) describe how to edit objects
- f) describe how to print slides and handouts

Content

- 5.1.11T1 Types of presentation packages
- 5.1.11T2 Creating slides
- 5.1.11T3 Formatting slides
- 5.1.11T4 Running slides
- 5.1.11T5 Editing objects
- 5.1.11T6 Printing slides and handouts

Practice

5.1.11P0 Specific Objectives

By the end of the module unit the trainee should be able to:

- a) open presentation packages
- b) create slides
- c) format slides
- d) run slides
- e) edit objects
- f) printing slides and handouts

Content

- 5.1.11P1 Opening a presentation package
- 5.1.11P2 Creating slides
- 5.1.11P3 Formatting slides
- 5.1.11P4 Running slides
- 5.1.11P5 Editing objects
- 5.1.11P6 Printing slides and handouts

5.1.11C Competence

The trainee should have the ability to:

- i) Create slides
- ii) Format slides
- iii) Edit slides
- iv) Run the presentation
- v) Print the slide and handout

5.1.12 EMERGING TRENDS AND ISSUES IN INFORMATION COMMUNICATION TECHNOLOGY

Theory

5.1.12T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) explain how to identify emerging trends and issues in Information and Communication Technology
- b) explain the challenges posed by emerging trends and issues in Information and Communication Technology
- c) explain ways of coping with challenges posed by emerging trends and issues in Information and Communication Technology

trends and issues in information and communication technology

Content

5.1.12PT1 Group discussion on the emerging trends and issues in Information and Communication Technology

Suggested teaching/Learning Activities

- Discussion
- Illustration
- Demonstration
- Note taking
- Practical exercise
- Visits to industries
- Project work

5.1.12C Competence

The trainee should have the ability to: cope with emerging issues and technologies related to ICT

Suggested teaching/Learning Resources

- Electrical power supply
- Computers and their peripherals
- Assorted software

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

Practice

5.1.12P0 *Specific Objective*
By the end of the sub module unit the trainee should be able to discuss the emerging

6.1.0 ENTREPRENEURSHIP

6.1.01 Introduction

This module unit is intended to equip the trainee with necessary knowledge; skills and attitudes that will enable him/her start, operate and manage a personal or group business enterprise effectively. It is also intended to instil in a trainee the drive necessary to venture into profit making activities.

6.1.02 General Objectives

At the end of the module unit, the trainee should be able to:

- a) demonstrate positive attitude towards self employment
- b) understand concepts and elements of entrepreneurship development
- c) demonstrate entrepreneurial behaviour in starting, operating and managing a business
- d) prepare a viable business plan

6.1.03 Module Unit Summary And Time Allocation

Entrepreneurship

| Code | Sub Module Unit | Content | Time Hrs |
|-------------|-------------------------------|---|-----------------|
| 6.1.1 | Entrepreneurship | <ul style="list-style-type: none">• Definition of terms• Contribution of entrepreneurship towards national development• Self employment versus salaried employment | 6 |
| 6.1.2 | Evolution of Entrepreneurship | <ul style="list-style-type: none">• History of entrepreneurship in Kenya• Economic, political and social factors affecting entrepreneurial development• Entrepreneurial cultural practices in Kenya, South Africa and India | 6 |
| 6.1.3 | Entrepreneurial Culture | <ul style="list-style-type: none">• The entrepreneurial culture• Cultural factors that promote entrepreneurial development• Cultural factors inhibiting entrepreneurial development• Ways of managing factors | 4 |

| | | | |
|-------|------------------------------------|--|----|
| | | that inhibit development of entrepreneurial culture | |
| 6.1.4 | The Entrepreneur | <ul style="list-style-type: none"> • Myths associated with entrepreneurship • Types of entrepreneurs • Characteristics/traits of an entrepreneur • Roles of an entrepreneur in an enterprise | 4 |
| 6.1.5 | Entrepreneurial Opportunities | <ul style="list-style-type: none"> • Business ideas • Business idea generation • Sources of business ideas • Identification and evaluation of business opportunities • Matching Competence with business opportunities | 6 |
| 6.1.6 | Starting a Small Business | <ul style="list-style-type: none"> • Forms of business ownership • Factors to be considered when starting a small enterprise • Procedure of starting a small enterprise • Business life cycle • Challenges faced when starting a small enterprise • Resources for a business | 6 |
| 6.1.7 | Enterprise Management | <ul style="list-style-type: none"> • Definition of terms • Managing of the enterprise resources • Managing the business finances • Business records • Business support services • Marketing activities in a small enterprise | 8 |
| 6.1.8 | Enterprise Social Responsibilities | <ul style="list-style-type: none"> • Meaning of enterprise social responsibility • Importance of enterprise social responsibility • Social concerns of an enterprise | 4 |
| 6.1.9 | Business Plan | <ul style="list-style-type: none"> • The Business Plan • Components of a Business Plan | 10 |

| | | | |
|-------------------|--|--|-----------|
| 6.1.10 | Information and Communication Technology in Entrepreneurship | <ul style="list-style-type: none"> • Benefits of ICT to a small enterprise • Use of computer applications software in a small business | 10 |
| 6.1.11 | Emerging Trends in Entrepreneurship | <ul style="list-style-type: none"> • Emerging trends in enterprise management • Challenges posed by emerging trends and issues • Management of challenges posed by emerging trends and issues in entrepreneurship | 4 |
| Total time | | | 66 |

| | |
|---|--|
| 6.1.1 INTRODUCTION TO ENTREPRENEURSHIP | 6.1.1 C Competence The trainee should have the ability to: contribute to national development through self employment |
| Theory | |
| 6.1.1T0 Specific Objectives By the end of the sub module unit, the trainees should be able to: a) define various terms used in entrepreneurship b) explain the contribution of entrepreneurship towards national development c) explain the differences between self and salaried employment | 6.1.2 EVOLUTION OF ENTREPRENEURSHIP Theory |
| <i>Content</i> | |
| 6.1.1T1 Definition of terms | 6.1.2T0 <i>Specific Objectives</i> By the end of the sub module unit, the trainee should be able to; a) describe the history of entrepreneurship in Kenya b) explain economic, political and social factors affecting entrepreneurial development c) explain various entrepreneurial cultural practices in Kenya, South Africa and India |
| 6.1.1T2 Contribution of entrepreneurship towards national development | |
| 6.1.1T3 Self employment versus salaried employment | |
| Practice | <i>Content</i> |
| 6.1.1P0 Specific Objective By the end of the sub module unit, the trainees should be able identify the role played by employer and employee | 6.1.2T1 History of entrepreneurship in Kenya 6.1.2T2 Economic, political and social factors affecting entrepreneurial development 6.1.2T3 Entrepreneurial cultural practices in Kenya, South Africa and India |
| <i>Content</i> | |
| 6.1.1P1 Visit a business enterprise in the locality and interview employers/employees and identify their roles | |

Practice

- 6.1.2P0 *Specific Objective*
By the end of the sub module unit, the trainee should be able to identify cultural practices in Kenya, South Africa and India

Content

- 6.1.2P1 Case study on economic, political and social factors affecting entrepreneurial development in Kenya, South Africa and India

6.1.2C Competence

The trainee should have the ability to: handle social factors that hinder entrepreneurial development

6.1.3 ENTREPRENEURIAL CULTURE

Theory

- 6.1.3T0 *Specific Objectives*
By the end of the sub module unit, the trainee should be able to;
- a) explain the concept of culture
 - b) outline cultural habits that enhance entrepreneurial development
 - c) outline cultural factors inhibiting entrepreneurial development
 - d) explain ways of managing factors that inhibit development of entrepreneurial culture in Kenya
 - e) entrepreneurial culture in Kenya

Content

- 6.1.3T1 Entrepreneurial culture
6.1.3T2 Cultural habits that promote entrepreneurial development
6.1.3T3 Cultural factors inhibiting entrepreneurial development
6.1.3T4 Ways of managing factors that inhibit development of entrepreneurial culture in Kenya

Practice

- 6.1.3P0 *Specific Objective*
By the end of the sub module unit, the trainee should be able to identify the cultural habits which promote or inhibit entrepreneurial development

Content

- 6.1.3P1 Visit a successful entrepreneur in the locality and collect information on cultural habits that inhibit or promote entrepreneurial development

6.1.3C Competence

The trainee should have the ability to: deal with cultural biases that hinder entrepreneurial development

6.1.4 THE ENTREPRENUER

Theory

6.1.4T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) explain the myths associated with entrepreneurship
- b) describe types of entrepreneurs
- c) state the characteristics/traits of an entrepreneur
- d) explain the roles of an entrepreneur in an enterprise

Content

6.1.4T1 Myths associated with entrepreneurship

6.1.4T2 Types of entrepreneurs

6.1.4T3 Characteristics/traits of an entrepreneur

6.1.4T4 Role of an entrepreneur in an enterprise

Practice

6.1.4P0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) assess his or her entrepreneurial potential
- b) write a profile on a successful entrepreneur in the locality

Content

6.1.4P1 Trainees to do self-assessment exercise on their entrepreneurial potential

6.1.4P2 Visit a successful

entrepreneur within the locality and write a profile on him.

6.1.4C Competence

The trainee should have the ability to: identify entrepreneurial potential in self

6.1.5 ENTREPRENEURIAL OPPORTUNITIES

Theory

6.1.5T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) define a business idea
- b) explain ways of generating business ideas
- c) explain the various sources of business ideas
- d) outline and evaluate business opportunities
- e) explain ways of matching entrepreneurial competencies with
- f) business

Content

6.1.5T1 Business idea

6.1.5T2 Generation of business ideas

6.1.5T3 Sources of business ideas

6.1.5T4 Identification and evaluation of Business opportunities

6.1.5T5 Ways of matching entrepreneurial competencies and matching with business opportunities

Practice

- 6.1.5P0 Specific Objectives**
By the end of the sub module unit, the trainee should be able to:
- a) generate business ideas
 - b) evaluate business opportunities

Content

- 6.1.5P1 Brainstorming on business ideas
- 6.1.5P2 Business opportunity evaluation

6.1.5C Competence

The trainee should have the ability to: identify and evaluate a business opportunity

6.1.6 STARTING A SMALL BUSINESS

Theory

- 6.1.6T0 Specific Objectives**
By the end of the sub module unit, the trainee should be able to:
- a) explain the different forms of business ownership
 - b) explain the factors to be considered when starting a small enterprise
 - c) explain the procedure of starting a small enterprise
 - d) explain the business life cycle
 - e) outline challenges that are faced when starting a small enterprise
 - f) state business resources

Content

- 6.1.6T1 Forms of business ownership
- 6.1.6T2 Factors to be considered when starting a small enterprise
- 6.1.6T3 Procedure of starting a small enterprise
- 6.1.6T4 Business life cycle
- 6.1.6T5 Challenges faced when starting a small enterprise
- 6.1.6T6 Business Resources

Practice

- 6.1.6P0 Specific Objective**
By the end of the sub module unit, the trainee should be able to illustrate a business life cycle, using a diagram

Content

- 6.1.6P1 Illustration of a business life cycle

6.1.6C Competence

The trainee should have the ability to: set up a small enterprise

6.1.7 ENTERPRISE MANAGEMENT

Theory

- 6.1.7T0 Specific Objectives**
By the end of the sub module unit, the trainee should be able to:
- a) define enterprise management

- b) explain ways by which various resources in an enterprise should be managed
- c) managed
- d) outline ways of managing business finances
- e) describe business records
- f) state business support services
- g) explain relevant marketing activities in a small enterprise

Content

- 6.1.7T1 Definition of terms
- 6.1.7T2 Managing of the enterprise resources
- 6.1.7T3 Managing the business finances
- 6.1.7T4 Business records
- 6.1.7T5 Business support services
- 6.1.7T6 Marketing activities in a small enterprise

Practice

6.1.7P0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) use various resources to manage a business
- b) keep business records

Content

- 6.1.7P1 Assist a business enterprise in locality to manage business resources
- 6.1.7P2 Management of business records

6.1.7C Competence

The trainee should have the ability to: properly manage a small business enterprise

6.1.8 ENTERPRISE SOCIAL RESPONSIBILITIES

Theory

6.1.8T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) explain the meaning of enterprise social responsibility
- b) explain the importance of enterprise social responsibility
- c) outline the social concerns of an enterprise

Content

- 6.1.8T1 Meaning of enterprise social responsibility
- 6.1.8T2 Importance of enterprise social responsibility
- 6.1.8T3 Social concerns of an enterprise

Practice

6.1.8P0 Specific Objective

By the end of the sub module unit, the trainee should be able to undertake a relevant community social activity

Content

- 6.1.8P1 Participate in a community social activity within the locality

6.1.8C Competence

The trainee should have the ability to: integrate business enterprise with the society

6.1.9 BUSINESS PLAN

Theory

6.1.9T0 *Specific Objectives*

- By the end of the sub module unit, the trainee should be able to:
- a) explain a business plan
 - b) state the components of a business plan

Content

6.1.9T1 Business plan

6.1.9T2 Components of a business plan

Practice

6.1.9P0 *Specific Objectives*

- By the end of the sub module unit, the trainee should be able to:
- a) collect relevant data to enable him/her write a business plan
 - b) write a business plan

Content

6.1.9P1 Trainee to go out and collect data relevant to his/her business plan area

6.1.9T2 Writing business plan

6.1.9C Competence

The trainee should have the ability to: write a plan for a business

6.1.10 INFORMATION AND COMMUNICATION TECHNOLOGY IN ENTREPRENEURSHIP

Theory

6.1.10T0 *Specific Objectives*

- By the end of the sub module unit, the trainee should be able to:
- a) explain the benefits of ICT to a small enterprise
 - b) describe the use of computer application software in a small business

Content

6.1.10T1 Benefits of ICT to a small business enterprise

6.1.10T2 Use of a computer application in a small business enterprise

Practice

6.1.10P0 *Specific Objective*

- By the end of the sub module unit, the trainee should be able to identify benefits of ICT in a small business enterprise

Content

6.1.10P1 Visit a small business enterprise with ICT and identify benefits of ICT

6.1.10C Competence

The trainee should have the ability to: use ICT in a business enterprise

6.1.11 EMERGING TRENDS IN ENTREPRENEURSHIP

Theory

6.1.11T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) state the emerging trends in entrepreneurship
- b) explain the challenges posed by the emerging trends and issues in entrepreneurship
- c) outline ways of managing challenges posed by emerging trends and issues in entrepreneurship

Content

6.1.11T1 Emerging trends in enterprise management

6.1.11T2 Challenges posed by emerging trends and issues

6.1.11T3 Management of challenges posed by emerging trends and issues in entrepreneurship

Suggested Learning Activities

- i) Discussions
- ii) Visits to existing businesses and customers, Chamber of Commerce, trade fairs and exhibitions
- iii) Preparation of business records
- iv) Brainstorming on types of technologies used
- v) Personal interviews
- vi) Case studies
- vii) Simulation
- ix) Field visits

Suggested Learning Resources

- i) Television and radios
- ii) Manuals, newspapers and business journals
- iii) Guest speaker

Suggested Methods Assessment

- i) Question and answer
- ii) Presentation
- iii) Field report
- iv) Continuous Assessment Test (CAT)
- v) Written examination

7.1.0 ENGINEERING MATHEMATICS I

7.1.01 INTRODUCTION

This module unit is designed to equip the trainee with the knowledge, skills and attitudes to apply Mathematical skills in their trade area.

The trainee is expected to use Advanced Mathematical tables and a non-programmable scientific calculator.

7.1.02 GENERAL OBJECTIVES

At the end of this module unit, the trainee should be able to:

- a) understand mathematical concepts relevant to electrical engineering
- b) apply mathematical concepts in design work and problem solving in electrical engineering
- c) enhance his understanding of analytical concepts in the trade and in life

7.1.03 MODULE UNIT SUMMARY AND TIME ALLOCATION

ENGINEERING MATHEMATICS I

| Code | Sub-Module Unit | Content | Time Hrs |
|-------------|------------------------|--|-----------------|
| 7.1.1 | Indices and Logarithms | <ul style="list-style-type: none">• Indices• Logarithms | 4 |
| 7.1.2 | Algebra | <ul style="list-style-type: none">• Simultaneous Equations• Quadratic Equations | 4 |
| 7.1.3 | Trigonometry | <ul style="list-style-type: none">• Trigonometric ratios• Factor formulae• Solution of triangles• Trigonometric Equations | 8 |
| 7.1.4 | Hyperbolic functions | <ul style="list-style-type: none">• Hyperbolic function | 4 |
| 7.1.5 | Inverse function | <ul style="list-style-type: none">• Inverse functions | 6 |
| 7.1.6 | Complex Numbers | <ul style="list-style-type: none">• Introduction• Argand Diagram• Operations of Complex Numbers• De Moivre's theorem | 6 |

| | | | |
|-------------------|-------------------------------|---|-----------|
| 7.1.7 | Coordinate Geometry | <ul style="list-style-type: none"> • Polar equations • Cartesian equation • Graphs of polar equations • Normals and tangents | 6 |
| 7.1.8 | Permutations and Combinations | <ul style="list-style-type: none"> • Definition of permutation • Definition of combination • The factorial notation • Expressions involving permutations and combinations • Solution of problems involving permutations and combinations | 6 |
| 7.1.9 | Binomial Expansion | <ul style="list-style-type: none"> • Binomial theorem Power series using binomial theorem • Roots of numbers using binomial theorem • Estimation of errors of small changes using binomial theorem | 6 |
| 7.1.10 | Calculus I | <ul style="list-style-type: none"> • Differentiation • Applications of Differentiation | 8 |
| 7.1.11 | Calculus II | <ul style="list-style-type: none"> • Methods of integration • Application of integration | 8 |
| Total Time | | | 66 |

7.1.1 INDICES AND LOGARITHMS

7.1.1T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- define the terms base and index.
- state the laws of indices.
- perform simple operations of indices
- define the term logarithm
- state the laws of logarithms
- change of bases of logarithms
- evaluate given expressions using the laws of logarithms
- apply the laws of logarithms in solving problems.

Content

- 7.1.1T Definition of base and index
 - i) a^n where a is the base and n is the index
- 7.1.1T2 Statement of Laws of indices
 - i) $(am)(an) = am+n$
 - ii) $\frac{a^m}{a^n} = am-n$
 - iii) $(am)n = amn$
 - iv) a^0
- 7.1.1T3 Operation of indices 1
- 7.1.1T4 Definition of logarithms
 - i) $\log_a P = x$
 - ii) $P = ax$
 - iii) $\ln M = r$
 - iv) $m = er$
- 7.1.1T5 Laws of logarithms

i) $\log AB = \log A + \log B$

ii)

$$\frac{A}{B}$$

iii) $\log \frac{A}{B} = \log A - \log B$

iv) $\log P^n = n \log P$

v) $\log aa = 1$

vi) $\log a1 = 0$

7.1.1T 6 Change of bases

i) $\log aP = \frac{\log_{10} P}{\log_{10} a}$

7.1.1T7 Evaluation of expression using the laws of logarithms

7.1.1T8 Application of the laws of logarithm in solving problems

- i) Roots
- ii) Powers
- iii) Bases

7.1.1C Competence

The trainee should have the ability to: work with logarithms in solving electrical problem

7.1.2 ALGEBRA

Theory

7.1.2T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- solve linear simultaneous equations in 3-unknowns
- solve quadratic equations

- c) reduce equations to quadratic equations
 - d) solve equations reduced to quadratic equations
 - e) state and use the binomial theorem
 - f) apply binomial theorem to estimate errors of small changes.
 - g) solution of linear simultaneous equations
- double angles and factor formulae
 - b) Solve triangles, trigonometric equations
 - c) Define hyperbolic ratios, chx, shx, thx, cosechx, cothx, sechx and their corresponding functions (odd and even)
 - d) State Osborne's rule and use it to solve hyperbolic equations.

Content

- 7.1.2T1 Reduction of equations to quadratic equations
 7.1.2T2 Quadratic equation

$$3e^{2x} + 7e^x + 3 = 0$$

$$e^x + e^{-x} = 2$$

- 7.1.2T3 Solution of equations reduced to quadratic equations
 7.1.2T4 Statement of the Binomial theorem
 $(1+x)^n = 1 + nC_1x + nC_2x^2 + \dots$
 7.1.2T5 Use the Binomial theorem to derive series of the form $(a+b)^n$ and e^x
 7.1.2T6 Application of Binomial theorem to errors
 7.1.2T7 Solution of linear problems
 - i) Small changes
 - ii) Errors

7.1.3 TRIGONOMETRY

Theory

- 7.1.3T0 *Specific Objectives*
 By the end of the sub module unit, the trainee should be able to:
 a) define trigonometric ratios, compound angles,

Content

- 7.1.3T1 Definition of trigonometric equations
 - i) Compound angles and its derivation
 - ii) Double angle formulae and its derivation
 - iii) Factor formulae and its derivation
- 7.1.3T2 Solve given trigonometric equations
 - i) Solution of trigonometric equations
 - ii) Solution of triangles
- 7.1.3T3 Definition of Hyperbolic ratios
- 7.1.3T4 Osborne's rule
- 7.1.3C **Competence**
 The trainee should have the ability to: use simultaneous equations in solving problems in circuit parameters

7.1.4 HYPERBOLIC FUNCTIONS

Theory

7.1.4T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) define coshx, thx, sechx, cosechx, cothx.
- b) sketch the graphs of chi, shx, sechx, cosechx, and coth.
- c) deduce properties such as chi 0-1, chi is even, shx and thx odd functions.
- d) evaluate hyperbolic functions for given arguments.
- e) verify, simple relationships.
- f) state Osborne's rules
- g) use Osborne's rule to translate trigonometric identities into hyperbolic identities.
- h) solve equations of the form $achx + achx = c$.
- i) derive series expansions for chx and shx.

Content

- 7.1.4T1 Definition of chx, shx, sechx, cosechx, cothx.
- 7.1.4T2 Sketches of chx, sechx, cosechx, cothx.
- 7.1.4T3 Deduction of properties such as $ch x$, chx even and shx and thx odd.
- 7.1.4T4 Evaluation of hyperbolic functions for given arguments ch4, sh3, ch.7s.
- 7.1.4T5 Verification of the relationships

$$ch^2 x - sh^2 x = 1$$

$$shx - chx = e^x$$

7.1.4T6 Statement of Osborne's rules.

7.1.4T7 Use of Osborne's rules

7.1.4T8 Solution of equations of the form

$$a ch x + b chx = c$$

7.1.4T9 Derivation of the series expansion of chx, shx.

7.1.5 INVERSE FUNCTIONS

Theory

7.1.5T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to;

- a) identify a new-to-one function
- b) define a pair of inverse functions where there is one-to-one relationship.
- c) identify simple functions of inverse functions.
- d) define the inverse functions arcchx, arcshx, and arc tahnx.
- e) deduce, the graphs of arcchx, arcshx, and arc tahnx.
- f) describe the many value nature of functions
- g) define the "principal value" of the inverse trigonometric functions.
- h) define the inverse hyperbolic functions.

Content

- 7.1.5T1 Identification of one-to-one functions.
 $(f x) = x, f(x) = x f(x) = x^3$

| | | |
|---------|--|---|
| 7.1.5T2 | Definition of pair of inverse functions where there is a one-to-one relationship $\text{ex-ex} = \frac{1}{2} \ln 1 + x \dots e^x + \text{ex} 1-x$ | g) apply complex numbers to engineering problems. |
| 7.1.5T3 | Identification of simple functions of inverse functions | |
| 7.1.5T4 | Definition of inverse functions $\text{arc cos} x$, arcsinx , $\text{arc tan} x$ | |
| 7.1.5T5 | Deduction of the graphs of d above. $y^2 = x$ (ii) $y^2 + x^2 = 1$ | |
| 7.1.5T6 | Description of the many value nature of functions | |
| 7.1.5T7 | Definition of the Principal value of inverse trigonometric functions. | |
| 7.1.5T8 | Definition of the inverse hyperbolic functions $\text{arc ch} x$, $\text{arc sh} x$, and $\text{arc th} x$ | |

7.1.6 COMPLEX NUMBERS

7.1.6T Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) define a complex number
- b) define the conjugate, argument, modulus of a complex number
- c) state the complex number in its three forms.
- d) represent the complex number on the Argand diagram
- e) perform arithmetic operations on complex numbers
- f) state and apply de Moivre's theorem

Content

| | |
|---------|--|
| 7.1.6T1 | Definition of complex number |
| 7.1.6T2 | Definition of conjugate, argument, modulus of a complex number |
| 7.1.6T3 | Statement of complex number in its three forms: - Cartesian, polar, exponent. |
| 7.1.6T4 | Representation of complex number on the Argand diagram. |
| 7.1.6T5 | Performing of arithmetic operations <ul style="list-style-type: none"> i) Addition and subtraction ii) Multiplication and division |
| 7.1.6T6 | Statement and application of De Moivre's theorem <ul style="list-style-type: none"> i) Roots of numbers ii) Derivation of trigonometric identities |
| 7.1.6T7 | Application of complex numbers to engineering problems <ul style="list-style-type: none"> i) Impedances ii) Forces iii) Loci iv) Zero of functions |

7.1.6C Competence

The trainee should have the ability to: solve engineering problems using complex numbers

7.1.7 COORDINATE GEOMETRY

Theory

7.1.7T0 Specific Objectives

By the end of the sub module unit, unit the trainee should be able to:

- a) Convert polar equations to Cartesian equation
- b) Convert Cartesian equation to polar equations
- c) Plot graphs of polar equations
- d) Determine normals and tangents using coordinate geometry.

Content

- 7.1.7T1 Polar equations
- 7.1.7T2 Cartesian equation
- 7.1.7T3 Graphs of polar equations
- 7.1.7T4 Normals and tangents

7.1.7C Competence

The trainee should have the ability to: work out problems in coordinate geometry.

Suggested Learning Resources

- i) Charts
- ii) Squared grid-board
- iii) Calculators

7.1.8 PERMUTATIONS AND COMBINATIONS

Theory

7.1.8T0 Specific Objectives

By the end of the sub module unit, unit the trainee should be able to:

- a) define the term permutation
- b) define the term combination
- c) express numbers in factorial notation
- d) simplify expressions involving permutations and combinations
- e) solve problems involving permutation and combination.

Content

- 7.1.8T1 Definition of permutation
- 7.1.8T2 Definition of combination
- 7.1.8T3 The factorial notation
- 7.1.8T4 Expressions involving permutations and combinations
- 7.1.8T5 Solution of problems involving permutations and combinations

7.1.8C Competence

The trainee should have the ability to: solve problems in permutations and combinations.

Suggested Learning Resources

- Charts
- Real life situations

7.1.9 BINOMIAL EXPANSION

Theory

7.1.9T0 Specific Objectives

By the end of the sub module unit, unit the trainee should be able to:

- a) state the binomial theorem
- b) apply the binomial theorem in deriving

- c) power series of simple functions
- c) apply binomial theorem to estimate errors of small changes
- d) apply binomial theorem to estimate roots of numbers
- f) apply differentiation
- g) define partial derivatives of a function of two variables
- h) differentiate a function of two variables or more
- i) solve problems involving small changes or errors using partial derivatives
- j) determine stationary points of functions of two variables

Content

- 7.1.9T1 Binomial theorem
- 7.1.9T2 Power series using binomial theorem
- 7.1.9T3 Roots of numbers using binomial theorem
- 7.1.9T4 Estimation of errors of small changes using binomial theorem

7.1.9C Competence

The trainee should have the ability to: apply binomial theorem to estimating errors

Suggested Learning Resources

- Charts

7.1.10 CALCULUS I

Theory

7.1.10T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) define the derivative of function
- b) differentiate a function from the first principles
- c) refer to the table of derivatives of common functions
- d) state and use rules of differentiation
- e) determine higher derivatives

- f) apply differentiation
- g) define partial derivatives of a function of two variables
- h) differentiate a function of two variables or more
- i) solve problems involving small changes or errors using partial derivatives
- j) determine stationary points of functions of two variables

Content

- 7.1.10T1 Definition of the derivative of a function.
- 7.1.10T2 Differentiation from the first principles of common functions
 $\{x^n, \sin x, \cos x, e^x, \ln x\}$

- 7.1.10T3 Reference to tables of derivatives of common functions
- 7.1.10T4 Statement and use of rules of differentiation
 - i) Sum
 - ii) Product
 - iii) Quotient
 - iv) Chain
 - v) Parametric
 - vi) Implicit
- 7.1.10T5 Determination of higher derivatives
- 7.1.10T6 Application of differentiation
 - i) Stationary points
 - ii) Curve sketching
 - iii) Ratios of change
 - iv) Small errors
- 7.1.6T7 Derivative of a function of two variables
- 7.1.6T8 problem solving involving small changes or errors

- 7.1.6T9 Determination of stationary points of functions of two variables
- 7.1.11 **CALCULUS II**
- Theory**
- 7.1.11T0 *Specific Objectives*
- By the end of the sub module unit, the trainee should be able to:
- define integration as the reverse process of differentiation
 - state the two types of integrals
 - refer to table of indefinite integrals of common functions
 - use methods of integration
 - apply integration.

- Content*
- 7.1.11T1 Definition of integration
 - 7.1.11T2 Types of integrals.
 - i) Definite
 - ii) Indefinite
 - 7.1.11T3 Reference of table of integrals of common functions
 - 7.1.11T4 Use of methods of integration
 - i) Substitution

- Polynomials, trigonometric, inverse trigonometric, logarithmic, hyperbolic.
- Reduction formulae
- Partial fractions
- Integration by parts
- Use of complex numbers

- 7.1.11T5 Application of integration
- Area
 - Volume
 - Mean values
 - 1st and 2nd moments
 - Centre of mass
 - Centroids of area and volumes
 - R.M.S value
 - Arc length
 - Time constants
 - R-L-E and R-C-E circuits
 - Energy of inductor and capacitor

Suggested Learning Resources

- Charts
- Mathematical tables
- Calculators

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

8.1.0 PHYSICAL SCIENCE

8.1.01 Introduction

This module unit is designed to equip the trainee with the knowledge, skills and attitudes in physical sciences necessary to enhance the understanding in the trade area.

8.1.02 General Objectives

At the end of this module unit the trainee should able to:-

- a) Understand physical science principles
- b) Apply relevant physical science principles in solving trade problems
- c) Analyze and interpret physical quantity in physical science.

8.1.03 Module Unit Summary and Time Allocation

Physical Science

| Code | Sub-Module Unit | Content | Time Hours |
|-------------|------------------------|---|-------------------|
| 8.1.1 | Nuclear physics | <ul style="list-style-type: none">• Structure of atom• Nature of radiations• Radioactive decay• Detection of radiation• Radio isotopes• Nuclear reactions• X-rays | 12 |
| 8.1.2 | Vibrations | <ul style="list-style-type: none">• Simple harmonic motion (S.H.M)• Damped and forced vibrations | 8 |
| 8.1.3 | Waves | <ul style="list-style-type: none">• Wave phenomenon• Electromagnetic waves• Light waves• Sound waves | 10 |
| 8.1.4 | Heat | <ul style="list-style-type: none">• Thermometry• Calorimetry• Heat transfer• Kinetic Theory of gases• Thermodynamics | 8 |
| 8.1.5 | Inorganic chemistry | <ul style="list-style-type: none">• Periodic classification• Structure and bonding• Acids and bases• Thermo chemistry | 6 |

| | | | |
|-------------------|-------------------|---|-----------|
| | | <ul style="list-style-type: none"> • Electrolysis • Homologous series • Hydro carbons • Compounds | |
| 8.1.6 | Organic chemistry | | 4 |
| Total time | | | 48 |

| | |
|--|---|
| 8.1.1 NUCLEAR PHYSICS | |
| Theory | |
| 8.1.1T0 Specific Objectives | |
| By the end of the sub module unit, the trainee should be able to: | |
| a) describe the structure of nucleus | 8.1.1T5 iv) Geiger Muller counter |
| b) describe the properties and nature of radiation | Description of radio isotopes |
| c) perform simple calculations on law of radioactive decay | i) Applications: medicine, industry, agriculture, dating |
| d) describe method of detection of radiation | ii) Safety and hazards of radiation |
| e) describe radio isotopes and their applications | 8.1.1T6 Descriptions of nuclear reactions |
| f) describe nuclear reactions | i) Nucleus binding energy and binding energy graph |
| g) Explain production and properties of x-rays | ii) Stable and unstable nuclei |
| | iii) Fission chain reactions |
| | iv) Controlled chain reaction |
| | v) The nuclear reactor |
| | vi) Uses |
| <i>Content</i> | 8.1.1T7 Explanation of production and properties of x-rays |
| 8.1.1T1 Description of structure of nucleus | i) Production |
| i) Force in nucleus | ii) Properties |
| ii) Neutron-proton ratios in relation to stability | iii) Applications |
| 8.1.1T2 Description of nature and properties of radiations | iv) Hazards and safety precautions |
| i) Modes of decay | |
| ii) Law of radioactive decay | 8.1.2 VIBRATIONS |
| iii) Half life period | |
| iv) Range of radiation: | Theory |
| 8.1.1T3 Calculations calculation involving law of radioactive decays | |
| 8.1.1T4 Description of method of detection of radiation | 8.1.2T0 Specific Objectives |
| i) Spark counter | By the end of the sub module unit, the trainee should be able to: |
| ii) Scintillation counters | a) describe and perform calculations on simple harmonic motion |
| iii) Photographic films | b) explain and perform calculations on damped and forced vibrations |

| | | |
|----------|--|--|
| | | 8.1.2C Competence The trainee should have the ability to: Handle effects of vibrations in engineering work. |
| | <i>Content</i> | |
| 8.1.2T 1 | Description and calculations on simple harmonic motion (S.H.M) i) Conditions, acceleration, velocity and displacement ii) Energy changes in S.H.M iii) Simple pendulum iv) Extension springs v) Loaded tubes in liquids vi) LC circuit vii) Addition of mutually perpendicular vibrations viii) Simple calculations on S.H.M | 8.1.3 WAVES |
| 8.1.2T | Explanation and calculations on damped and forced vibrations i) Resonance and its importance | Theory |
| | Practice | |
| 8.1.2TP0 | <i>Specific Objectives</i> By the end of the sub module unit, the trainee should be able to: a) perform simple harmonic motion experiments b) demonstrate damped and forced vibrations | 8.1.3T1 Explanation of wave phenomenon i) Plane progressive waves, equations and characteristics ii) Longitudinal and transverse waves iii) Stationery waves nodes and antinodes iv) Relationship between V.F and λ of waves |
| 8.1.2P1 | <i>Content</i> Perform simple harmonic motion | 8.1.3T2 Analysis of electromagnetic waves i) Spectrum ii) Solutions of plane wave equations iii) Energy in travelling waves iv) Wave polarization |
| 8.1.2P2 | Demonstration of damped and forced vibrations | 8.1.3T3 Analysis of light waves i) Superposition of waves |

| | | |
|---------|--|---|
| | <ul style="list-style-type: none"> ii) Refraction and reflection iii) Diffraction iv) Interference v) Polarization of light waves vi) Applications | By the end of the sub module unit, the trainee should be able to: |
| 8.1.3T4 | <ul style="list-style-type: none"> i) Analysis of sound waves i) Propagation and detection ii) Superposition iii) Sound pressure level iv) Effects of media on propagation v) Acoustics vi) Ultrasonics | <ul style="list-style-type: none"> a) define temperature scales b) explain and analyze calorimetry c) explain and analyze heat transfer d) explain and analyze kinetic theory of gases e) explain and analyze thermodynamic behaviour of gases |
| | | |

Practice

| | |
|---------|---|
| 8.1.3P0 | <i>Specific Objectives</i> |
| | By the end of the sub module unit, the trainee should be able to: |
| | <ul style="list-style-type: none"> a) Perform experiments to determine the sound pressure levels b) Demonstrate the effects of media in sound propagation |
| | |

Content

| | |
|---------|--|
| 8.1.3P1 | Determination of sound pressure levels |
| 8.1.3P2 | Propagation of sound through; <ul style="list-style-type: none"> i) Solids ii) Liquids iii) Air |

8.1.4 HEAT

Theory

8.1.4T0 *Specific Objectives*

| | |
|---------|---|
| 8.1.4T1 | <i>Content</i> |
| | Definition of temperature scales |
| | <ul style="list-style-type: none"> i) Absolute scale ii) Celsius scale iii) Fahrenheit scale iv) Kelvin scale v) Types of thermometers |
| 8.1.4T2 | Explanation and analysis of calorimetry |
| | <ul style="list-style-type: none"> i) Definitions ii) Calculations of heat capacity, specific heat capacity, capacity heat gain and loss iii) Methods of determining heat capacity, specific heat capacity and latent heat iv) Molecular terms and reason for change of state v) Applications of heat capacities and latent heat vi) Thermal storage systems vii) Refrigeration viii) Heat exchangers |
| 8.1.4T3 | Explanation and analysis of heat transfers |
| | <ul style="list-style-type: none"> i) Forms of heat transfer |

| | | |
|---------|---|--|
| | <ul style="list-style-type: none"> ii) Thermal conductivity iii) Thermal resistance iv) Newton's laws of cooling v) Black body radiation vi) U.V and IR radiations vii) Interaction between radiation and matter | By the end of the sub module unit, the trainee should be able to: |
| 8.1.4T4 | <p>Explanation and analysis of kinetic Theory of gases</p> <ul style="list-style-type: none"> i) Assumptions ii) The RMS and mean velocity of molecules iii) Derivation of gas laws iv) Boyles law v) Charles' law vi) Pressure law vii) Ideal gas equations viii) Dalton's law of partial pressures ix) Deviation from ideal gas behaviour x) Van-der-Waal's equation xi) Liquefaction of gases | <p>a) perform experiments on heat transfer</p> <p>b) measure temperature</p> |
| 8.1.4T5 | <p>Explanation and analysis of thermodynamics</p> <ul style="list-style-type: none"> i) Thermal behaviour of ideal gasses ii) Adiabatic changes iii) Isothermal changes iv) Isobaric changes v) Isochoric changes vi) Specific heat capacities vii) First law of thermodynamics viii) Relationship between the specific heat capacity at constant pressure | |
| | Practice | |

8.1.4P0 *Specific Objectives*

| | |
|---------|---|
| | <i>Content</i> |
| 8.1.4P1 | Heat transfer methods <ul style="list-style-type: none"> i) Conduction ii) Convection iii) Radiation |
| 8.1.4P2 | Measurement of temperature using mercury and digital thermometers |
| | Competence |
| | The trainee should have the ability to: Apply the study of heat in industrial electric heating |

8.1.5 INORGANIC CHEMISTRY

Theory

| | |
|---------|---|
| 8.1.5T0 | <i>Specific Objectives</i> |
| | By the end of the sub module unit, the trainee should be able to: |
| a) | explain the Mendeleef periodic classification |
| b) | describe the physical and chemical properties |
| c) | analyze acid and bases |
| d) | explain thermo-chemistry and its applications |
| e) | describe electrolysis |

| | |
|---------|---|
| | <i>Content</i> |
| 8.1.5T1 | Explanation of Mendeleef periodic classification -Electrochemical series |

| | | |
|---------|--|--|
| 8.1.5T2 | Description of physical and chemical properties i) Valence and atomic constitution ii) Size of atoms and ions iii) Electron affinity iv) Electro-negativity v) Polarization (Fajon's rule) vi) Types of reactions | perform experiments on Faradays' laws of electrolysis. |
| 8.1.5T3 | Analysis of acids and bases i) Theory of acids and bases ii) Calculation of acid and base equations iii) Principle of ionic equilibrium iv) PH values and Theory of indicators | Content 8.1.5P1 Demonstration of faradays' laws of electrolysis |
| 8.1.5T4 | Explanation of thermo chemistry and its applications i) Enthalpy changes in chemical reactions ii) Law of conservation of energy and Hess's law iii) Types of heat reactions iv) Applications of laws of thermodynamics in calculation of enthalpy changes | Competence The trainee should have the ability to: Apply the law of electrolysis in batteries, corrosion and corrosion control |
| 8.1.5T5 | Description of electrolysis i) Conductance and conductivity ii) Potential series iii) Faraday's laws iv) Application | |

Practice

8.1.5P0 *Specific Objectives*
By the end of the sub module unit, the trainee should be able to

8.1.6 ORGANIC CHEMISTRY

Theory

8.1.6T0 *Specific Objectives*
By the end of the sub module unit, the trainee should be able to:
a) explain bonding in carbon compounds
b) determine molecular weights of carbon compounds
c) identify types of isomerisms
d) identify types of functional groups
e) list systematic names of organic compounds
f) explain chemistry of aliphatic compounds

Content

- 8.1.6T1 Explanation of bonding in carbon compounds
8.1.6T2 Determination of molecular weights
i) Empirical and molecular formula

- ii) Calculation of molecular weights
- 8.1.6T3 Identification of Isomerisms
- 8.1.6T4 Identification of types of functional groups
 - i) Halides
 - ii) Hydroxyl
 - iii) Carboxyl
- 8.1.6T5 List of systematic names of organic compounds
 - i) Saturated compounds
 - ii) Unsaturated compounds
 - iii) Aromatic compounds
- 8.1.6T6 Explanation of Aliphatic compounds
 - i) Sources of hydrocarbons
 - ii) Properties and uses
 - iii) Reactions
 - iv) Resins

8.1.6C Competence

The trainee will have the ability to:

- i) Perform simple harmonic motion experiments
- ii) Perform experiments to determine the sound pressure levels
- iii) Perform experiments on heat transfer
- iv) Measure temperature
- v) Perform experiments on faradays' laws of electrolysis

Suggested Teaching/Learning resources

- i) Text books
- ii) Laboratory instruments
- iii) Overhead projectors

9.1.0 MECHANICAL SCIENCE

9.1.01 Introduction

The module unit is designed to equip the trainee with the knowledge, skills and attitudes necessary for the understanding the mechanical engineering principles that relate to the electrical and electronic engineering trade.

9.1.02 General Objectives

At the end of this module unit, the trainee should be able to:

- a) Understand the concepts in mechanical engineering science.
- b) Apply the relevant mechanical engineering principles in design work and problem solving in the electrical engineering trade and other life experiences
- c) Appreciate safety programmes for mechanical science

9.1.03 Module Unit Summary and Time Allocation

Mechanical Science

| Code | Sub Module Unit | Content | Time Hrs |
|-------|------------------------|--|----------|
| 9.1.1 | Work, Energy and Power | <ul style="list-style-type: none">• Forms of Energy• Energy Conservation• Calculations | 2 |
| 9.1.2 | Statics | <ul style="list-style-type: none">• Resolution of Co-Planar Forces | 6 |
| 9.1.3 | Dynamics | <ul style="list-style-type: none">• Principles of dynamic rotation• Problem solving | 8 |
| 9.1.4 | Strength of materials | <ul style="list-style-type: none">• Stress and Strain• Material tests• Factors affecting choice of materials | 10 |
| 9.1.5 | Governors | <ul style="list-style-type: none">• Types of governors• Functions and Characteristics of governors | 8 |
| 9.1.6 | Power Transmission | <ul style="list-style-type: none">• Coupling and Drives• Motor analyses• Vibrations | 8 |
| 9.1.7 | Fluid mechanics | <ul style="list-style-type: none">• Fluid Pressure• Measurement of fluid pressure | 10 |

| | | | |
|-------------------|----------------------|---|-----------|
| | | <ul style="list-style-type: none"> • Calculations • Applications of the principle of flow | |
| 9.1.8 | Thermodynamics | <ul style="list-style-type: none"> • Terminologies • The principle of thermodynamics • The steam plant | 8 |
| 9.1.9 | Impulse and momentum | <ul style="list-style-type: none"> • The principle of momentum • Principles Impulse | 6 |
| Total time | | | 66 |

9.1.1 WORK, ENERGY AND POWER

Theory

9.1.1T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) describe forms of energy
- b) convert energy from one form to another
- c) carry out calculations on work, energy and power.

Content

9.1.1T1 Description of forms energy

- i) Work
- ii) Energy
- iii) Power
- iv) Energy
- v) conservation

9.1.1T2 Conversion of energy

- i) Kinetic
- ii) Potential

9.1.1T3 Perform calculations on Work, Energy and Power

Practice

9.1.1P0 Specific Objectives

By the end of the sub module unit, the trainee should be able to perform experiments on conversion of energy

Content

9.1.1P1 Conversion of energy

- i) Potential energy
- ii) Kinetic energy

9.1.2 STATICS

Theory

9.1.2T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to verify the principles of resolution of co-planar forces.

Content

9.1.2T Verification of the principles of resolutions of co- planar

- i) Definitions
- ii) Resultant of co-planar forces
- iii) Equilibrium of co-planar forces
- iv) Definitions of moment, couple and torque.

Practice

9.1.2P0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) Verify the principles of resolution and composition of co- planer forces
- b) Determine moments of forces.
- c) Verify equilibrium of forces

Content

9.1.2P1 Verification of the principles of resolution and composition of co-planer forces

- i) Polygon of forces rule
- ii) Triangle of forces rule

- iii) Parallelogram of forces rule
- 9.1.2P2 Determination of moments of force
 - i) Centre of area of a lamina
 - ii) Centre of gravity of an irregular body
 - iii) Reaction at the support for uniform simply supported beams carrying a point load
- 9.1.2P3 Verification of equilibrium of forces

9.1.2C Competence

The trainee should have the ability to: apply the knowledge of work, energy and power in the study of machines

9.1.3 DYNAMICS

Theory

9.1.3T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) explain principles of dynamic of rotation
- b) solve problems in dynamics

Content

9.1.3T1 Principle of dynamic

- i) Angular velocity
- ii) Angular acceleration

9.1.3T2 Problem solving

- i) State equations
- ii) Centripetal/ centrifugal forces

Practice

9.1.3P0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) perform experiment and plot the angular velocity time graphs
- b) demonstrate simple harmonic motion.

Content

9.1.3P1 Plotting angular velocity time graphs

9.1.3P2 Simple harmonic motion

9.1.4 STRENGTH OF MATERIALS

Theory

9.1.4T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) determine stress and strain
- b) explain tests carried out in materials
- c) determine factors affecting choice of materials

Content

9.1.4T1 Stress and Strain

- i) Direct and torsional stress
- ii) Relationship between stress and strain
- iii) Introduction to 3 dimensional stress

9.1.4T2 Material Testing

- i) Destructive & non-destructive stress
- ii) Tensile tests, , tension, impact, hardness, creep, fatigue

- iii) Corrosion & its prevention
- 9.1.4T3 Materials Selection
- i) Ferrous and non-ferrous
 - ii) Sheet strip bar and other sections in common use
 - iii) Heat treatment of metals
 - iv) Selection of materials with reference to their mechanical & physical properties, indicating standard reference

Practice

9.1.4P0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) Verify Hooke's law
- b) perform the tensile test of mild steel to destruction
- c) determine the modulus of rigidity of rubber

Content

- 9.1.4P1 Verification of Hooke's law
Plot Hooke's law curve for an elastic material (force against extension)
- 9.1.4P2 Perform tensile testing of mild steel to destruction
- i) Elastic limit
 - ii) Proportional limit
 - iii) Yield point
 - iv) Tensile strength
 - v) Percentage elongation
 - vi) Percentage reduction in area
 - vii) Ultimate unit
- 9.1.4P3 Determination of the modulus of rigidity of rubber

9.1.5 GOVERNORS

Theory

9.1.5T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) describe types of governors
- b) describe functions and characteristics of governors

Content

- 9.1.5T1 Description of the operations of governors
- 9.1.5T2 Description of the characteristics of governors
- i) Sensitivity
 - ii) Friction
 - iii) Stability

9.1.6 POWER TRANSMISSION

Theory

9.1.6T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) describe types of coupling devices
- b) analyse motor under the action of forces giving linear and angular acceleration
- c) discuss element vibrations and the effect of rotating machines

Content

- 9.1.6T1 Different types of coupling
- i) Clutches, belts, gears
 - ii) Ropes chains

- iii) Fluid and eddy current couplers
 - 9.1.6T2 Motor under the action of forces giving linear and angular acceleration
 - 9.1.6T3 Balancing of rotating systems including several rotors spaced along a shelf
 - 9.1.6T4 Elementary vibrations and the effect of rotating machinery
- 9.1.6C Competence**
- The trainee should have the ability to: apply the knowledge of power transmission in the study of rotating machines

- ii) U-tube manometer
 - iii) Bourdon gauge
- 9.1.7T3 Solve problems involving resultant pressure of liquid on curved surfaces
 - i) Laminar flow
 - ii) Turbulent flow
- 9.1.7T4 Application of flow principles through pipes
 - i) Tapered pipes
 - ii) Inclined pipes
 - iii) The venturimeter
 - iv) Pilot tube
 - v) Small and large orifices

Practice

9.1.7 FLUID MECHANICS

Theory

9.1.7T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) explain the transmission of fluid pressure.
- b) describe methods of measuring atmospheric and fluid pressure.
- c) perform calculation involving resultant pressure of a fluid.
- d) state the applications of the principle of flow

Content

- 9.1.7T1 Transmission of fluid pressure in hydraulic machines
- 9.1.7T2 Explanation of the different methods of measurement of fluid pressure
 - i) Piezo-tube

9.1.7P0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) verify that pressure at any level in fluid is equal in all directions
- b) verify that pressure acts in a direction normal to its containing surfaces
- c) show that pressure due to a column of a liquid depends upon the density of the liquid and the height of the column
- d) verify Archimedes principle
- e) verify the principle of fluid flow

Content

- 9.1.7P1 Verification that pressure at any level in fluid is equal in all directions
- 9.1.7P2 Verification that pressure acts in a direction normal to its containing surfaces

9.1.7P3 Showing that pressure due to a column of a liquid depends upon the density of the liquid and the height of the column

9.1.7T4 Verification of Archimedes principle

- i) Specific gravity of solids
- ii) Specific gravity of liquid

9.1.7T5 Verification of the principle of fluid flow

- i) through an orifice
- ii) through a venturimeter

9.1.8 THERMODYNAMICS

Theory

9.1.8T0 *Specific Objectives*

By the end of this sub-unit, the trainee should able to:

- a) define terms used in the study of thermodynamics
- b) explain principles of thermodynamics
- c) describe the steam plant and its cycle.

Content

9.1.8T1 Terms in thermodynamics

- i) Working and pure substance
- ii) Phase
- iii) Cycle
- iv) Enthalpy and entropy

9.1.8T2 Explanation of principles of thermodynamic

- i) First law of thermodynamic
- ii) Second law of thermodynamic
- iii) Energy flow equation
- iv) Gas process
- v) Isothermal

9.1.8T3 Description of steam plant and its cycle

- i) Component of the steam plant
- ii) Carnot cycle
- iii) Ranking cycle
- iv) Efficiency

9.1.9 IMPULSE AND MOMENTUM

Theory

9.1.9T0 *Specific Objectives*

By the end of the sub module unit, the trainee should be able to:

- a) describe principles of momentum
- b) describe impulse in reference to mechanical science

Content

9.1.9T1 Description of principles of momentum

9.1.9T2 Description of impulse

- i) Collision of two bodies
- ii) Thrust of a jet
- iii) Applications

9.1.9C Competence

The trainee should have the ability to:

- i) Perform experiments on conversion of energy
- ii) Determine moments of forces
- iii) Perform experiment and plot the angular velocity time graphs
- iv) Perform the tensile test of mild steel to destruction

*Suggested Teaching /Learning
Resources*

- Laboratory instruments
- Over head projectors
- Text books

10.1.0 MATERIALS, PROCESSES AND WORKSHOP PRACTICE

10.1.01 Introduction

This module unit is intended to equip the trainee with the necessary knowledge, skills and attitude required to understand the concepts of materials, processes and workshop practice and their application in the field of electrical and electronic engineering

10.1.02 General Objectives

At the end of the module unit, the trainee should be able to:

- a) Observe safety rules and regulations in the workshop
- b) Acquire knowledge of engineering materials and processes
- c) Create awareness of the human aspect of error in handling tools and equipment.
- d) Appreciate quality of finished products

10.1.03 Module Unit Summary and Time Allocation

Materials, Processes and Workshop Practice

| Code | Sub-Module Unit | Content | Time Hrs |
|-------------|-----------------------------------|--|-----------------|
| 10.1.1 | Workshop Safety | <ul style="list-style-type: none">• General workshop safety• Causes of accidents• Industrial safety• Classification of fires• Electrical safety• Workshop layout | 10 |
| 10.1.2 | Materials and Processes | <ul style="list-style-type: none">• Metals, non-metals and alloys• Properties of materials• Extraction processes• Finishes and decorative process• Electrical materials and applications• Metal forming processes | 6 |
| 10.1.3 | Metal Shop Tools and Measurements | <ul style="list-style-type: none">• Term used in measurement• Marking out techniques• Workshop hand tools | 12 |
| 10.1.4 | Joining of Metals | <ul style="list-style-type: none">• Mechanical joining of metals• Thermal joining | 12 |

| | | | |
|-------------------|--|--|-----------|
| 10.1.5 | Workshop Machines and Applications | <ul style="list-style-type: none"> • Workshop machines • Operation of different types • Safety precautions while using various machines | 10 |
| 10.1.6 | Sheet Metal Work | <ul style="list-style-type: none"> • Common sheet metals • Uses of tools • Forming in sheet metal • Edge treatment of joints • Fabrication machines | 16 |
| Total Time | | | 66 |

10.1.1 WORKSHOP SAFETY

Theory

10.1.1T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) explain the safety regulations in the workshop
- b) explain courses of accidents in a workshop
- c) outline legislation regarding industrial safety
- d) explain classification of methods of extinguishing fires
- e) explain electrical safety in the buildings
- f) explain factors considered in workshop layout

Contents

- 10.1.1T1 General workshop safety
- 10.1.1T2 Courses of accidents
- 10.1.1T3 Industrial safety
 - i) Factory's and other places of work Act
 - ii) Special regulations
 - iii) Hazardous areas
- 10.1.1T5 Classification of fires
 - i) Fire fighting procedure
 - ii) Extinguishers
- 10.1.1T6 Electrical safety
 - i) Preventive measures
 - ii) Treatment of electric shock
 - iii) Mouth to mouth
 - iv) Holger Nelson method
- 10.1.1T7 Workshop layout
 - i) Factors

- ii) Location
- iii) Material handling
- iv) Storage
- v) Safety
- vi) Aesthetic
- vii) Plan of workmanship
- viii) Machine layout
- ix) Electrical supply

Practice

10.1.1P0 Specific Objectives

By the end of the sub module-unit, the trainee should able to:

- a) identify sources safety hazards in the workshop
- b) apply appropriate preventive measures against workshop hazards
- c) perform first aid
- d) carry out fire extinguishing drills for various classes of fire

Content

- 10.1.1P1 Identification of safety hazards in the workshop
 - i) Slippery floors
 - ii) Rotating machines
 - iii) Horse play
 - iv) Bare live cables
 - v) Tools handling
 - vi) Defective tools
 - vii) Machines and situations
- 10.1.1P2 Application of appropriate preventive measures
 - i) Clothing
 - ii) Hand tools
 - iii) Machine tools
 - iv) Electrical accidents
 - v) Fires
 - vi) Glare
 - vii) Radiation

- viii) Machine guard
 - ix) Ultra violet light
 - x) Cleanliness
 - xi) First aid
 - xii) Gang ways
- 10.1.1P3 First aid
- i) The need for a first aid kit
 - ii) The content of a first aid kit and
 - iii) Their applications
 - iv) Care for a first aid kit
 - v) Burns
 - vi) Electric shock
 - vii) Cuts and HIV and aids prevention
 - viii) Toxic materials
 - ix) HIV and aids prevention and wound cleaning and dressing
 - x) Assessing the need for a physician
- 10.1.1P4 Fire extinguishing drills

10.1.1C Competence

The trainee should have the ability to:

- Demonstrate the knowledge of safety in work places
- Handle a first aid kit
- Perform first aid
- Identify and sources of accidents and prevent the same

Suggested teaching/Learning Activities

- Discussion
- Illustration
- Demonstration
- Note taking
- Practical exercise

Suggested Learning Resources

- i) Protective clothing
- ii) First aid kit
- iii) First aid specialist (personnel)
- iv) Teachers notes
- v) Fire extinguishers
- vi) Charts on safety
- vii) Resource persons for fire fighting

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests
- Project

10.1.2 MATERIALS AND PROCESSES

Theory

10.1.2T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) distinguish between metals non metals and alloys
- b) explain the properties of engineering materials
- c) explain methods of extraction of different materials
- d) explain finishes and decorative process of materials
- e) explain the properties electrical materials and their applications

| | | |
|----------|---|--|
| | f) explain the various methods of metal forming processes | v) Construction of cables vi) Cable sizes |
| | | 10.1.2T6 Metal forming processes |
| | | i) Forging-folding ii) Foundry work/casting iii) Filing, bending and threading |
| | | Practice |
| | | 10.1.2P0 <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: a) identify ferrous and non ferrous materials b) identify plastics materials c) identify various types of cables |
| | | <i>Content</i> |
| 10.1.2T1 | Metals and non- metals | 10.1.2P1 Ferrous material i) Iron ii) Steel iii) Alloy steel |
| | i) Metals ii) Non metals iii) Alloys iv) Ferrous metal v) Non ferrous metals | 10.1.2P2 Non ferrous materials i) Alluminium ii) Bronze iii) Zinc iv) Copper v) Brass vi) Tin |
| 10.1.2T2 | Properties of materials | 10.1.2P3 Plastic materials i) Polyvinyl chloride (PVC) ii) Rubber iii) Mica iv) Wood v) Porcelain vi) Synthetic materials |
| | i) Ductility ii) Toughness iii) Strength iv) Hardness v) Malleability vi) Corrosion vii) Resistance viii) Heat treatment ix) Conductivity | 10.1.2P4 Cables i) Construction ii) Extrusion iii) Drawing iv) Rolling |
| 10.1.2T3 | Extraction process | |
| | i) Iron ii) Steel iii) Alluminium iv) Copper v) Bronze vi) Plastic materials | |
| 10.1.2T4 | Finishes and decorative process | |
| | i) Picking and cleaning ii) Polishing iii) Electroplating iv) Colouring v) Lacquering vi) Enamelling vii) Etching | |
| 10.1.2T5 | Engineering materials and applications | |
| | i) Conductors and application ii) Insulators and application iii) Semi – conductors and application iv) Properties | |

| | | |
|---|---|---|
| | v) Stranding vi) Insulating and sheathing | 10.1.3T1 Term used in measurement i) Scales – linear and non linear ii) Tolerance iii) Limits iv) Fits |
| 10.1.2C Competence | The trainee should have the ability to: i) Identify various materials used in the engineering field ii) Select various materials for various applications iii) Safety in handling materials in engineering field | 10.1.3T2 Marking out techniques i) Line and measurement ii) Use of rulers iii) Vernier caliper iv) Scribes v) Scribing block vi) Vernier height gauge vii) Centre punch viii) Surface plate ix) Micrometer screw gauge x) Angular measurement |
| | <i>Suggested Learning Resources</i> | 10.1.3T3 Workshop hand tools i) Vices ii) Files iii) Saws iv) Hammer v) Chisels vi) Snips vii) Tap and dues |
| | - Metals – ferrous and non ferrous - Alloys - Plastics - Ceramics - Fibre glass - Synthetic materials - Rubber - Charts - Reference books - Internet | Practice |
| 10.1.3 METAL SHOP TOOLS AND MEASUREMENTS | | 10.1.3P0 <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: a) define terms used in workshop measurement b) explain marking out techniques c) state correct use of workshop tools |
| 10.1.3 Specific Objectives | By the end of the sub-module unit, the trainee should be able to: a) define terms used in workshop measurement b) explain marking out techniques c) state correct use of workshop tools | d) mark and carry out a given practical exercise e) maintain tools |
| | <i>Content</i> | |

| | <i>Content</i> | <i>Theory</i> |
|--|---|--|
| 10.1.3P1 | Ordinary measurement i) Steel rules ii) inside and outside caliper | 10.1.4T1 <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: a) explain various methods of mechanical jointing of metals b) explain various methods of thermal joining of metals |
| 10.1.3P2 | Precision measurement i) Vernier calipers ii) Micrometers iii) Angle measurements if use protectors iv) Precautions in use of measuring | |
| 10.1.3P3 | Marking out tools i) Scriber ii) Divider iii) Centre punch surface plat iv) Angle place v) Vernier height gauge vi) Protector v-block | |
| 10.1.3P4 | Precautions in use of marking tools i) Workshop cutting hand tools ii) Chisels iii) Hacksaw iv) Punches v) Files vi) Precautions in the use of hand tools | 10.1.4T1 Mechanical joining of metals i) Temporary removable joints ii) Screw – types – threads – applications iii) Bolts and nuts iv) Studs and keys v) Riveting vi) Pop riveting vii) Precautions |
| 10.1.3P5 | Maintenance of tools | 10.1.4T2 Thermal joining i) Soldering ii) Soft soldering iii) Hard soldering iv) Brazing v) Oxy-acetylene welding vi) Electric arc welding vii) Necessary pre cautioning |
| 10.1.3C Competence The trainee should have the ability to: | | Practice |
| <ul style="list-style-type: none"> - Use measuring tools correctly - Use various tools safely - Carry out various metal fitting exercises | | 10.1.4P1 <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: a) identify tools and equipment used in various mechanical jointing of metals |
| <i>Suggested Learning Resources</i> | | |
| <ul style="list-style-type: none"> - Work shop tools and equipment | | |
| 10.1.4 JOINING OF METALS | | |

- b) identify tools and equipment used in various thermal joining of metals
- c) join metals using appropriate methods
- iii) Observe quality control and safety
- iv) Carry out a given exercise correctly within a given time
- v) Maintain tools and equipment

Content

- 10.1.4P1 Equipment for Mechanical joining
- i) Fasteners screws, bolts and nuts
 - ii) Self interlocking joints
 - iii) Grooved seam
 - iv) Folding seam
 - v) Paned seam
 - vi) Care of tools and equipment
 - vii) Mechanical riveting
 - viii) Types of rivets
 - ix) Materials
 - x) Size
- 10.1.4P2 Equipment for Thermal joining
- i) Soldering
 - ii) Brazing
 - iii) Arc welding
 - iv) Spot welding
 - v) Seam welding
 - vi) Heat sources
 - vii) Seam welding
 - viii) Filler metal
 - ix) Fluxes
- 10.1.4P3 Metal joining process
- i) Safety
 - ii) Personal
 - iii) Others
 - iv) Tools and equipment

10.1.4C Competence

The trainee should have the ability to:

- i) Select the right tools for the right job
- ii) Use right procedures in metal joining

Suggested Learning Resources

- Soldering iron
- Soldering wire/rod
- Rivet grim and rivets
- Screws nuts and bolts
- Oxy – acetylene gas equipment
- Drilling machine
- Arc welding machine
- Blow lamp
- Films and posters

10.1.5 WORKSHOP MACHINES AND APPLICATIONS

Theory

10.1.5T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) identify various types of workshop machines
- b) explain the operation of various workshop machines
- c) observe necessary safety precautions while using workshop machines

Content

- 10.1.5T1 Types of Workshop machines
- i) Drilling machine
 - ii) Hand drills
 - iii) Centre lathe machine
 - iv) Shaping machine

- 10.1.5T2 v) Grinding machine
Operation of different types of workshop machines
i) Methods of work holding
ii) Drilling
iii) Turning
iv) Facing
- 10.1.5T3 Safety precautions while using workshop machines

Practice

10.1.5P0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- select the right tool for the right job
- perform given tasks using workshop machines
- demonstrate safe working habits
- maintain workshop machine

Content

- 10.1.5P1 Identification of tools
i) Drilling machine
ii) Centre lathe
iii) Pulling machine
iv) Shaping machine
v) Grinding machine
- 10.1.5P2 Operation of machines exercises
i) Drilling
ii) Facing
iii) Turning
iv) Knurling
- 10.1.5P3 Demonstrate safe working habit
- 10.1.5P4 Maintenance of workshop machines

10.1.5C Competence

The trainee should have the ability to:

- Selection of right tools
- Perform given tasks safely and correctly
- Operate given machines correctly

Suggested Learning Resources

- Drilling machines
- Lathe machines
- Grinding machines
- Necessary tools
- Instructional sheets

10.1.6 SHEET METAL WORK

Theory

10.1.6T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- identify common sheet metals
- use sheet metal tools
- explain the process of sheet metal work
- explain edge treatment of joints in sheet metal work
- operate sheet metal fabrication machines

Content

- 10.1.6T1 Identification of common sheet metals
i) Galvanized sheet iron
ii) Tin plate
- 10.1.6T2 Uses of tools
i) Cutting tools
ii) Forming tools
iii) Marking out tools
- 10.1.6T3 Forming in sheet metal work
i) Metal forming process

- ii) Testing squareness
 - iii) Testing flatness
- 10.1.6T4 Edge treatment of joints
 - i) Soldering
 - ii) Forging
 - iii) Filling
 - iv) Binding
- 10.1.6T5 Sheet metal fabrication machines
 - i) Shearing machines
 - ii) Bending machines
 - iii) Punching machines
 - iv) Notching machine

Practice

- 10.1.6P0 *Specific Objectives*
 By the end of the sub-module unit, the trainee should be able to:
- a) interpret drawings in sheet metal work
 - b) estimate materials for sheet metal work
 - c) identify sheet metal fabrication tools and machines
 - d) carry out markings on a piece of sheet metal work
 - e) assemble part of a given practical exercise on sheet metal
 - f) demonstrate safety awareness in the use of sheet metal
 - g) maintain tools and machines

Content

- 10.1.6P1 Interpretation of drawing
- 10.1.6P2 Material estimate from given drawing
- 10.1.6P3 Identification of tools

- i) Dividers
 - ii) Punches
 - iii) Surface plate
 - iv) Angle plate
 - v) Vernier height gauge
 - vi) Protractor
 - vii) V-block
 - viii) Machines
 - ix) Shearing machines
 - x) Bending machines
 - xi) Punching machines
 - xii) Notching machines
 - xiii) Brakes and roll forming machines
- 10.1.6P4 Marking out procedures
 10.1.6P5 Sheet metal parts
 - making and assembly
- 10.1.6P6 Observation of safety
 10.1.6P7 Maintenance tools and equipment

10.1.6C Competence

- The trainee should have the to:
- i) Fabricate a sheet metal project
 - ii) Maintain tools and equipment

Suggested Teaching/Learning Resources

- Various workshop machines and metal tools
- Folding , vices (bench portable pipe vice)
- Pipe folding machines
- Shearing machines

11.1.0 ENGINEERING DRAWING**11.1.01 Introduction**

This module unit intended to assist the trainee in developing the abilities to communicate ideas within the engineering field correctly and be able to interpret engineering drawings.

11.1.02 General Objectives

At the end of the module unit the trainee should be able to:

- a) understand drawings of common components in proportion
- b) appreciate concepts applied in technical drawing
- c) interpret working drawings
- d) produce drawings in various projections and
- e) perspectives

11.1.03 Module Unit Summary and Time Allocation**Engineering Drawing**

| Code | Sub Module Unit | Content | Time Hrs |
|-------------------|---------------------------------------|--|-----------|
| 11.1.1 | Basic Concepts of Engineering Drawing | <ul style="list-style-type: none">• Drawing as a means of communication• Use and care of drawing instruments• Lines and Lettering• Dimensioning Techniques• Scales | 8 |
| 11.1.2 | Plane geometry | <ul style="list-style-type: none">• Construction of Polygons• Construction of Circles• Hyperbola, loci. | 14 |
| 11.1.3 | Development and interpretation | <ul style="list-style-type: none">• Elevations• Auxiliary views• Projection of points of intersection• Surface development | 16 |
| 11.1.4 | Projections | <ul style="list-style-type: none">• Terminologies• Forms of projections | 16 |
| 11.1.5 | Engineering Working drawings | <ul style="list-style-type: none">• Interpretation of part drawings• Production of sketches from parts drawing | 12 |
| Total time | | | 66 |

11.1.1 BASIC CONCEPTS OF ENGINEERING DRAWING

Theory

11.1.1T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) state the role of drawing as a means of communication.
- b) Use and care for drawing instruments appropriately
- c) draw and print quality lines and letters
- d) dimension a given drawing
- e) draw to a given scale.

Content

11.1.1T1 Drawing as a means of communication

- i) Use and care of drawing tools
- ii) Use of Scaled rule
- iii) Free Hand Sketch of Engineering tools

11.1.1T2 Lines and Lettering

- i) Types of lines
- ii) Choice of pencils leads
- iii) Upper and lower case

11.1.1T3 Techniques of Dimensioning

- i) Linear dimensioning
- ii) Angular dimensioning

11.1.1T4 Construction to scales

- Reproduction of drawing to scale.

11.1.2 PLANE GEOMETRY

Theory

11.1.2T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) construct the various types of polygons
- b) draw circles hyperbola, loci

Content

11.1.2T1 Constructions

Polygons

11.1.2T2 Constructions of Circles, Hyperbola, loci.

11.1.3 DEVELOPMENT AND INTERPRETATION

Theory

11.1.3T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) draw the front elevation and plan of a sectional solid.
- b) produce an auxiliary view from a given elevation and plan.
- c) project points of intersecting solids.
- d) develop surfaces of intersecting solids.

Content

11.1.3T1 Section of Solids

- i) Prisms
- ii) Pyramids
- iii) Cones

11.1.3T2 Auxiliary views and plans

- 11.1.3T3 Projection of intersecting solids
 i) Core
 ii) Pyramid
 iii) Triangular prisms
- 11.1.3T4 Development of surfaces
 i) cylinder to cone
 ii) cylinder to pyramid
 iii) cylinder to triangular prism

11.1.4 PROJECTIONS

Theory

- 11.1.4T0 *Specific Objectives*
 By the end of the sub module unit, the trainee should be able to:
 a) define terms related to projections
 b) identify forms of projection

Content

- 11.1.4T1 Definition of terms related to projection
 i) Axes
 ii) Horizontal
 iii) Vertical
 iv) Side elevation
 v) Planes of projection
 vi) Horizontal
 vii) Vertical
- 11.1.4T2 Identification of forms of projections
 i) Orthographic
 ii) 1st angle
 iii) 3rd angle
 iv) Pictorial
 v) Isometric
 vi) Oblique
 vii) Axonometric
 viii) Auxiliary
 ix) Orthographic

- x) Isometric
 xi) Oblique
 xii) Axonometric
 xiii) Auxiliary drawings
 xiv) Perspective

- 11.1.4T3 Sectioning
 i) Types of sectional views
 ii) Full sectional views
 iii) Off-set sectional views
 iv) Half-sectional views
 v) Aligned section views
 vi) Resolved sectional views
 vii) Removed sectional views
 viii) Broken out sectional views

11.1.5 ENGINEERING WORKING DRAWING

Theory

- 11.1.5T0 *Specific Objectives*
 By the end of the sub module unit, the trainee should be able to:
 a) extract information as required from given simple part drawing and assembly.
 b) produce sketches and drawings

Content

- 11.1.5T1 Reading and interpretation of drawings
 i) Representation of pictorial drawing in 1st and 3rd angle
 ii) Exploded
 iii) Part list
 iv) Dimensioning
 v) Types of Clearance
 vi) Orthographic
- 11.1.5T3 Produce drawings in orthographic projection

11.1.5C Competence

- The trainee should have the ability to:
- i) Draw and print quality lines and letters.
 - ii) Dimension a given drawing
 - iii) Draw to a given scale.
 - iv) Construct various types of polygons
 - v) Draw circles, hyperbola, loci etc
 - vi) Draw the front elevation and plan of a sectional solid.
 - vii) Produce an auxiliary view from a given elevation and plan.
 - viii) Develop surfaces of intersecting solids.
 - ix) Extract information as required from given simple part drawing and assembly

Suggested Teaching/Learning Resources

- Text books
- Drawing equipments
- Appropriate stationery

12.1.0 ELECTRICAL ENGINEERING PRINCIPLES

12.1.01 Introduction

This module unit is intended to equip the trainee with knowledge, skills and attitude required to understand the basic electrical engineering principles necessary for training in the area of trade.

12.1.02 General Objectives

At the end of the module unit, the trainee should be able to:

- a) Understand the concepts of electrical quantities
- b) Perform basic calculations on dc and ac circuits
- c) Explain the behaviour of magnetic materials, magnetism and electromagnetism
- d) Describe the construction and operation of dc sources
- e) Explain the basic concepts of ac generation
- f) Describe the theory of dielectrics, principles and characteristics of capacitors
- g) Analyze analogue ac and dc meters

12.1.03 Module Unit Summary and Time Allocation

Electrical Engineering Principles

| Code | Sub Module Unit | Content | Time Hrs |
|-------------|---------------------------------------|--|-----------------|
| 12.1.1 | Electrical quantities and application | <ul style="list-style-type: none">• Basic SI units• Derived units• Units of electrical quantities• Calculations | 8 |
| 12.1.2 | Cells and Batteries | <ul style="list-style-type: none">• Electrolysis and applications• Definition of electricity• Construction of simple cell• Determination of E.m.f in cells• Differentiation of primary and secondary• Construction and applications | 6 |

| | | | |
|--------|------------------------------|---|----|
| | | <ul style="list-style-type: none"> • of cells • Calculations • Charging methods | |
| 12.1.3 | Electrical Instruments | <ul style="list-style-type: none"> • Analogue instruments • Repulsion and attraction moving coil instruments • Shunts and multipliers • Multimeters | 10 |
| 12.1.4 | DC Circuit Theory | <ul style="list-style-type: none"> • Definition of resistivity • Ohms law • Series circuits • Parallel circuits • Series-parallel networks • Kirchhoff's Laws, • Superposition theorem • Calculations • Chemical effects due to electric current | 8 |
| 12.1.5 | Magnetism & Electromagnetism | <ul style="list-style-type: none"> • Electromagnetic fields • Leakage and flux fringing • Laws of Electromagnetic induction • Inductance • Hysteresis • Calculations | 8 |
| 12.1.6 | Electrostatics | <ul style="list-style-type: none"> • Definitions • Types of capacitors • Concept of charge and electrostatic field • Dielectric field • Calculations | 8 |
| 12.1.7 | AC Theory | <ul style="list-style-type: none"> • Simple ac generator • Terminologies applied to ac generators • Unidirectional and directional waveforms • Passive elements in ac circuits • Calculations | 8 |
| | Single Phase | <ul style="list-style-type: none"> • Constructional features • Principles of operation | 10 |

| | | | |
|-------------------|--------------|---|-----------|
| 12.1.8 | Transformers | <ul style="list-style-type: none">• Tests for single phase transformers• Applications of single phase transformers | |
| Total Time | | | 66 |

12.1.1 ELECTRICAL QUANTITIES AND APPLICATION

Theory

12.1.1T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) state the basic SI units.
- b) recognize derived SI units.
- c) state various units of electrical quantities
- d) perform simple calculations

Content

12.1.1T1 Basic SI unit quantities

- i) Length
- ii) Mass
- iii) Time

12.1.1T2 Derived SI units

12.1.1T3 Electrical quantities

- i) Coulomb
- ii) Newton
- iii) Joule
- iv) Volt
- v) Ohm
- vi) Siemens
- vii) Watt

12.1.1T4 Simple calculations

12.1.2 CELLS AND BATTERIES

Theory

12.1.2T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) describe electrolysis and its applications
- b) define the term electricity
- c) describe the construction and operation of a simple cell
- d) determine the total e.m.f and internal resistance of cells connected in series and in parallel
- e) distinguish between primary and secondary cells
- f) explain the applications and construction of different types of cells
- g) perform calculations on secondary cells
- h) describe charging methods of batteries

Content

12.1.2T1 Description of electrolysis and its applications

12.1.2T2 Definition of electricity

12.1.2T3 Construction and operation of a simple cell

12.1.2T4 Determination of total internal resistance of cells connected in series and in parallel, and hence the E.m.f

- 12.1.2T5 Distinguishing between primary and secondary cells
- 12.1.2T6 Construction and applications of different types of cells
- 12.1.2T7 Calculations
 - i) E.m.f
 - ii) Internal resistance
- 12.1.2T8 Charging methods
 - i) Constant current
 - ii) Constant voltage
 - iii) Trickle charge
 - iv) Booster charge
 - v) Battery ratings
 - vi) Simple calculations

Practice

- 12.1.2P0 *Specific Objectives*
 By the end of the sub module unit, the trainee should be able to:
- a) perform experiments on electrolysis
 - b) determine internal resistance of cells connected in series and in parallel
 - c) perform experiments on charging of batteries

Content

- 12.1.2P1 Electrolysis
- 12.1.2P2 Internal resistance of cells connected in series and in parallel
- 12.1.2P3 Battery charging

12.1.2C Competence

The trainee should have the ability to:

- i) Perform experiments on electrolysis
- ii) Determine internal resistance of cells connected in series and in parallel
- iii) Charge batteries

Suggested Learning Resources

- Various batteries
- Sulphuric acid
- Distilled water
- Battery chargers
- Test instruments

12.1.3 ELECTRICAL INSTRUMENTS

Theory

- 12.1.3T0 *Specific Objectives*
 By the end of the sub module unit, the trainee should be able to:
- a) describe the construction and operation of electrical instruments
 - b) describe the construction and operation of the thermocouple
 - c) extend the range of meters using shunts and multipliers
 - d) explain the operation of a multimeter

Content

- 12.1.3T1 Construction and operation of electrical instruments

- i) Moving iron
 - ii) Moving coil
- 12.1.3T2 Thermocouple
- i) Advantages and disadvantages
 - ii) Applications
- 12.1.3T3 Extension of range of instruments
- i) Shunts
 - ii) Multipliers
 - iii) Operation of multimeter
 - iv) Ammeter
 - v) Voltmeter
 - vi) Ohmmeter
- i) Voltage or potential drop
 - ii) Current
 - iii) Resistance or continuity
 - iv) Frequency
 - v) Power
 - vi) Time and period of waveforms
 - vii) Testing components
- 12.1.3T3 Repair and Maintenance of instruments
- i) Voltmeters
 - ii) Ammeters
 - iii) Ohmmeters
 - iv) Frequency meters
 - v) Wattmeter's
 - vi) Multimeters
 - vii) Cathode – ray oscilloscope
 - viii) Safe use of instruments

Practice

12.1.3P0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) identify different types of instruments
- b) perform measurements using instruments
- c) repair and maintain instruments

Content

- 12.1.3P1 Types of instruments (analogue/digital)
- i) Voltmeters
 - ii) Ammeters
 - iii) Ohmmeters
 - iv) Frequency meters
 - v) Wattmeter
 - vi) Multimeters
 - vii) Cathode – Ray Oscilloscope
- 12.1.3P2 Measurements of electrical quantities

12.1.3C Competence

The trainee should have the ability to:

- i) identify various measuring instruments
- ii) perform electrical measurements using the instruments
- iii) repair and maintain electrical measuring instruments

Suggested Learning Resources

- i) Voltmeters
- ii) Ammeters
- iii) Ohmmeters

- iv) Frequency meters
- v) Wattmeter's
- vi) Multimeters
- vii) Cathode – ray oscilloscope
- viii) Conductors

12.1.4 DC CIRCUIT THEORY

Theory

12.1.4T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) define resistivity
- b) define Ohm's
- c) calculate voltage, current and resistance in a series circuit
- d) calculate voltage, current and resistance in a parallel circuit
- e) calculate voltage, current and resistance in a series-parallel circuit
- f) state Kirchoff's laws
- g) state the superposition theorem
- h) solve simple circuit problems using Kirchoff's and superposition theorems
- i) explain chemical effects due to electric current

Content

12.1.4T1 Definition of:

- i) Resistivity
- ii) Conductors

- iii) Conductivity
- iv) Effect of temperature change in the value of resistance
- v) Effect of positive temperature coefficient
- vi) Alloyed resistance temperature coefficient
- vii) Heat energy released by current

12.1.4T2 Ohm's Law

12.1.4T3 Voltage, current and resistance in a series circuit

12.1.4T4 Voltage, current and resistance in a parallel circuit

12.1.4T5 Voltage, current and resistance in a Series-parallel circuit

12.1.4T6 Statement of Kirchhoff's theorems

12.1.4T7 Superposition theorem

12.1.4T8 Solving circuit problems using Kirchhoff's and Superposition theorems

12.1.4T9 Chemical effects due to electric current

- i) Electrolysis
- ii) Faraday's Laws of electrolysis
- iii) Practical use of electrolytic action
- iv) Electro-plating
- v) Electrolytic corrosion
- vi) Practice

12.1.4P0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- connect simple electrical circuits
- measure various electrical quantities
- verify Ohm's law
- verify that the resistance of a material depends on area, length and resistivity
- verify Kirchhoff's law

Content

- 12.1.4P1 Simple electrical circuits
- 12.1.4P2 Measurement of electrical quantities
 - i) Current
 - ii) Voltage
 - iii) Resistance
 - iv) Power
- 12.1.4T3 Verification of Ohm's law
- 12.1.4T4 Determination of conductor resistance
 - i) Resistance
 - ii) Resistivity
 - iii) length
 - iv) Area
- 12.1.4T5 Verification of kirchhoff's laws
 - i) Current law
 - ii) Voltage law
- 12.1.4T3 Testing of capacitance
- 12.1.4T4 Experiments on charging and discharging of capacitors

12.1.4C Competence

The trainee should have the ability to:

- Measure electrical quantities
- Determine conductor resistance

Suggested Learning Resources

- Dc power source
- Assorted resistance
- Measuring instruments
- Bread boards
- Connecting leads

12.1.5 MAGNETISM AND ELECTROMAGNETISM

Theory

12.1.5T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- describe the concept of magnetic fields and field distribution
- explain leakage flux and fringing
- describe the basic laws of electromagnetic induction
- explain the concepts of inductance
- plot and explain the hysteresis loop
- explain and solve problems relating to magnetic circuits

Content

- 12.1.5T1 Description of electromagnetic fields
- i) Permanent magnet
 - ii) Between a pair of poles
 - iii) In a current carrying conductor
 - iv) In parallel wires
 - v) In a loop
 - vi) In a solenoid
- 12.1.5T2 Leakage flux and fringing
- 12.1.5T3 Laws of electromagnetic induction
- i) Faraday's law
 - ii) Lenz's law
 - iii) Fleming's rules
- 12.1.5T4 Inductance
- i) Self
 - ii) Mutual
 - iii) Calculations
 - iv) Practical applications of induced electromotive force
- 12.1.5T5 Hysteresis loop
- i) Plotting
 - ii) Explanation
- 12.1.5T6 Problems relating to magnetic circuits
- i) Series
 - ii) parallel
- b) verify the existence of magnetic field
- c) apply the principles of electromagnetism

Content

- 12.1.5P1 Magnetic materials
- i) Identification
 - ii) Classification
 - iii) Magnetic
 - iv) Non magnetic
- 12.1.5P2 Verification of the existence of magnetic field
- i) Bar magnet
 - ii) Horse shoe magnet
 - iii) Combination of magnets
 - iv) Current carrying conductor
- 12.1.5P3 Applications of electromagnetism
- Construction of electromagnet

12.1.5C Competence

The trainee should have the ability to:

- i) Construct an electromagnet
- ii) Apply magnets in the engineering field

Suggested Learning Resources

- Permanent magnets
- Electromagnet
- Power
- Wires
- Bells
- Soft iron

Practice

12.1.5P0 Specific Objectives

By the end of the sub module/unit, the trainee should be able to:

- a) identify various types of magnetic materials

12.1.6 ELECTROSTATICS

Theory

12.1.6T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) define electrostatic quantities
- b) types of capacitors
- c) describe the concept of charge and electrostatic field
- d) explain the dielectric effect
- e) perform calculations involving capacitance

Content

12.1.6T1 Definitions of electrostatic quantities and units

- i) Electric flux
- ii) Electric flux density
- iii) Electric field intensity
- iv) Permittivity
- v) Capacitance
- vi) Charge
- vii) Derivation of the formula

$$C = \frac{EA}{d} = \frac{\epsilon_r \epsilon_0 A}{d}$$

12.1.6T2 Types of capacitors

- i) Paper capacitors
- ii) Electrolytic capacitors
- iii) Ceramic capacitors
- iv) Aluminium foil capacitor
- v) Polyester capacitor

- vi) Tantalum capacitor
- vii) Multiplate capacitor
- viii) Variable capacitor
- ix) Applications

- x) Description of charge concept

12.1.6T3 Charge

- i) Electric field strength
- ii) Capacitance and its units

12.1.6T4 Dielectric field effect

12.1.6T5 Calculations

- i) Capacitors in series
- ii) Capacitors in parallel
- iii) Energy stored in a capacitor

Practice

12.1.6P0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) identify various types of capacitors
- b) measure capacitance in connections
- c) test a capacitor
- f) perform experiments on charging and discharging of capacitors

Content

12.1.6P1 Types of capacitors

12.1.6T2 Measurement of capacitance in various connections

Testing of capacitance

12.1.6T3 Experiments on charging and discharging of capacitors

Capacitors

12.1.6C Competence

- The trainee should have the ability to:
- i) Identify capacitors
 - ii) Measure capacitance
 - iii) Test capacitance
 - iv) Apply capacitors in electrical circuits

Suggested Teaching Learning Resources

- Assorted capacitors
- Test instruments
- Bread boards

12.1.7 AC THEORY

Theory

12.1.7T0 Specific Objectives

- By the end of the sub module unit, the trainee should be able to:
- a) describe the principle of ac generators
 - b) explain the terms used with ac generators
 - c) derive the e.m.f equation
 - d) explain the effects of various passive elements in an ac circuits
 - e) perform calculations related to sinusoidal waveforms

Content

- 12.1.7T1 Description of principles of AC generation
- i) Effect of rotating a coil in a magnetic field
 - ii) Waveforms for unidirectional and alternating fields
 - iii) Graphical illustrations of AC waveforms

- 12.1.7T2 Terms used in generators
- i) Waveforms
 - ii) Period
 - iii) Frequency
 - iv) Instantaneous value
 - v) Amplitude, average values

- vi) Root mean square values and its derivation by graphical methods
- vii) Graphical addition of two sinusoidal waveforms
- viii) Effects of passive elements in ac circuits
 - Resistance
 - Capacitance
 - Inductance
 - Phase difference
 - Vector diagrams

- 12.1.7T3 Derivation of the EMF equation

- 12.1.7T4 Effects of passive elements in an ac circuit

- 12.1.7T5 Calculations

Practice

12.1.7P0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) identify components of an ac generator
- b) generate a sine wave
- c) establish the features of an ac waveform
- d) verify the effects of passive elements in ac circuits
- e) perform experiments to show the effect of power factor

Content

12.1.7P1 Identification of components of ac generator

12.1.7T2 Sine wave generation

12.1.7T3 Features of an ac waveform

- i) Cycle
- ii) Frequency
- iii) Period
- iv) Amplitude

12.1.7T4 Effects of R – L – C on voltage and current in ac circuit

- i) Series circuits
- ii) Parallel

12.1.7T5 Experiment on power factor

12.1.7C Competence

The trainee should have the ability to:

- i) Perform power factor improvement
- ii) Install power factor correction equipment

Suggested Learning Resources

- Resistors
- Capacitors
- Inductors

12.1.8 SINGLE PHASE TRANSFORMERS

Theory

12.1.8T1 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) describe the construction of single phase transformers
- b) explain the principle of operation of single phase transformers
- c) test single phase transformers
- d) state applications of single phase transformers

Content

12.1.8T1 Construction of single phase transformer

12.1.8T2 Explanation of operation of single phase transformers

- i) Transformer equation

- ii) Voltage transformation
 - iii) Current transformation
 - iv) Impedance transformation
 - v) Equivalent circuit
 - vi) Phasor diagram
 - vii) Transformer efficiency
- 12.1.8T4 Testing of transformers
- i) No load test
 - ii) Short circuit
 - iii) Transformer polarity test
- 12.1.8T5 State applications of single phase transformers
- i) Matching
 - ii) Auto-transformer

Practice

- 12.1.8P0 *Specific Objectives*
- By the end of the sub module unit, the trainee should be able to:
- a) test transformers for proper operation
 - b) connect transformers to single phase and three phase circuits
 - c) connect instrument transformers

Content

- 12.1.8P1 Transformer tests
- i) Connectivity
 - ii) Earthing
 - iii) Insulation resistance
 - iv) Open circuit
 - v) Short circuit

- vi) Efficiency
- 12.1.8P2 Connection of transformers
- i) Schematic diagrams
 - ii) Wiring diagrams
- 12.1.8T3 Instrument transformers

Suggested teaching/Learning Activities

- Discussion
- Illustration
- Demonstration
- Note taking
- Practical exercise
- Calculations

Suggested teaching/Learning Resources

- Electrical measuring instruments
- Electronic tool kit
- Electrical tool kit
- Ac power supply
- Dc Power supply

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests
- Project

**13.1.0 ELECTRICAL INSTALLATION
TECHNOLOGY**

13.1.01 Introduction

This module unit is designed to equip the trainee with the knowledge, skills and attitudes necessary to carry out Electrical Installation work in domestic premises.

13.1.02 General Objectives

At the end of this module unit, the trainee should be able to:

- a) Appreciate the necessary safety precautions in electrical workshop and environs
- b) Use and care for electrical tools appropriately
- c) Understand the Methods of cable installation
- d) Apply acquired knowledge to trace faults in domestic installations
- e) Maintain and service wiring systems and equipment

13.1.03 Module Unit Summary and Time Allocation

Electrical Installation Technology I

| Code | Module Unit | Content | Time Hrs |
|-------------|---|---|-----------------|
| 13.1.1 | Safety | <ul style="list-style-type: none">• Workshop safety hazards• Electrical safety• First aid | 4 |
| 13.1.2 | Electrical Tools | <ul style="list-style-type: none">• Tools used in Electrical• Care and maintenance of tools | 6 |
| 13.1.3 | Electrical Power Supply | <ul style="list-style-type: none">• Electrical power sources• Typical layout for a hydro power generating plant• Electrical power transmission and distribution systems | 8 |
| 13.1.4 | Electrical Instruments and Measurements | <ul style="list-style-type: none">• Types of measuring instrument• Instruments and their quantities of measurement• Interpretation of instrument's scales• Methods of performing electrical measurements | 6 |

| | | | |
|---------|--------------------------------------|---|----|
| 13.1.5 | Conductors and Cables Joints | <ul style="list-style-type: none"> • Types of cables • Sizes and ratings. • Definition of a joint • Properties of a good joints • Types of joints • Methods of making permanent joints • Methods of making temporary joints • IEEE regulations on cables and cable joints | 6 |
| 13.1.6 | Wiring System and Accessories | <ul style="list-style-type: none"> • Types of wiring system • Factors affecting choice • Application of given systems • Types of accessories | 14 |
| 13.1.7 | Domestic Lighting and Power Circuits | <ul style="list-style-type: none"> • Final sub-circuits • Sequence of control for domestic installations • Ring and radial final sub-circuits • Wiring methods for lighting final sub-circuits • Cooker and water heater final sub-circuits | 20 |
| 13.1.8 | Earthing and Protection | <ul style="list-style-type: none"> • Terms used in earthing • Purpose for earthing • Parts of an earthing system • Different methods of earth • Over current protection • Tests for an earthing system • Relevant IEE regulations | 14 |
| 13.1.9 | Battery Charging | <ul style="list-style-type: none"> • Charging methods • Battery maintenance | 10 |
| 13.1.10 | Bell and Alarm Circuits | <ul style="list-style-type: none"> • Types of electrical bells • Components of a bell circuit • Bell indicators • Burglar alarm circuits • Fire alarm circuits | 12 |
| 13.1.11 | Tests and Inspection | <ul style="list-style-type: none"> • Need for testing • Tests on completed installations and major extensions and alterations • IEE regulations requirements for bell circuits | 7 |

| | | | |
|-------------------|--------------------|--|------------|
| | | <ul style="list-style-type: none"> • Inspection of completed installations | |
| 13.1.12 | Structured Cabling | <ul style="list-style-type: none"> • Structured cabling system (SCs) • Entrance facilities (EFs) • Types of cabling • Types of topologies • Applications of SCs | 10 |
| Total Time | | | 117 |

13.1.1 SAFETY

Theory

13.1.1T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) identify workshop safety hazards
- b) identify electrical safety hazards
- c) explain correct procedures of handling accidents

Content

- 13.1.1T1 Identification of workshop safety hazards
 - i) Protective clothing
 - ii) Care and maintenance of tools, materials and equipment
 - iii) Location and operation of safety equipment
 - iv) First aid box
 - v) Fire extinguishers
 - vi) Safe working habits

- 13.1.1T2 Identification of electrical safety hazards
 - i) Dangers of electricity
 - ii) Fire
 - iii) Burns
 - iv) Electric shock
 - v) Sources of electrical hazards
 - vi) Bare wires
 - vii) Carelessness in handling electrical equipment

- 13.1.1T3 Correct procedure for handling accidents in cases of:
 - i) Cuts
 - ii) Fire
 - iii) Electric shock
 - iv) Burns

Practice

13.1.1P0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) care and maintain of workshop tools and equipment
- b) carry out first aid
- c) demonstrate safe working procedures

Content

- 13.1.1P1 Maintenance of tools and equipment
 - Location of safety equipment
- 13.1.1P2 First aid
 - i) First aid
 - ii) Artificial respiration
 - iii) Dressing of wounds and cuts
- 13.1.1T3 Safe working procedures
 - i) Proper clothing
 - ii) Acceptable behaviour in the workshop

13.1.1C Competence

The trainee should have the ability to:

- i) Observe and apply safety regulations in workshops
- ii) Carry out artificial respiration
- iii) Maintain workshop tools and equipment

Competence

The trainee should have the ability to:

- Demonstrate knowledge of safety in their workplaces
- Perform first aid

- Prevent accidents in the workshop and other work places
- Extinguish all classes of fire

Suggested Teaching/Learning

Activities

- Discussions
- Demonstration
- Role play
- Practical exercises

Suggested Teaching/Learning

Resources

- First aid kits
- Electrical tools and equipment
- Fire extinguishers
- Charts on safety
- Resources personnel for fire fighting drills

Suggested Evaluation Methods

- Oral tests
- Timed practical tests
- Assignment
- Timed written tests

13.1.2 ELECTRICAL TOOLS

Theory

13.1.2T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) list tools commonly used in Electrical and Electronics Engineering
- b) explain the maintenance of tools

Content

13.1.2T1 Tools used in Electrical and Electronics Technology.

13.1.2T2 Explaining care and maintenance of tools
caring cleaning techniques

Servicing (oiling / greasing)

Practice

13.1.2P0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) demonstrate safe application of tools commonly used in electrical and electronic engineering field
- b) perform maintenance of tools in the workshop and other working places
- c) store materials using appropriate methods

Content

13.1.2P1 Safe application of tools used in Electrical and Electronics Technology.

- i) Cutting tools
- ii) Stripping tools
- iii) Fastening tools
- iv) Fixing tools
- v) Measuring tools
- vi) Holding tools
- vii) Other general purpose tools

13.1.2P2 Maintenance of tools right tool for the right job

- i) Caring
- ii) Cleaning techniques
- iii) Servicing (oiling/greasing)

13.1.2P3 Storage of electrical workshop materials and tools

13.1.2C Competence

The trainee should have the

ability to:

- Select the right tools for the right job
- Maintain various tools in the electrical field

Suggested Teaching Methods

- Practical exercises
- Discussion
- Demonstration on safe handling of hand tools

Suggested Learning Resources

- Various tools in the electrical field
- Tools' cleaning and maintaining aids

Suggested Assessment Methods

- Oral test
- Practical tests
- Assignment

13.1.3 ELECTRICAL POWER SUPPLY

13.1.3T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) explain the types of electrical power sources
- b) describe typical layout for a hydro power generating plant
- c) outline electrical power transmission and distribution systems

Content

13.1.3T1 Electrical power sources

- i) Hydro-electric
- ii) Thermal
- iii) Diesel

- iv) Gas
- v) Nuclear
- vi) Geo-thermal
- vii) Magneto-Hydro
- viii) Solar
- ix) Battery
- x) Emerging technology

13.1.3T2 Typical layout for a hydro-power generating plant

13.1.3T3 Electrical power transmission and distribution systems

13.1.3P0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) Sketch a layouts for a hydropower generating plant
- b) Draw a line diagram for grid transmission and distribution system

Content

13.1.3P1 Layout of generating stations

- i) Hydro
- ii) Thermal
- iii) Diesel
- iv) Gas
- v) Nuclear
- vi) Geothermal
- vii) Magneto-hydro

13.1.3P2 Operating sequence of generating stations

- i) Hydro
- ii) Thermal
- iii) Diesel
- iv) Gas
- v) Nuclear
- vi) Geothermal
- vii) Magneto-hydro

Competence

- The trainee should have the ability to:
- Draw power station schematics
 - Carry out operating sequence for generating stations in model form

Suggested Teaching/Learning Resources

- Power station model
- Overhead projector
- Field visit to various power generating stations

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

13.1.4 ELECTRICAL INSTRUMENTS AND MEASUREMENTS

13.1.4T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- name types of measuring instruments
- list the instrument used for measuring each electrical quantity
- interpret instruments' scales
- outline the methods of performing electrical measurements.

Content

13.1.4T1 Types of measuring instrument as:

- Ammeters
- Voltmeters

- Ohmmeters
- Multi meters
- Watt meter types of measuring instruments for each quantity and unit:
- Current
- Voltage
- Resistance
- Power
- Energy

13.1.4T1 Interpretation of instrument's scales

- scale spans
 - Fractional units/representation
 - scale reading

13.1.4T1 Methods of performing electrical measurements

- measurement of resistance
- Measurement of voltage
- Measurement of current
- Measurement of power
- Measurement of energy
 - Wattmeter

Practice

13.1.4P1 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- identify types of instruments
- perform measurements using instruments
- interpret instrument scales

Content

13.1.4P1 Identification of various types of measuring instruments

- Ammeters
- Voltmeters

| | | |
|---------------------------|---|---|
| | <ul style="list-style-type: none"> iii) Multimeters iv) Ohmmeters v) Wattmeter | Theory |
| 13.1.4P2 | Performing measurements for: | 13.1.5T0 <i>Specific Objectives</i> By the end of the sub module unit, the trainee should be able to: |
| | <ul style="list-style-type: none"> i) Current ii) Voltage iii) Resistance iv) Power | <ul style="list-style-type: none"> a) describe types of cables by construction and size b) determine the rating of a cable given the size. c) define a joint d) state the properties of a good joint e) explain the methods of making permanent joints f) explain the methods of making temporary joints g) state the relevant I.E.E regulations |
| 13.1.43 | Interpretation of instruments scales | |
| 13.1.4C Competence | | <i>Content</i> |
| | The trainee should have the ability to: | 13.1.5T1 Types of cables <ul style="list-style-type: none"> i) PVC sheathed ii) PCP sheathed iii) PVC SWA iv) MIMS cable v) PIL SWA vi) Cable sizes <ul style="list-style-type: none"> - Conductor, Insulation sheath, number of cores. |
| | <ul style="list-style-type: none"> i) Interpret readings from instrument indication ii) Use various types of electrical measuring instruments iii) Set instrument calibration ready for measurements iv) Perform experiments using instruments. v) Write a laboratory report on experiments carried out. | 13.1.5T2 Determination of cables current rating <ul style="list-style-type: none"> - Factors that affect cable current rating. |
| | <i>Suggested Teaching Methods</i> | 13.1.5T3 Definition of a joint <ul style="list-style-type: none"> i) Types of joints |
| | <ul style="list-style-type: none"> - Demonstration - Practical exercises - Discussion | 13.1.5T4 Properties of a good joint <ul style="list-style-type: none"> i) Permanent ii) Temporary |
| | <i>Suggested Learning Resources</i> | 13.1.5T5 Making permanent joints by Soldering <ul style="list-style-type: none"> i) Married joint ii) Tee Joint iii) Telegraphic joint |
| | <ul style="list-style-type: none"> - Measuring instruments - Electrical components - Bread boards | |
| | <i>Suggested Assessment Methods</i> | |
| | <ul style="list-style-type: none"> - Oral tests - Practical tests - Assignments | |
| 13.1.5 | CONDUCTORS AND CABLES | |

| | | |
|----------|---|---|
| | <ul style="list-style-type: none"> iv) Pot and ladle technique | <ul style="list-style-type: none"> v) Practical exercise |
| 13.1.5T6 | Making temporary joints <ul style="list-style-type: none"> i) Use of bolts and nuts ii) Screws | <i>Suggested Teaching /Learning Resources</i> <ul style="list-style-type: none"> i) Cable pieces ii) Solder iii) Electrical tool kit iv) Wire brush v) Assorted Files |
| | Practice | |
| 13.1.5P0 | <i>Specific Objectives</i> | <i>Suggested Evaluation Methods</i> |
| | By the end of the sub module unit, the trainee should be able to: <ul style="list-style-type: none"> a) Identify electrical cables b) Perform cable joints | <ul style="list-style-type: none"> i) Oral tests ii) Timed written tests iii) Assignments iv) Timed practical tests v) Project vi) Project Report writing and presentation |
| | <i>Content</i> | |
| 13.1.5P1 | Identification of electrical cables | |
| 13.1.5P2 | Cable joints <ul style="list-style-type: none"> i) Tools and materials for cable joints ii) Cable preparation iii) Performing the joints iv) Methods of cable joints v) Types of cable joints <ul style="list-style-type: none"> - Married - Telegraph - Bell hanger's vi) T -Married vii) Quality control | <p>13.1.5C Competence Ability to make electrically and mechanically sound cable joints</p> <p>13.1.6 WIRING SYSTEMS</p> <p>Theory</p> <p>13.1.6T0 Specific objectives</p> <p>By the end of the sub module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) define wiring systems b) describe the various wiring systems and their associated fittings c) explain factors that affect choice of wiring systems d) select appropriate wiring systems for a given situations |
| | <i>Suggested teaching/Learning Activities</i> | |
| | <ul style="list-style-type: none"> i) Illustration ii) Demonstration iii) Note taking iv) Observation | <p>Content</p> <p>13.1.6T1 Definition of wiring systems</p> |

| | | |
|----------|--|--|
| 13.1.6T2 | Wiring systems and the associated fittings | using various types of wiring systems |
| 13.1.6T3 | Factors affecting the choice of an appropriate wiring system. | |
| 13.1.6T4 | <p>Wiring systems and their accessories</p> <ul style="list-style-type: none"> i) PVC sheathed wiring system ii) Metallic Conduits iii) Steel iv) Aluminium v) Copper vi) Flexible steel vii) Plastic conduits viii) Plastic Conduits ix) Cable Trunking x) PVC mini trunking xi) Metallic trunking xii) Busbar trunking xiii) Rising trunking xiv) Overhead xv) Cable ducts xvi) Manhole, casting and dispection xvii) MIMS Cables xviii) Cable tray xix) PILC SWA Cables xx) PVC SWA Cables xxi) Overhead Wiring System xxii) Bare overhead system xxiii) Catenary wiring | |
| | | <i>Content</i> |
| | | <p>13.1.6P1 Installations using various wiring systems</p> <ul style="list-style-type: none"> i) PVC sheathed wiring system ii) Metallic Conduits iii) Steel iv) Aluminium v) Copper vi) Flexible steel vii) PVC Conduits viii) Cable Trunking ix) PVC mini trunking x) Metallic trunking xi) Busbar trunking xii) Rising trunking xiii) Overhead xiv) Cable ducts xv) Manhole, casting and dispection xvi) MIMS Cables xvii) Cable tray xviii) PILC SWA Cables xix) PVC SWA Cables xx) Overhead Wiring System xxi) Bare overhead system xxii) Catenary wiring |

Practice

| | |
|----------|--|
| 13.1.6P0 | <p><i>Specific objectives</i></p> <p>By the end of the sub module unit; the trainee should be able to perform electrical installations</p> |
|----------|--|

13.1.6C Competence

The trainee should have the ability to: choose a suitable wiring system for various applications

Suggested teaching/Learning

Resources

- i) Various samples of materials used in various wiring systems
 - PVC
 - Steel conduit

| | | |
|-----|--|--|
| | - Trunking - Mineral insulated cables | Content Grouping of final sub-circuits |
| ii) | Assorted accessories associated with various wiring systems | 13.1.7T2 Sequence of control at the power Intake point |
| | | - Equipment at the intake point distribution board, rating of final sub-circuits. |
| | - Illustration - Demonstration - Note taking - Practical exercise - Project work - Visits to industries | 13.1.7T3 Ring and radial final sub-circuits |
| | | 13.1.7T4 Wiring methods for lighting final sub-circuits - Switching methods |
| | | 13.1.7T5 Operation of cooker and water heater final sub-circuits i) Rating ii) Use of simmerstat iii) Thermostat iv) Three heat switch. v) Relevant IEE regulations. |

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests
- Project

13.1.7 DOMESTIC LIGHTING AND POWER CIRCUITS

Theory

13.1.7T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) identify groups of final sub-circuits
- b) explain the sequence of control for a domestic installation
- c) explain the ring and radial final sub-circuits
- d) explain the wiring methods for lighting final sub-circuits
- e) explain the operations of the cooker and water heater final sub-circuits

Practice

13.1.7P0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) design electrical lighting and power lay out diagrams
- b) interpret lay out diagrams for lighting
- c) install and wire lighting and power circuits according to the lay out diagram
- d) observe safety, IEEE regulations, code of practice and standards

when installing lighting and power circuits

Content

- 13.1.7P1 Lay out diagrams for lighting and power circuits
 - i) Electrical symbols in wiring diagrams
 - ii) Lighting circuits switching circuits
- 13.1.7P2 Interpretation of electrical wiring diagrams
- 13.1.7P3 Methods of connecting lighting and power circuits
 - i) Lighting circuits
 - Loop in method
 - Ceiling rose method
 - ii) Power circuits
 - Radial circuits
 - Ring circuits

13.1.7C Competence

- i) Complete a domestic installation
- ii) Perform electrical tests on completed installations
- iii) Diagnose and repair faults domestic installations

Suggested teaching/Learning Activities

- Illustration
- Demonstration
- Note taking
- Observation
- Practical exercise
- Project work
- Visits to industries

Suggested Teaching/Learning Resources

- First aid kits

- Electrical tools and equipment
- Fire extinguishers

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

13.1.8 EARTHING AND PROTECTION

Theory

13.1.8T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) define the terms 'earthing' and 'protection'
- b) state the purpose of earthing in an installation
- c) state the parts of an earthing system
- d) explain the various methods of earthing
- e) describe the construction and operation of over current and earth leakage protective devices.
- f) Explain the procedure for carrying earth tests on an installation
- g) state I.E.E regulation requirements

Content

- 13.1.8T1 Defining of 'earthing' and 'protection'
- 13.1.8T2 Purpose of earthing and protection in an installation
- 13.1.8T3 Parts of an earthing system

| | | |
|----------|--|--|
| | i) Earthing continuity ii) Conductor iii) Earthing lead iv) Earth electrode | <i>Content</i> |
| 13.1.8T4 | Methods of earthing an installation i) Direct earthing, ii) Protective multiple earthing | 13.1.8P1 Earthing of installation i) Earth continuity conductor ii) Earthing lead iii) Earth electrode |
| 13.1.8T5 | Construction and operation of various protective devices | 13.1.8P2 Tests on residual current circuit breaker i) Contacts ii) Coil iii) Reset button |
| 13.1.8T6 | Types of excess current protection i) Fuses ii) Circuit breakers iii) Earth leakage circuit breakers iv) Advantages and disadvantages. | 13.1.8P3 Installation of residual current circuit breaker 13.1.8P4 Measurement of earth loop impedance 13.1.8P5 Measurement of earth resistance area 13.1.8P6 Earth tests |
| 13.1.8T7 | Relevant IEE requirements | |

Practice

- 13.1.8P0 *Specific objectives*
 By the end of the sub module unit, the trainee should be able to:
- a) perform earthing on various types of installations
 - b) test residual current circuit breakers
 - c) install residual current circuit breakers in an installation
 - d) measure earth loop impedance
 - e) measure earth resistance area
 - f) perform earth tests on a completed installation

| | |
|--|---|
| | <i>Content</i> |
| | 13.1.8P1 Earthing of installation i) Earth continuity conductor ii) Earthing lead iii) Earth electrode |
| | 13.1.8P2 Tests on residual current circuit breaker i) Contacts ii) Coil iii) Reset button |
| | 13.1.8P3 Installation of residual current circuit breaker |
| | 13.1.8P4 Measurement of earth loop impedance |
| | 13.1.8P5 Measurement of earth resistance area |
| | 13.1.8P6 Earth tests |

13.1.8C Competence

The trainee should have the ability to:

- i) Select suitable circuit protective devices
- ii) Perform all earthing requirements for an installation to the regulatory boards standards and all other authorities

Suggested teaching/Learning Activities

- Illustration
- Demonstration
- Note taking
- Observation
- Practical exercise
- Visits to industries

Suggested teaching/Learning Resources

- Earthing devices and materials
- Residual current circuit breakers

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

13.1.9 BATTERY CHARGING

Theory

13.1.9T0 Specific objectives

By the end of the sub module unit the trainee should be able to:

- a) explain the constant voltage charging method
- b) describe the maintenance of various batteries

Content

13.1.9T1 Constant voltage battery charging circuit

- i) Charging circuit
- ii) Constant current charging
- iii) Floating battery charging
- iv) Trickle

13.1.9T2 Maintenance of batteries

- i) Lead-acid cells
- ii) Alkaline
- iii) Zinc air

Practice

13.1.9P0 Specific objectives

By the end of the sub module unit, the trainee should be able to:

- a) Identify rechargeable batteries
- b) Set up rechargeable batteries for charging

- c) Test rechargeable batteries

Content

- 13.1.9P1 Identification of batteries
- 13.1.9P1 Setting up batteries for charging
- 13.1.9P2 Testing of batteries

13.1.9C Competence

The trainee should have the battery to charge a battery

Suggested teaching/Learning Activities

- Illustration
- Demonstration
- Note taking
- Observation
- Practical exercise
- Visits to industries

Suggested teaching/Learning Resources

- Battery charging units
- Rechargeable batteries
- Electrical tool equipment

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

13.1.10 BELL AND ALARM CIRCUITS

Theory

13.1.10T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) describe the construction and operation of various types of bells
- b) explain the function of various components of a basic bell circuit
- c) describe the construction and application of bell indicators
- d) explain the construction and operation of burglar alarm circuit
- e) explain the construction and operation of fire alarm systems

Content

13.1.10T1 Construction and operation of:

- i) Simple stroke bell
- ii) Trembler bell
- iii) Continuous ringing bell
- iv) Door chimes
- v) Buzzer
- vi) Polarized
- vii) Electronic bells

13.1.10T2 Function of various component of basic bell circuits

- i) Relay
- ii) Bell Transformers
- iii) Batteries

13.1.10T3 The construction and application of bell indicators

- i) Electromagnetic
- ii) Luminous
- iii) Electronic
- iv) Types of indicator devices

13.1.10T4 Construction and operation of burglar and fire alarm circuits

- i) Normally open burglar alarm / fire alarm
- ii) Normally closed burglar alarm / fire alarm
- iii) Zone of protection

13.1.10T4 Construction and operation of fire alarm systems

Practice

13.1.10P0 Specific objectives

By the end of the sub module unit, the trainee should be able to:

- a) Identify and select various types of bells for various applications
- b) Identify and select suitable accessories for use with various types of bells
- c) Install bell and alarm circuits
- d) Test bell and alarm circuits

Content

13.1.10P1 Identification and selection of bells

13.1.10P2 Identification of bell accessories

13.1.10P3 Installation of bell and alarm circuits

| | | |
|-----------|---|--|
| 13.1.10P4 | Tests on bell and alarm circuits | a) explain the need for testing b) explain the various tests in an installation c) state the I.E.E regulation requirements d) explain visual inspections on an installation |
| 13.1.10C | Competence The trainee should have the ability to: install, maintain and diagnose faults in bell circuits | |

Suggested teaching/Learning Activities

- Illustration
- Demonstration
- Note taking
- Observation
- Practical exercise
- Project work

Suggested teaching/Learning Resources

- Assorted types of bells and alarm devices
- Assorted types of cables
- Electrical and electronic tool kit
- Wiring boards

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests
- Project

13.1.11 TESTING AND INSPECTION OF ELECTRICAL INSTALLATIONS

Theory

| | |
|-----------|--|
| 13.1.11T0 | <i>Specific Objectives</i> By the end of the sub module unit the trainee should be able to: |
|-----------|--|

Content

| | |
|-----------|---|
| 13.1.11T1 | Purpose of, testing. I.E.E regulation requirements |
| 13.1.11T2 | Procedure for testing i) Polarity ii) Insulation resistance iii) Effectiveness of earthing iv) Ring circuit continuity |
| 13.1.11T3 | I.E.E regulations requirements |
| 13.1.11T4 | Inspection on an installation i) Causes of lose connections e.g. poor joints ii) Parts that require maintenance in an installation iii) Colour coding of cables iv) Quantities of materials specified |
| 13.1.11T5 | Quality and standard of materials |
| 13.1.11T6 | Workmanships |

Practice

| | |
|-----------|---|
| 13.1.11P0 | <i>Specific objectives</i> By the end of the sub module unit, the trainee should be able to: |
|-----------|---|

- a) Identify test instruments
- b) Perform electrical installations inspection and tests

Content

- 13.1.11P1 Test instruments
Ohmmeter
 - i) Bell and battery
 - ii) Insulation resistance tester
 - iii) Earth loop impedance tester
 - iv) Multimeter
- 13.1.11P2 Electrical installation tests
 - i) Procedure for testing installations
 - Polarity tests
 - Insulation resistance tests
 - Effectiveness of the earthing tests
 - Ring circuit continuity tests

13.1.11C Competence

The trainee should have the ability to: test an installation for proper and safe operation.

Suggested teaching/Learning Activities

- Illustration
- Demonstration
- Note taking
- Observation
- Practical exercise
- Visits to industries

Suggested teaching/Learning Resources

- Electrical Measuring instruments

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests
- Project

13.1.12 STRUCTURED CABLING

Theory

13.1.12T0 Specific Objectives

By the end of the sub module unit the trainee should able to:

- a) describe generic structured cabling system (SCs)
- b) explain entrance facilities (EFs) for SCs
- c) explain types of topologies in cabling systems
- d) explain applications for structure cabling systems

Content

- 13.1.12T1 Structured cabling systems (SCS)
 - i) Architectural structure of building
 - ii) Connecting hardware
 - iii) Standardization
- 13.1.12T2 Entrance facilities (EFs)
 - i) Underground
 - ii) Buried
 - iii) Aerial
- 13.1.12T3 Types of cabling
 - i) Backbone
 - ii) Horizontal
- 13.1.12T4 Types of topologies
 - i) Star

- ii) Bus
 - iii) Ring
 - iv) Hybrid
 - v) Star-wired
 - vi) Clustered star
 - vii) hierarchical
- 13.1.12T5** Types of Installation
- i) Electrical power
 - ii) Telecommunications
 - iii) Data and computer

Suggested teaching/Learning Resources

- i) Electrical and electronic tool kit
- ii) Assorted types of cables to include cables for:
 - Electrical works
 - Telecommunications systems
 - Data and computer systems

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests
- Project
- Project Report writing and presentation

Practice

- 13.1.12P0** *Specific objectives*
 By the end of the sub module unit, the trainee should be able to perform cabling for various

Content

- 13.1.12P1** Structured cabling systems (SCS)
- i) Electrical power
 - ii) Telecommunications
 - iii) Data and computer

13.1.12C Competence

The trainee should have the ability to: do cabling for all types of installations and data networking systems

Suggested teaching/Learning Activities

- Illustration
- Demonstration
- Note taking
- Observation
- Practical exercise
- Calculations
- Project work
- Role play
- Visits to industries

- 14.1.0 SOLAR INSTALLATION SYSTEMS**
- 14.1.01 Introduction**
The solar system module unit is designed to equip the trainee with knowledge skills and attitude necessary to understand and install solar installation systems.
Trainees will appreciate and apply prior knowledge and skills acquired in Electrical Installation of this course.
- 14.1.02 General Objectives**
At the end of module unit, the trainee should be able to:
- Understand the basic principles of solar systems
 - Acquire relevant skills for installation solar systems
 - Create awareness in the application of solar systems
 - Observe safety rules and standards when installing solar system panels
 - Institute quality control measures while installing solar systems
 - Prepare, maintenance schedules and maintain solar systems
- 4.1.03 Module Unit Summary and Time Allocation**

Solar Installation Systems

| Code | Sub-Module Unit | Content | Time Hrs |
|-------------|--|--|-----------------|
| 14.1.1 | Introduction to Solar Installation Systems | <ul style="list-style-type: none"> • Solar energy and its conversion • Terms used with solar systems • Methods of solar energy harvesting • Applications of solar energy | 10 |
| 14.1.2 | Solar (Photo Voltaic) Systems | <ul style="list-style-type: none"> • Parts of a photovoltaic • Functions of each part of a voltaic system • layout of the photo voltaic system | 16 |
| 14.1.3 | Solar Systems' Accessories | <ul style="list-style-type: none"> • Types of accessories • Types of cable joints • Wiring systems • Choice of wiring systems | 12 |

| | | | |
|-------------------|--|---|-----------|
| | | <ul style="list-style-type: none"> • Tests performed on completed installations • Regulations governing solar installations | |
| 14.1.4 | Maintenance and Servicing of Solar Systems | <ul style="list-style-type: none"> • Procedure for maintenance • Repair and trouble shooting | 16 |
| 14.1.5 | Solar System Sizing | <ul style="list-style-type: none"> • Terminologies • Sizing a solar system • Daily load energy demand • Equipment, cables and accessories sizing • Application of solar data | 12 |
| Total Time | | | 66 |

14.1.1 INTRODUCTION TO SOLAR INSTALLATION SYSTEMS

Theory

14.1.1T0 Specific Objectives
By the end of the sub-module unit, the trainee should be able to:

- a) explain solar energy and its conversion
- b) define various terms used with solar energy
- c) state various methods of solar energy harvesting
- d) list applications of solar energy

Content

14.1.1T1 Solar energy and its conversion:
i) Sun as a source of energy
ii) Conversion of solar to chemical energy (photosynthesis)
iii) Solar to heat (thermal)
iv) Solar to electricity
v) Solar to biomass

14.1.1T2 Definition of terminologies:

- i) Radiation
- ii) Direct and indirect radiation
- iii) Insolation

14.1.1T3 Methods of solar energy harvesting:
i) Solar module (solar cells)
ii) Parabolic reflectors
iii) Dish reflectors
iv) Box reflectors
v) Flat plate collectors (water heating)

14.1.1T4 Applications of solar energy:
i) Crop drying
ii) Cooking
iii) Water heating
iv) Electricity
v) Space heating
vi) Green houses

Practice

14.1.1P0 Specific Objectives
By the end of the sub-module unit, the trainee should be able to:
a) perform solar energy harvesting using various methods
b) apply solar energy in day – to – day life

Content

14.1.1P1 Solar energy harvesting:
i) Solar module (solar cells)
ii) Parabolic reflectors
iii) Dish reflectors
iv) Box reflectors
v) Flat plate collectors (water heating)

14.1.1P2 Applications of solar energy:
i) Crop drying
ii) Cooking
iii) Water heating
iv) Electricity
v) Space heating
vi) Green houses

14.1.1C Competence

The trainee should have the ability to:

- i) Identify various forms of solar energy

- ii) Harvest solar energy
- iii) Utilize solar energy in various forms

Suggested teaching/Learning Activities

- Illustration
- Demonstration
- Note taking
- Observation
- Practical exercise
- Calculations
- Project work
- Visits to solar installation sites

Suggested teaching/Learning Resources

- Assorted accessories for solar systems
- Wooden vertical board
- Masonry wall
- Soldering gun
- Solder
- Tools
- Equipment and apparatus for solar systems

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests
- Project
- Project Report writing and presentation

Suggested Learning Resources

- Solar energy equipment and apparatus
- Solar module (solar cells)
- Parabolic reflectors
- Dish reflectors
- Box reflectors
- Flat plate collectors (water heating)
- Charts for solar installations

- Field visits to solar homes

14.1.2 SOLAR INSTALLATION SYSTEMS

Theory

14.1.2T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) list the various parts of a photovoltaic systems
- b) explain the functions of each part of a voltaic system
- c) illustrate the layout of a photo voltaic system

Content

14.1.2T1 Parts of a photovoltaic system.

- i) Module array
- ii) Charge controller
- iii) Battery
- iv) Inverter
- v) Wires and accessories

14.1.2T2 Functions of parts of Photo Voltaic Systems

- i) Charge controller
- ii) Battery
- iii) Inverter
- iv) Wires and accessories
- v) Loads

14.1.2T3 Solar system lay out

- i) Block diagram
- ii) Schematic diagrams

Practice

14.1.2P0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) identify various components of a photo voltaic systems
- b) read and interpret a solar system layout.
- c) install a photo voltaic (solar system) using the right tools.

Content

14.1.2P1 Components of a photo voltaic system

- i) Module array
- ii) Charge controller
- iii) Battery
- iv) Inverter
- v) Wires and accessories
- vi) Loads

14.1.2P2 Solar system lay-out

- i) Block diagram
- ii) Schematic diagrams.

14.1.2P3 Installation of a solar system

14.1.2C Competence

The trainee should have the ability to:

- i) Identify the various parts of a photo voltaic system
- ii) Read and interpret solar system drawings
- iii) Install solar systems

Suggested Learning Resources

- Solar module
- Charge controllers
- Inverter
- Lead-acid cells

- Solar batteries
- Various accessories and wires
- Manila papers (Charts)
- Tools
- Solar system service kit

Suggested teaching/Learning Activities

- Illustration
- Demonstration
- Note taking
- Observation
- Practical exercise
- Calculations

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

14.1.3 SOLAR SYSTEMS' ACCESSORIES

Theory

14.1.3T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) describe various types of accessories.
- b) describe various types of cable joints
- c) list various types of wiring systems for a solar systems
- d) explain factors that are considered when choosing a wiring system
- e) outline the tests, in the right procedures on a complete installation

- f) apply various electrical regulations governing solar installations.

14.1.3T6 vi) Polarity tests
Electrical regulations governing solar installations

Content

- 14.1.3T1 Types of accessories
- i) AC and DC switches
 - ii) Socket outlets
 - iii) Lamp holders
 - iv) Ceiling roses
 - v) Patresses
 - vi) Consumer control units
 - vii) Consumer control units
- 14.1.3T2 Types of cable joints
- i) Telegraphic joint
 - ii) T Joint Married joint
 - iii) Bell hangers joint
- 14.1.3T3 Wiring systems
- i) Polyvinyl Chloride P.V.C Sheathed wiring systems
 - ii) Tough rubber sheath,
 - iii) Polyvinyl chloride(PVC) Conduit system
 - iv) Polychloroprene (PCP)
- 14.1.3T4 Factors that are considered when choosing a wiring system
- i) Cost
 - ii) Durability
 - iii) Safety
 - iv) Aesthetics
 - v) Nature of building
- 14.1.3T5 Tests procedures for an Installation:
- i) Physical inspection
 - ii) Electrical tests
 - iii) Ring continuity tests
 - iv) Effectiveness of the earth tests
 - v) Insulation tests

Practice

- 14.1.3P0 *Specific Objectives*
- By the end of the sub-module unit, the trainee should be able to:
- a) make various types of cable joints and terminations
 - b) select suitable wring systems and install P.V systems
 - c) perform in the right procedure, tests in a complete solar installation
 - d) carry out quality control checks

Content

- 14.1.3P1 Cable joints and terminations
- i) Joints
 - ii) Telegraph
 - iii) Scarf
 - iv) Britannia
 - v) Bell hanger's
 - vi) T Joint
 - vii) Married
 - viii) Terminations
 - ix) Loop
 - x) Claw
 - xi) Spade
 - xii) Crimped
 - xiii) Lug
 - xiv) Crimping
- 14.1.3P2 Wiring systems for solar systems
- i) sheathed wiring systems
 - ii) tough rubber sheath

- iii) Poly -Vinyl Chloride(PVC) sheath
 - iv) Poly-Chloroprene (PCP)
 - v) Regulations and standards for P.V installations
 - vi) conduit wiring systems for P.V systems
 - vii) PVC conduit wiring systems
- 14.1.3P3 Tests procedures for an installation:
- i) Physical inspection
 - ii) Electrical tests
 - iii) Polarity
 - iv) Earthing
 - v) Insulation
 - vi) Ring continuity
- 14.1.3P4 Electrical regulations governing solar installations
- 14.1.3P5 Quality control checks for solar systems installations
- i) Material selection
 - ii) Selection of tools and equipment
 - iii) Measuring, marking out and fixing of components and equipment and application of acceptable tolerance
 - iv) Termination techniques
 - v) Testing of the completed installation
 - vi) Compliance with the set standards
 - vii) Good quality finish and appearance

14.1.3C Competence

The trainee should have the ability to:

- a) Identify the accessories for a photo voltaic system
- b) perform cable joints
- c) install electrical circuit using various types of wiring systems
- d) test solar electrical systems in the right sequence
- e) apply electrical regulations and standards in the photo voltaic installation work

Suggested teaching/Learning Activities

- Demonstration
- Note taking
- Observation
- Practical exercise

Suggested Learning Resources

- Assorted accessories
- Chalk board
- Text books
- Instruments
- Resource persons
- Manuals

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments

14.1.4 MAINTENANCE AND SERVICING OF SOLAR SYSTEMS

Theory

14.1.4T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

| | | | |
|----------|---|----------|--|
| | a) explain the procedures for solar system maintenance b) outline troubleshooting and repair procedures of a solar system. | 14.1.4P1 | Testing a solar system for proper operation i) Checking / testing the outputs of a module – Voltage, current and power ii) Checking parameters of a charge controller iii) Checking for loose connections |
| 14.1.4T1 | <i>Content</i> Solar system maintenance procedure, i) Battery maintenance ii) Cleaning, iii) Topping up electrolyte level, iv) Checking the state of charge, v) equalizing charge vi) Module maintenance: vii) Dusting and testing modules viii) Checking of connections ix) System records and manuals | 14.1.4P2 | Servicing and maintaining a solar system i) Battery – topping up ii) Electrolyte level iii) Charge level iv) Module cleaning. v) Checking for loose connections vi) Checking all other connections, vii) Charge controller, viii) Inverter, ix) Loads x) Checking for burnt out lamps and replacing the same xi) Applying current electrical regulations and codes of practice in all areas of tests and inspection |
| 14.1.4T2 | Trouble shooting procedures: i) Module condition ii) Battery condition iii) Control and Protection devices iv) Lamp conditions | | |

Practice

| | |
|----------|---|
| 14.1.4P0 | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: a) test a solar system for proper operation b) service and maintain a solar system for proper operation |
|----------|---|

Content

14.1.4C Competence

The trainee should have the ability to:

- i) Install a photo voltaic system
- ii) Test a photo voltaic system
- iii) Service and maintain photo voltaic system

Suggested teaching/Learning Activities

- Illustration

- Demonstration
- Note taking
- Observation
- Practical exercise

Suggested Learning Resources

- i) Solar system tool kit
- ii) Solar Battery
- iii) Solar Module
- iv) Solar energy inverter
- v) Solar system service kit.

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

14.1.5 SOLAR SYSTEM SIZING

Theory

14.1.5T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) explain terminologies used with solar systems
- b) explain the need for sizing a solar system
- c) determine the daily load energy demand for any system specifications
- d) determining the right size of equipment, cables and accessories
- e) size a typical solar system given all the necessary data.

Content

- 14.1.5T1 Terminologies for solar system technology
- i) Module outputs and specifications

- ii) Daily energy requirement
- iii) Number of battery storage days
- iv) Battery capacity
- v) Depth of discharge/depth of charge
- vi) Insolation
- vii) Tracking

- | | |
|----------|--|
| 14.1.5T2 | Need for sizing |
| | <ul style="list-style-type: none"> i) Need for the right size of the module ii) Need for the right charge controller iii) Need for the battery iv) Need for the right size of fuse and circuit breaker |
| 14.1.5T3 | Determination of daily energy demand as: |
| | <ul style="list-style-type: none"> i) Energy due to lamp ii) Energy due to other loads iii) Power required to cater for the loses iv) Total daily energy demand |
| 14.1.5T4 | Determination the right size of equipment: |
| | <ul style="list-style-type: none"> i) Module ii) Cables and accessories factors to consider: iii) Charge controller – Factors to consider: iv) Inverter factors to consider v) Battery. |
| 14.1.5T5 | Step – by –step sizing of solar systems |
| | <ul style="list-style-type: none"> i) Total daily energy demand ii) Systems voltage |

- iii) Systems current hours
- iv) Insolation effect
- v) Autonomy effect
- vi) Tracking effect
- vii) Choice of modules, battery charge controllers inverters
- viii) Choice of cables and accessories.

Practice

- 14.1.5P0 *Specific Objectives*
 By the end of the sub-module unit, the trainee should be able to size a typical solar system.
- 14.1.5P0 *Content*
 Needs of an installations
 - i) Need for sizing
 - ii) Daily energy demand

14.1.5C Competence
 The trainee should have the ability to: identify the right wires, apparatus for a solar system.

Suggested teaching/Learning Activities

- Illustration
- Demonstration
- Note taking
- Calculations
- Project work

Suggested teaching and learning resources

- Drawing board
- Calculator
- Catalogues
- Data for solar equipment

Suggested Evaluation Methods

- Oral tests
- Assignments
- Project

15.1.0

ANALOGUE ELECTRONICS I

15.1.01

Introduction

Analogue electronics is a study that deals with electronic systems with a continuously variable signal. This module unit is intended to impart knowledge, skills and attitudes required to enable the trainee understand the principles of operations of various electrical circuits, equipment and devices in the industries. This unit forms a foundation for Analogue Electronics II in Module II.

15.1.02

General Objectives

At the end of the module unit, the trainee should be able to:

- a) Understand the operation of analogue electronic devices
- b) Apply analogue electronic components in the construction of power supply units and other electronic devices
- c) Observe safety when using analogue electronic components and devices

15.1.1

Module Unit Summary and Time Allocation

Analogue Electronics I

| Code | Module Unit | Content | Time Hrs |
|-------------|-------------------------|---|-----------------|
| 15.1.1 | Atomic Theory of matter | <ul style="list-style-type: none">• Atomic structure• Energy levels | 8 |
| 15.1.2 | Thermionic Emission | <ul style="list-style-type: none">• Principles of the CRT• Advantages and limitations of valves• Motions of electrons• Principles of the CRO• Applications of thermionic emission | 10 |
| 15.1.3 | Semi conductor theory | <ul style="list-style-type: none">• Intrinsic semi conductor.• Effect of temperature on intrinsic semiconductor• Doping p and n types• Formation of extrinsic | 8 |

| | | | |
|-------------------|------------------------------|---|-----------|
| | | semiconductor | |
| 15.1.4 | Semi-conductor diodes | <ul style="list-style-type: none"> • PN junction diode • Forward and reverse bias of pn junction diodes • Applications of pn junction diodes | 10 |
| 15.1.5 | Bipolar Junction Transistors | <ul style="list-style-type: none"> • Operation of NPN and PNP • Characteristics • Biasing methods • Determination of gains using Dc/ac load-lines | 8 |
| 15.1.6 | Field Effect Transistor | <ul style="list-style-type: none"> • Operation of field effect transistors • Biasing methods • Determination of gains using dc/ac load-lines | 10 |
| 15.1.7 | Power supply units | <ul style="list-style-type: none"> • Transformation • Rectification • Filtering • Stabilization • Regulation • Voltage multiplication • Power conversion | 12 |
| Total Time | | | 66 |

15.1.1 ATOMIC THEORY OF MATTER

Theory

15.1.1T0 Specific Objectives

By the end of the sub module unit the trainee should be able to:

- a) explain atomic structure
- b) explain energy level of an Atom

Content

15.1.1T1 Explanation of atomic structure

- i) The atom
- ii) Rutherford's atomic model
- iii) Plank's quantum Theory of radiation
- iv) Bohr's model

15.1.1T2 Explain the energy levels

- i) Energy level diagram
- ii) Collision of electrons and atoms
- iii) Photons of light
- iv) Spectral lines
- v) Photo ionization
- vi) Conduction band
- vii) Valence band
- viii) Forbidden gap

15.1.2 THERMIONIC EMISSION

Theory

15.1.2T0 Specific Objectives

By the end of the sub module unit the trainee should be able to:

- a) explain principles of thermionic emission

- b) state the advantages and limitations of valves in electronic industry
- c) explain the motion of electrons in a magnetic and electrostatic field
- d) describe the construction and operation of a Cathode Ray Tube (CRT)
- e) describe the construction and operation of a Cathode Ray Oscilloscope (CRO)
- f) explain the application of thermionic emission

Content

15.1.2T1 Principles of thermionic emission

- i) Work function
- ii) Space charge
- iii) Direct and indirect heating
- iv) Electron emitting materials

15.1.2T2 Applications and limitations of valves

15.1.2T3 Motion of electrons in magnetic and electrostatic fields

- i) Force
- ii) Deflection in transverse field
- iii) Magnetic field deflection
- iv) Electrostatic field deflection
- v) Electron velocity
- vi) Deflection of an electron beam

15.1.2T4 Cathode Ray Tube

- i) Construction
- ii) Operation
- iii) Application

15.1.2T5 Cathode Ray Oscilloscope

- i) Describe the construction by block diagram
- ii) Describe the operation
- 15.1.2T6 Applications
- b) explain effect of temperature on intrinsic semiconductor
- c) describe doping
- d) describe formation of extrinsic semiconductor

Practice

15.1.2P0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) operate a cathode-ray oscilloscope (CRO)
- b) take measurements using a CRO

Content

15.1.2P1 Operating a CRO

15.1.2P2 Taking measurements using a CRO

15.1.2C Competence

The trainee should have the ability to:

- i) Operate a CRO
- ii) Take measurements using a CRO

Learning Resources

- i) Cathode-ray oscilloscope
- ii) Signal generators
- iii) Probes

15.1.3 SEMI CONDUCTOR THEORY

Theory

15.1.3T0 Specific Objectives

By the end of the sub module unit the trainee should be able to:

- a) explain intrinsic semiconductor

Content

15.1.3T1 Bond in Intrinsic semi conductors

- i) Ge Si
- ii) Covalent bonding

15.1.3T2 Temperature on intrinsic semi conductor materials

15.1.3T3 Doping

15.1.3T4 Formation of extrinsic semi conductor

- iv) p type
- v) n type

Practice

15.1.3P0 Specific Objectives

By the end of the sub module unit, the trainee should be able to verify the effect of temperature on a diode performance

Content

15.1.3P1 Verification of the effect of temperature on diode

15.1.3C Competence

The trainee should have the ability to:

- i) Verify the effect of temperature on diodes
- ii) Use a diode in electronic circuits

Suggested teaching/Learning Activities

- Demonstration

- Note taking
- Observation
- Practical exercise

Suggested teaching/Learning Resources

- i) Various types of diodes
- ii) Electronic tool kit
- iii) Power supply

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

15.1.4 SEMICONDUCTOR DIODE

Theory

15.1.4T0 Specific Objectives

By the end of the sub module unit the trainee should able to:

- a) describe formation of PN junction
- b) explain forward and reverse bias of PN junction
- c) explain applications of semiconductor diodes

Content

15.1.4T1 Formation of an PN junction diode.

- i) Diffusion
- ii) Depletion layer
- iii) Barrier potential

15.1.4T2 Forward and reverse mode of operation of PN junction diode.

- i) Drift
- ii) Forward characteristics
- iii) Reverse characteristics
- iv) Zener Avalanche effect

15.1.4T3 Application of semiconductor diodes

- i) Power diodes
- ii) signal diodes

Practice

15.1.4P0 Specific Objectives

By the end of the sub module unit, the trainee should be

able to:

- a) identify the diode terminals
- b) determine diode characteristics

Content

15.1.4P1 Identifying diode terminals

15.1.4P2 Determining diode characteristics

15.1.4C Competence

The trainee should have the ability to:

- i) Identify diode terminals
- ii) Determine diode characteristics

Suggested teaching/Learning Activities

- Demonstration
- Note taking
- Observation
- Practical exercise

Learning Resources

- i) Assorted semi conductor diodes
- ii) DC power supply
- iii) Multimeters
- iv) Graph paper
- v) X-ray plotter

Suggested Evaluation Methods

- Oral tests
 - Timed written tests
 - Assignments
 - Timed practical tests
- DC load-line
- i) Gain estimates
 - ii) Current, voltage and power gain
 - iii) Maximum power curve.

15.1.5 BIPOLEAR JUNCTION TRANSISTORS

Theory

15.1.5T0 Specific Objectives

By the end of the sub module unit the trainee should be able to:

- a) describe the construction and operation of a Bipolar Junction Transistors (BJT)
- b) explain the characteristics of Bipolar Junction Transistor
- c) describe the biasing methods
- d) determine gains using DC load lines

Content

15.1.5T1 Construction and operation of BJTs

- i) NPN
- ii) PNP

15.1.5T2 Static characteristics of BJTs

- i) Input
- ii) Output
- iii) Transfer

15.1.5T3 Transistor biasing methods

- i) Base bias
- ii) Emitter bias
- iii) Collector base feedback bias
- iv) Potential divider bias

15.1.5T4 DC load-lines

Practice

15.1.5P0 Specific Objectives

By the end of the sub module unit the trainee should be able to:

- a) identify the type of transistors
- b) determine static transistor characteristics
- c) bias a transistor amplifier
- d) construct dc loadlines

Content

15.1.5P1 Identifying types of transistors

15.1.5P2 Determining static characteristics of transistors

15.1.5P3 Biasing transistor amplifier

15.1.5P4 Constructing dc loadlines

15.1. C Competence

The trainee should have the ability to:

- i) Construct a single stage transistor amplifier
- ii) Test a single stage transistor amplifier

Suggested teaching/Learning Activities

- Illustration
- Demonstration
- Note taking

Learning Resources

- i) Power supplies
- ii) Assorted transistors
- iii) Breadboard

- Oral tests
 - Timed written tests
 - Assignments
 - Timed practical tests
- DC load-line
- i) Gain estimates
 - ii) Current, voltage and power gain
 - iii) Maximum power curve.

15.1.5 BIPOLAR JUNCTION TRANSISTORS

Theory

15.1.5T0 Specific Objectives

By the end of the sub module unit the trainee should be able to:

- a) describe the construction and operation of a Bipolar Junction Transistors (BJT)
- b) explain the characteristics of Bipolar Junction Transistor
- c) describe the biasing methods
- d) determine gains using DC load lines

Content

15.1.5T1 Construction and operation of BJTs

- i) NPN
- ii) PNP

15.1.5T2 Static characteristics of BJTs

- i) Input
- ii) Output
- iii) Transfer

15.1.5T3 Transistor biasing methods

- i) Base bias
- ii) Emitter bias
- iii) Collector base feedback bias
- iv) Potential divider bias

15.1.5T4 DC load-lines

Practice

15.1.5P0 Specific Objectives

By the end of the sub module unit the trainee should be able to:

- a) identify the type of transistors
- b) determine static transistor characteristics
- c) bias a transistor amplifier
- d) construct dc loadlines

Content

15.1.5P1 Identifying types of transistors

15.1.5P2 Determining static characteristics of transistors

15.1.5P3 Biasing transistor amplifier

15.1.5P4 Constructing dc loadlines

15.1. C Competence

The trainee should have the ability to:

- i) Construct a single stage transistor amplifier
- ii) Test a single stage transistor amplifier

Suggested teaching/Learning Activities

- Illustration
- Demonstration
- Note taking

Learning Resources

- i) Power supplies
- ii) Assorted transistors
- iii) Breadboard

- iv) Connecting leads
 - v) Multimeters
 - vi) X-Y plotter
 - vii) Assorted resistors
 - Observation
 - Practical exercise
 - Calculations
 - Project work
 - Role play
 - Visits to industries
- 15.1.6T3 DC load-lines
- ii) Source bias
 - iii) Drain base feedback bias
 - iv) Potential divider bias
 - i) DC Load-line
 - ii) Estimation gain (current, voltage and power)
 - iii) Maximum power curve.

Practice

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

15.1.6 FIELD EFFECT TRANSISTORS

Theory

15.1.6T0 Specific Objectives

By the end of the sub module unit the trainee should be able to:

- a) explain the characteristics of field effect transistor
- b) describe the biasing methods
- c) determine gains using dc and ac load-lines

Content

15.1.6T1 Construction and operation of FETs

- i) Static characteristics of fets
- ii) Jfets
- iii) Mosfets
- iv) Input
- v) Output
- vi) Transfer

15.1.6T2 FETs biasing methods

- i) Gate bias

15.1.6P0 Specific Objectives

By the end of the sub module unit the trainee should be able to:

- a) identify the types of FETs
- b) determine static FET characteristics
- c) bias a FET
- d) construct dc loadline

Content

- 15.1.6P1 Identifying types of FETs
- 15.1.6P2 Determination static characteristic of FETs
- 15.1.6P3 Biasing a FET amplifier
- 15.1.6P4 Construction of dc loadlines

15.1.6C Competence

The trainee should have the ability to:

- i) Construct a single stage FET amplifier
- ii) Test a single stage FET amplifier

Suggested teaching/Learning Activities

- Demonstration
- Note taking
- Observation
- Practical exercise

Suggested teaching/Learning Resources

- i) Field effect transistors
- ii) Power supply
- iii) Electronic tools
- iv) Electrical measuring instruments

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

15.1.7 POWER SUPPLIES

Theory

15.1.7T1 Specific Objectives

By the end of the sub module unit the trainee should able to:

- a) describe block diagram of power supply
- b) explain principles rectification
- c) explain smoothing and filtering
- d) explain power regulation/stabilizer methods
- e) describe voltage multiplier methods
- f) describe methods of power conversion

Content

15.1.7T1 Description of the block diagram of power supply

- i) Transformation
- ii) Rectification
- iii) Filters
- iv) Regulator

15.1.7T2 Explanation of principles rectification

- i) Half wave
- ii) Full wave bi-phase

- iii) Bridge
- 15.1.7T3 Explanation
 - filtration/smoothing
 - i) Capacitor filter
 - ii) Inductive filtering
- 15.1.7T4 Explanation power regulation/stabilizer methods
 - i) Zener diode regulator
 - ii) Linear regulators
 - iii) Switched regulators
- 15.1.7T5 Description of voltage multiplier methods
 - i) Doubler
 - ii) Tripler
 - iii) Cockcroft walton
- 15.1.7T6 Description of methods of power conversion
 - i) Dc to ac
 - ii) Dc to dc

Practice

15.1.7P0 Specific Objectives

By the end of the sub module unit the trainee should be able to:

- a) Construct a power supply unit
- b) Test a power supply unit

Content

15.1.7P1 Construction of power supply units

15.1.7P2 Testing a power supply unit

15.1.7C Competence

The trainee should have the ability to: construct and test a power supply unit

Suggested teaching/Learning Activities

- Demonstration
- Note taking
- Observation

- Practical exercise

Teaching/Learning Resources

- i) Step-down transformer
- ii) Rectifier diodes
- iii) Smoothing capacitor
- iv) Zener diode regulations
- v) Transistor regulations
- vi) IC regulators
- vii) Potentiometers
- viii) Assorted resistors

- ix) Multimeters
- x) CRP
- xi) RF bypass capacitors

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests
- Project

16.1.0 ELECTRICAL MEASUREMENTS AND FAULT DIAGNOSIS

16.1.01 Introduction

This course module unit is intended to provide the trainee with knowledge, skills and attitudes in order to carry out basic measurement and fault diagnosis, and understand reliability concepts.

16.1.02 General Objectives

By the end of this course, the trainee should be able to: -

- a) Explain fundamental and standard units of measurements
- b) Carry out measurements on various electrical quantities
- c) Diagnose faults in electrical and electronic equipment and devices
- d) Understand concepts of reliability

16.1.03 Module Unit Summary Module Unit

Electrical Measurements and Fault Diagnoses

| Code | Sub module units | Contents | Time Hrs |
|-------------|---------------------------------------|--|-----------------|
| 16.1.1 | Units | <ul style="list-style-type: none">• Fundamentals• Standard of units• Calculation | 6 |
| 16.1.2 | Measurement techniques | <ul style="list-style-type: none">• Measurement errors• <i>Measurement of:</i><ul style="list-style-type: none">• dc Voltage and current• Resistance• Ac current and voltage• Inductance and capacitance• Magnetic• Modulation• Frequency• Power | 24 |
| 16.1.3 | Electrical Circuits and common faults | <ul style="list-style-type: none">• The soldering process• Testing procedures for electrical circuits | 8 |
| 16.1.4 | Repair aids | <ul style="list-style-type: none">• Manuals• Instruments and Tools | 6 |
| 16.1.5 | Fault location and repair | <ul style="list-style-type: none">• Methods of fault location | 10 |

| | | | |
|-------------------|-----------------------|--|-----------|
| 16.1.6 | Maintenance | <ul style="list-style-type: none"> • Corrective maintenance • Preventive maintenance • Planned maintenance • Routine maintenance | 8 |
| 16.1.7 | Equipment Reliability | <ul style="list-style-type: none"> • Design and development • Types of failures • Periods of failures • Assessment, testing and inspection • Reliability analysis | 4 |
| Total Time | | | 66 |

16.1.1 UNITS

Theory

16.1.1T0 *Specific Objectives*

By the end of the sub - module unit, the trainee should be able to:

- a) explain the fundamental of units
- b) explain the standards of units
- c) perform calculations using the various systems of units

Content

16.1.1T1 Fundamental unit

- i) Absolute
- ii) Mechanical fundamental units
- iii) Auxiliary fundamental units
- iv) Derived units
- v) Multiples and sub-multiples of fundamental units

16.1.1T2 Standards of units

- i) International
- ii) Primary
- iii) Secondary
- iv) Working

16.1.1T3 Calculations

- i) Dimensions
- ii) E.S.U systems
- iii) E.M.U systems
- iv) M.K.S systems
- v) Errors

16.1.1C Competence

The trainee should have the ability to: use standard units in an electrical standards room

16.1.2 MEASUREMENT TECHNIQUES

Theory

16.1.2T0 *Specific Objectives*

By the end of the sub module unit, the trainee should be able to:

- a) describe various types of measurement errors
- b) analyze methods of direct current and voltage measurement
- c) analyze the methods of measurement of resistance
- d) analyze the methods for alternating current and voltage measurement
- e) analyze methods of measurement of inductance and capacitance
- f) analyze the methods and instruments used for magnetic measurement
- g) analyze the methods of measurement of frequency
- h) describe the methods of modulation measurement
- i) analyze the methods for measurement of power

Content

16.1.2T1 Measurement errors

- i) Relative
- ii) Instrumental
- iii) Environmental
- iv) Random
- v) Observation

| | | |
|----------|---|---|
| 16.1.2T2 | Measurement of direct current and voltage <ul style="list-style-type: none"> i) Shunt and ammeter method ii) Universal shunt method iii) Multi-range voltmeter method iv) D.C valve voltmeter. | v) Resonance (tuned circuit) methods <ul style="list-style-type: none"> vi) Q-meter |
| 16.1.2T3 | Resistance measurement <ul style="list-style-type: none"> i) Continuity testers ii) The voltmeter method iii) The ammeter method iv) The voltmeter-ammeter method v) The ohmmeter method vi) Valve ohmmeter method vii) Bridge method | 16.1.2T6 Magnetic measurement <ul style="list-style-type: none"> i) Construction and principles of operation of instruments ii) Flux meter iii) Ballistic galvanometer iv) Hibert's magnetic standard v) B-H curve and hysteresis loop vi) Step by step method vii) Lloyd Fisher square viii) Hall effect |
| 16.1.2T4 | Alternating current and voltage measurements <ul style="list-style-type: none"> i) Thermal instrument method ii) Rectifier instrument method iii) Source of errors iv) Temperature v) Frequency vi) waveforms vii) Multimeter viii) A.C valve voltmeter method ix) Electrostatic voltmeter method. | 16.1.2T7 Frequency measurement <ul style="list-style-type: none"> i) Digital frequency meter ii) Oscilloscope method up to 30MHz iii) Zero beat method iv) Absorption wave meter method v) Comparison method vi) Direct method vii) Resonance method viii) Heterodyne frequency method |
| 16.1.2T5 | Measurement of inductance and capacitance <ul style="list-style-type: none"> i) Equivalent circuit of a capacitor ii) Equivalent circuit of an inductor iii) The voltmeter-ammeter method iv) Bridge method | 16.1.2T8 Modulation measurements <ul style="list-style-type: none"> i) The CRO method ii) Ammeter or voltmeter method iii) Modulation meters iv) Frequency deviation meter |
| | | 16.1.2T9 Power measurement <ul style="list-style-type: none"> i) Bolometer method ii) Coaxial wave meter iii) Wattmeter method iv) Thermocouple method |

Practice

16.1.2P0 Specific Objectives

- By the end of the sub-module unit, the trainee should be able to:
- measure electrical quantities
 - Magnetic quantities

Content

16.1.2P1 Measurement of electrical quantities

- Direct current and voltage
- Resistance
- Alternating current and voltage
- Inductance
- Capacitance
- Power
- Frequency
- Modulation
- Magnetic

16.1.2P1 Measurement of magnetic quantities

16.1.2C Competence

The trainee should have the ability to:

- Measure electrical quantities
- Measure magnetic quantities

Suggested teaching/Learning Activities

- Illustration
- Demonstration
- Note taking
- Observation
- Practical exercise
- Calculations
- Visits to industries

Suggested teaching/Learning Resources

- Electrical and magnetic quantities measuring instruments

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

16.1.3 CIRCUITS AND COMMON FAULTS

Theory

16.1.3T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- explain the process of soldering
- explain the procedures for testing and diagnosing common faults in electrical circuits.

Content

16.1.3T1 Soldering

- Definition
- Types
- Faults
- Soldering iron

16.1.3T2 Circuits and faults

- Circuit components
 - Short circuits
 - Open circuit
- Integrated circuits and PCB
 - Input
 - Output
- PCB's
 - Open circuit
 - Short circuit

Practice

| | | |
|----------|---|--|
| | | <i>Suggested teaching/Learning Resources</i> |
| 16.1.3P0 | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: a) Perform soldering b) test and diagnose common faults in electrical circuits. | i) Electrical and electronic tool kits ii) Electrical and electronic circuits iii) Electrical and electronic devices iv) Electrical and electronic measuring instruments |
| | <i>Content</i> | |
| 16.1.3P1 | Soldering i) Soldering materials and tools ii) Types of solder iii) Types of Soldering iron | - Oral tests - Timed written tests - Assignments - Timed practical tests |
| 16.1.3P2 | Circuits and faults i) Circuit components - Short circuits - Open circuit ii) Integrated circuits and PCB - Input - Output iii) PCB's - Open circuit - Short circuit | 16.1.4 REPAIR AIDS Theory |
| 16.1.3C | Competence The trainee should have the ability to: test, diagnose and repair common faults in electrical circuits. | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: a) interpret electrical equipment manuals b) use electrical measuring instruments and tools to in testing repaired faults and interpret the readings |
| | <i>Suggested teaching/Learning Activities</i> | <i>Content</i> |
| | - Demonstration - Note taking - Observation - Practical exercise | 16.1.4P1 Interpretation of manuals i) Installation manuals ii) Operation manuals iii) Maintenance manuals |
| | | 16.1.4P2 Tools and Measuring instruments i) Measuring instruments - Multimeter - Frequency meters - Signal generators |

- Other testing
- Instrument
- Curve tracers
- ii) Tools
 - Screw drivers
 - Wire cutters
 - Adjustable spanners
 - Pliers, long nose
 - Soldering iron
 - Solder sucker
 - Solder wire
 - Probes

16.1.4C Competence

The trainee should have the ability to: repair faults in electrical circuits

Suggested teaching/Learning Activities

- Demonstration
- Note taking
- Observation
- Practical exercise

Suggested teaching/Learning Resources

- i) Electrical and electronic tool kits
- ii) Electrical and electronic circuits
- iii) Electrical and electronic devices
- iv) Electrical and electronic measuring instruments

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

16.1.5 FAULT LOCATION AND REPAIR

Theory

16.1.5T0 Specific Objectives

By the end of the sub-module unit, the trainee should able to describe the various methods of fault location

Content

- 16.1.5T1 Methods of fault location
- i) Functional test
 - ii) Physical checking
 - iii) Use of specified voltages and currents at test points
 - iv) Random and static tests
 - v) Input and output
 - vi) Half split
 - vii) Use of troubleshooting charts

Practice

16.1.5P0 Specific Objectives

By the end of the sub-module unit, the trainee should able to repair electrical and electronic equipment, appliances and machines

Content

- 16.1.5P1 Repair
- i) Soldering of dry joints and open circuits.
 - ii) Replacement of components
 - iii) Test and calibration

16.1.5C Competence

The trainee should have the ability to: repair electrical and electronic

| | |
|--|--|
| equipment, appliances and machines | 16.1.6T1 Corrective maintenance i) Definition ii) Work card iii) History card |
| <i>Suggested teaching/Learning Activities</i> <ul style="list-style-type: none"> - Illustration - Demonstration - Note taking - Observation - Practical exercise | 16.1.6T2 Preventive maintenance i) Definition ii) Audio sensitive gauges iii) Optical tools iv) Pressure gauges v) Temperature gauges vi) Vibration analyzers |
| <i>Suggested teaching/Learning Resources</i> <ul style="list-style-type: none"> - Electrical and electronic tool kits - Electrical and electronic circuits - Electrical and electronic devices - Electrical and electronic measuring instruments | 16.1.6T3 Planned maintenance i) Definition ii) Equipment registers iii) Code number giving location iv) Number of items in the location v) Costing the repairs vi) Computer storage vii) Register |
| <i>Suggested Evaluation Methods</i> <ul style="list-style-type: none"> - Oral tests - Timed written tests - Assignments - Timed practical tests | 16.1.6T4 Routine maintenance i) Cleaning equipment ii) Checking system performances |

16.1.6 MAINTENANCE

Theory

16.1.6T0 Specific Objectives

By the end of the sub - module unit, the trainee should able to:

- a) explain and carry out corrective maintenance
- b) describe and carry out preventive maintenance
- c) describe and carry out planned maintenance
- d) explain routine maintenance

Content

16.1.6P0 Specific Objectives

By the end of the sub - module unit, the trainee should able to perform various types of maintenance

Content

16.1.6P1 Maintenance

- i) Corrective maintenance
- ii) Preventive maintenance
- iii) Routine maintenance
- iv) Planned maintenance

16.1.6C Competence

The trainee should have the ability to: maintain electrical

| | |
|---|--|
| <p>installations, circuits and machines</p> <p><i>Suggested teaching/Learning Activities</i></p> <ul style="list-style-type: none"> - Illustration - Demonstration - Note taking - Observation - Practical exercise <p><i>Suggested teaching/Learning Resources</i></p> <ul style="list-style-type: none"> i) Electrical and electronic tool kits ii) Electrical and electronic circuits iii) Electrical and electronic devices iv) Electrical and electronic measuring instruments <p><i>Suggested Evaluation Methods</i></p> <ul style="list-style-type: none"> - Oral tests - Timed written tests - Assignments - Timed practical tests - Project - Project Report writing and presentation | <p>d) carry out reliability assessment, inspection and testing</p> <p>e) analyse reliability of various equipment</p> <p><i>Content</i></p> <p>16.1.7T1 Design and development</p> <ul style="list-style-type: none"> i) Definitions of terms used ii) Choice of components iii) Tests, stress and failure analysis iv) Complexity v) Inaccessibility vi) Environmental conditions <p>16.1.7T2 Various types of failures</p> <ul style="list-style-type: none"> i) Sudden ii) Gradual iii) Partial iv) Complete v) Catastrophic and degradation vi) Periods of failures vii) The bath tab diagram <p>16.1.7T3 Types of periods of failure</p> <ul style="list-style-type: none"> i) Failures due to incorrect operation ii) Definition and assessment of maintainability iii) Availability of equipment. <p>16.1.7T4 Reliability analysis</p> <ul style="list-style-type: none"> i) MTBF ii) MTTF iii) Reliability law <p>16.1.7C Competence</p> <p>The trainee should have the ability to: carry out reliability assessment, inspection and</p> |
|---|--|

tests on electrical and electronic devices

- Visits to standards laboratory
- Industrial attachment

Suggested teaching/Learning Activities

- Illustration
- Demonstration
- Note taking
- Observation
- Practical exercise
- Calculations

Suggested teaching/Learning Resources

- Calculator

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments

**DIPLOMA IN ELECTRICAL AND
ELECTRONIC ENGINEERING**

POWER OPTION

MODULE II

MODULE II - ELECTRICAL POWER GENERATION AND TRANSMISSION

Introduction

This module is designed to enable the trainee acquire necessary knowledge, skills, attitudes and Competence that can be utilized in Electrical , Electronics and Instrumentation works, and in a general production line

The graduate of this module has the necessary skills for the world of work as a technician or be self employed in an Electrical, Electronics and Instrumentation workshop.

General Objectives

At the end of this module the trainee should be able to:

- a) Understand the general concepts of electronic and instrumentation systems
- b) Understand industrial measurements and control techniques
- c) Appreciate maintenance of electronics and instrumentation systems
- d) Know the use of ICT in understanding electronics and instrumentation technology
- e) Appreciate the concepts of establishing a related business
- f) Observe safety regulations and standards when performing tasks

Key Competence

At the end of this module, the trainee should be able to demonstrate ability to;

- a) design and assemble electronics circuits
- b) measure and control various physical quantities in process production plant
- c) establish a business in the trade area

The units covered in this module are:

Code

- 17.2.0 Control Systems
- 18.2.0 Analogue Electronics II
- 19.2.0 Engineering Mathematics II
- 20.2.0 Digital Electronics
- 21.2.0 Engineering Drawing and Design
- 22.2.0 Industrial Programmable Logic controllers
- 23.2.0 Business Plan
- 24.2.0 Electric Circuit Analyses
- 25.2.0 Building Electrical Protection and Services
- 26.2.0 Electrical Power Generation and Transmission

17.2.0 CONTROL SYSTEMS

17.2.01 Introduction

This course module is aimed at providing the trainee with theoretical and practical understanding of control systems in the industries. A trainee undertaking this module unit require foundations of Mathematical concepts in Laplace transforms.

17.2.02 General Objectives

At the end of the module, the trainee should be able to:

- a) Understand the principles of engineering control systems
- b) Appreciate system response and performance
- c) Analyze system's stability for a given control task.
- d) Understand the need for compensation and use conventional techniques to compensate practical systems.
- e) Apply analogue system simulation to solve systems' mathematical equations.
- f) Understand the principles and applications of servo systems.

17.2.03 Module Unit Summary and Time Allocation

Engineering Control Systems

| Code | Sub Module Unit | Content | Time Hrs |
|-------------|------------------------|---|-----------------|
| 17.2.1 | Introduction | <ul style="list-style-type: none">• System terminology• Open and Closed loop | 2 |
| 17.2.2 | Block Diagrams | <ul style="list-style-type: none">• Canonical form simplification | 6 |
| 17.2.3 | Signal Flow Graphs | <ul style="list-style-type: none">• Conversion of block diagram to signal flow diagram• Simplification of system loop | 6 |
| 17.2.4 | System Modelling | <ul style="list-style-type: none">• Need for modelling• Transfer functions for simple networks• Practical systems | 6 |
| 17.2.5 | System Performance | <ul style="list-style-type: none">• Test signals• Dynamic responses• Damping | 6 |
| 17.2.6 | Stability | <ul style="list-style-type: none">• Types of Stability• Routh's stability Criterion• Nyquist stability Criterion• Bode Plots | 16 |

| | | | |
|-------------------|--|---|-----------|
| | | <ul style="list-style-type: none"> • Nichol's Chart • Root Locus | |
| 17.2.7 | System compensation | <ul style="list-style-type: none"> • Need for compensation • Compensation networks • Design of compensation networks | 8 |
| 17.2.8 | Analogue computing and system simulation | <ul style="list-style-type: none"> • Need for simulation • Principles of an Operational Amplifier (Op-amp) • Op-amp arithmetic circuit • Solution of equations • Scaling | 8 |
| 17.2.9 | Servo Systems | <ul style="list-style-type: none"> • Servo mechanism • AC and dc servo amplifiers • Phase sensitive rectifiers • Thyristor controlled dc servo systems • Operation of stepper motors • Characteristics curves for servo motors • Calculations for given data | 8 |
| Total Time | | | 66 |

17.2.1 INTRODUCTION TO CONTROL

Theory

17.2.1T0 Specific Objectives

By the end of the sub- module unit, the trainee should be able to:

- a) explain control terms
- b) compare and contrast open and closed loop systems

Content

17.2.1T1 Control system terms

- i) Control
- ii) System
- iii) Control system
- iv) Man-made system
- v) Natural system
- vi) Hybrid system
- vii) Controlled variable
- viii) Reference variable
- ix) Plant

17.2.1T2 Open and closed loop system

- i) Feedback
- ii) Features of open loop
- iii) Features of closed loop
- iv) Advantages and disadvantages

Competence

The trainee should have the ability to: identify and select types of control systems for electrical systems

Suggested teaching/Learning Activities

- Illustration
- Note taking
- Visits to industries

Suggested teaching/Learning Resources

- Sample practical control units

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments

17.2.2 BLOCK DIAGRAMS

Theory

17.2.2T0 Specific Objectives

By the end of the sub module unit the trainee should be able to simplify control system block diagram

Content

17.2.2T1 Simplification of block diagrams

- i) Canonical form
- ii) Transfer functions
- iii) Superposition
- iv) Error ratio
- v) Primary feedback ratio

Competence

The trainee should have the ability to: establish the transfer functions for various basic and mechanical systems

Suggested teaching/Learning Activities

- Illustration
- Note taking

Suggested teaching/Learning Resources

- Sample practical control units
- Simulators

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments

17.2.3 SIGNAL FLOW GRAPHS

Theory

17.2.3T0 Specific Objectives

By the end of the sub module unit the trainee should be able to:

- a) convert block diagrams to flow diagrams
- b) simplify system loops

Content

17.2.3T1 Conversion of block diagrams to flow diagrams

- i) Nodes
- ii) Sinks

17.2.3T2 Simplification of system loops

- i) Masons rule
- ii) Complex loop
- iii) Loop reduction

17.2.4 SYSTEM MODELLING

Theory

17.2.4T0 Specific Objectives

By the end of the sub- module unit, the trainee should be able to:

- a) explain the need for systems modelling
- b) derive transfer functions for simple networks and determine their transfer functions.
- c) represent practical systems with transfer functions.

Content

17.2.4T1 Need for modelling

17.2.4T2 Derivation of transfer functions for simple networks

- i) Electrical
- ii) Mechanical
- iii) (S) , $j\omega$, D operations

17.2.4T3 Presentation of practical systems

- i) Generators and Motors
- ii) Temperature control systems
- iii) Solving problem with given data

Competence

The trainee should have the ability to: convert block diagrams to signal flow diagrams

Suggested teaching/Learning Activities

- Illustration
- Note taking

Suggested teaching/Learning Resources

- Sample practical control units

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments

17.2.5 SYSTEM PERFORMANCE

Theory

17.2.5T0 Specific Objectives

By the end of the sub- module unit, the trainee should be able to

- a) describe test signals

- b) explain the dynamic response of 1st and 2nd order systems
- c) analyze the effects of various methods of damping

Content

- | | |
|----------|--|
| 17.2.5T1 | Test signals <ul style="list-style-type: none"> i) Step ii) Velocity iii) Acceleration iv) Sinusoidal v) Unity impulse |
| 17.2.5T2 | Dynamic response for 1 st and 2 nd order systems <ul style="list-style-type: none"> i) Response terms ii) Standard 2nd order equation iii) Response graphs iv) Derive dimensional 2nd order equation |
| 17.2.5T3 | Damping methods <ul style="list-style-type: none"> i) Velocity feedback ii) Error rate iii) Viscous damping iv) Effects of damping ratio v) Calculations of limiting values |

Suggested teaching/Learning Activities

- Illustration
- Note taking

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments

17.2.6 STABILITY

Theory

17.2.6T0 specific objectives

By the end of the sub - module unit, the trainee should be able to:

- a) explain types of stability
- b) describe Routh's stability criterion
- c) explain Nyquist diagrams
- d) plot bode plot
- e) construct Nichol's charts
- f) sketch Root Locus diagrams

Content

- | | |
|----------|--|
| 17.2.6T1 | Types of Stability <ul style="list-style-type: none"> i) Bounded input bounded output ii) Relative stability iii) Absolute stability |
| 17.2.6T2 | Routh's stability criterion <ul style="list-style-type: none"> i) Array formation ii) Determination of stability iii) Calculations |
| 17.2.6T3 | Nyquist diagrams <ul style="list-style-type: none"> i) Statement of Nyquist stability criterion ii) Nyquist diagram iii) Determination of gain and phase margins iv) Determination of gain and phase cross over frequency v) Calculation of a value K, required for stability vi) Description of type O, I, II and III of Nyquist systems vii) Sketches for open loop frequency |

| | | |
|----------|--|--|
| | <p>response for different systems</p> <p>viii) Analyses of Inverse Nyquist curve</p> <p>ix) Derivation of m and n circles</p> <p>x) Determination of maximum value of M and the frequency at which it occurs</p> <p>xii) Evaluation of band width.</p> | <p>viii) Band width</p> <p>ix) Closed loop frequency response</p> |
| 17.2.6T6 | <p>Root locus</p> <p>i) Construction</p> <p>ii) Analysis</p> | |
| 17.2.6T4 | <p>Bode plot</p> <p>i) Logarithmic diagrams for simple systems asymptotes for magnitude</p> <p>ii) Determination of:</p> <p>iii) Phase and gain cross over frequency</p> <p>iv) Phase and gain margins</p> <p>v) Stability</p> <p>vi) Output – input functions from a given asymptotic plots</p> | <p><i>Suggested teaching/Learning Activities</i></p> <ul style="list-style-type: none"> - Illustration - Note taking <p><i>Suggested teaching and Learning Resources</i></p> <ul style="list-style-type: none"> - Text books - Appropriate charts and graphs - Equipment - Mat lab programmes - internet |
| 17.2.6T5 | <p>Nichol's chart</p> <p>i) Description of Nichol's chart</p> <p>ii) Rectangular coordinates</p> <p>iii) Identification of M and N circles</p> <p>iv) Open loop frequency response curves</p> <p>v) Determination of:</p> <p>vi) Phase and gain margin</p> <p>vii) M_{\max} and ω_r</p> | <p><i>Suggested Evaluation Methods</i></p> <ul style="list-style-type: none"> - Oral tests - Timed written tests - Assignments <p>17.2.7 COMPENSATION</p> <p>Theory</p> <p>17.2.7T0 Specific objectives</p> <p>By the end of the sub - module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) explain the need for compensating networks b) derive transfer function of compensating networks c) design compensating network <p>Content</p> <p>17.2.7T1 Need for system compensation</p> <p>17.2.7T2 Compensating networks transfer functions</p> |

| | |
|---|--|
| 17.2.7T3 Compensation network i) Lead ii) Lag iii) Lead lag iv) Design – bode - Lead - Lag - Lead-lag - Compensation using 3- term controller | d) solve equations using operational amplifiers e) apply scaling methods |
| 17.2.7C Competence The trainee should have the ability to: design compensating net works for control systems | <i>Content</i> |
| <i>Suggested teaching /learning resources</i> | 17.2.8T1 Need for Simulation |
| - Text books - Equipment - Appropriate charts and graphs - Sample practical control units | 17.2.8T2 Operation of Operational amplifier |
| <i>Suggested Evaluation Methods</i> | 17.2.8T3 Operational amplifier arithmetic circuit |
| - Oral tests - Timed written tests - Assignments | 17.2.8T4 Solution of equations using operational amplifier |
| 17.2.8 ANALOGUE COMPUTING SYSTEM SIMULATION | i) Summer ii) Inverter iii) Integrator iv) Differentiator v) Logarithmic amplifier vi) Comparator |
| Theory | vii) Differential equations using Op Amp |
| 17.2.8T0 Specific objectives By the end of the sub - module unit, the trainee should be able to: a) describe need for simulation b) describe the principles of an operational amplifier c) explain op-amp arithmetic circuit | 17.2.8T5 Scaling method i) Amplitude ii) Time |
| Practice | <i>Specific objectives</i> |
| 17.2.8P0 By the end of the sub module unit, the trainee should be able to assemble electronic circuit to carry out analogue computing techniques | <i>Content</i> |
| 17.2.8P1 Analogue computing techniques i) Inverting ii) Integrating iii) Comparing iv) Summing v) Differentiating vi) Logarithmic | |

- 17.2.8C Competence**
- The trainee should have the ability to:
- i) Interconnect analogue computer component to form a system
 - ii) Perform measurements on systems
 - e) explain the operation and control of stepper motors
 - f) sketch characteristics curves of ac and dc servomotors
 - g) solve stepper motor related problems

Suggested teaching/Learning Activities

- Illustration
- Note taking
- Simulation

Suggested Teaching /Learning resources

- Text books
- Analogue computer components

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments

17.2.9 SERVO SYSTEMS

Theory

17.2.9T0 Specific objectives

By the end of the sub-module unit, the trainee should be able to:

- a) describe servo mechanisms
- b) describe the difference between ac and dc servo amplifiers
- c) explain phase sensitive rectifiers
- d) explain the operation of thyristor controlled dc servo systems

- Content*
- | | |
|-----------------------|---|
| 17.2.9T1 | Servo mechanisms |
| i) Position | |
| ii) Speed | |
| iii) Acceleration | |
| 17.2.9T2 | Servo amplifiers |
| i) DC | |
| ii) AC | |
| 17.2.9T3 | Phase sensitive rectifier |
| iii) Synchros | |
| iv) Applications | |
| 17.2.9T4 | Operation of Stepper motors |
| i) Constructions | |
| ii) Operations | |
| iii) Control circuits | |
| iv) Calculations | |
| v) Interfacing | |
| vi) Applications | |
| 17.2.9T5 | Characteristics curves of ac and dc servomotors |
| Sketching | |
| 17.2.9T6 | Calculations |

Practice

- 17.2.9P0 Specific Objectives**
- By the end of the sub-module unit the trainee should be able to:
- a) carry out measurement of an ac and dc servomechanism
 - b) take measurements on the performance of a stepper motor

Coniene

- 17.2.9P1 Measurements on a Servomechanisms
- 17.2.9P2 Measurements Stepper motors
- i) Phase tests

17.2.9C Competence

The trainee should have the ability to: use a servo motor in a control system

Suggested teaching/Learning

Activities

- Illustration
- Note taking
- Practical exercises

Suggested Teaching /Learning

resources

- Text books
- Servo motors
- Phase sensitive rectifiers

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments

18.2.0 ANALOGUE ELECTRONICS II

18.2.01 Introduction

Analogue electronics is a study that deals with electronic systems with a continuously variable signal. This module unit is intended to impart knowledge, skills and attitudes required to enable the trainee understand the principles of operations of various electrical circuits, equipment and devices in the industries.

Trainees will appreciate and apply the knowledge and skills learned in Analogue Electronics I of module I.

18.2.02 General Objectives

At the end of this module unit, the trainee should be able to:

- a) Understand the characteristics of special semi-conductor devices
- b) Understand the operation of electronic circuits
- c) Apply semi-conductor devices

18.2.03 Module Unit Summary and Time Allocation

Analogue Electronics II

| Code | Module Unit | Content | Time Hrs |
|-------------|---------------------------------|--|-----------------|
| 18.2.1 | Special Semi Conductor Devices | <ul style="list-style-type: none">• Principles of operation• Applications of special semiconductor devices | 12 |
| 18.2.2 | Amplifiers | <ul style="list-style-type: none">• RC coupled amplifiers• Analyses of linear amplifiers• Amplifier gain• Power amplifier• Tuned amplifiers• Wideband amplifiers• Amplifier distortion | 16 |
| 18.2.3 | Operational Amplifiers (Op-Amp) | <ul style="list-style-type: none">• Direct Coupled amplifiers• Differential amplifiers• OP-amp characteristics• OP-amp circuits | 16 |
| 18.2.4 | Feedback | <ul style="list-style-type: none">• Feedback principle• Feedback equations• Effects of negative feedback• Feedback connections | 10 |
| 18.2.5 | Sinusoidal Oscillators | <ul style="list-style-type: none">• Concept of oscillators• Oscillation requirements | 10 |

| | | | |
|-------------------|--|---|-----------|
| | | <ul style="list-style-type: none"> • Oscillator circuits | |
| 18.2.6 | Wave Shaping and Pulse Generating Circuits | <ul style="list-style-type: none"> • Wave shaping • Pulse generation | 12 |
| 18.2.7 | Opto- Electronics | <ul style="list-style-type: none"> • Theory of opto electronics • Lasers and masers • Properties and drive requirements • Photo devices • Applications | 12 |
| Total Time | | | 88 |

| | | | |
|----------|-----------------|--|---------------------------------|
| | 18.2.1 | SPECIAL SEMI CONDUCTOR DEVICES | |
| | | Theory | |
| 18.2.1T0 | | <i>Specific Objectives</i> | |
| | | By the end of the sub-module unit, the trainee should be able to: | |
| | | a) explain principles of semi conductor devices | |
| | | b) state the application of semi conductor devices | |
| | | <i>Content</i> | |
| 18.2.1T1 | | Principles of semi conductor devices | |
| | | i) Varactor diode | |
| | | ii) UJT | |
| | | iii) Programmable UJT | |
| | | iv) Silicon controlled rectifiers (SCRs) | |
| | | v) Silicon Controlled Switch (SCS) | |
| | | vi) Diac | |
| | | vii) Triac | |
| 18.2.1T2 | | Application of semi conductor devices | |
| | | Practice | |
| | 18.2.1P0 | <i>Specific Objectives</i> | |
| | | By the end of the sub-module unit, the trainee should be able to: | |
| | | a) identify device terminals | |
| | | b) verify device characteristics | |
| | | <i>Content</i> | |
| 18.2.1P1 | | Identification of terminals | |
| | | 18.2.1P2 | Verification of characteristics |
| | | 18.2.1C Competence | |
| | | The trainee should have the ability to: connect and test a special semi conductor device | |
| | | <i>Suggested teaching/Learning Activities</i> | |
| | | - Illustrations | |
| | | - Demonstration | |
| | | - Note taking | |
| | | - Observation | |
| | | - Practical exercise | |
| | | <i>Suggested Teaching/Learning Resources</i> | |
| | | i) Various special semi conductor devices | |
| | | ii) Breadboard | |
| | | iii) Circuit board | |
| | | iv) Power supply | |
| | | v) Data/catalogue books | |
| | | vi) Internet | |
| | | <i>Suggested Evaluation Methods</i> | |
| | | - Oral tests | |
| | | - Timed written tests | |
| | | - Assignments | |
| | | - Timed practical tests | |
| | | - Project | |
| | 18.2.2 | AMPLIFIERS | |
| | | Theory | |
| | 18.2.2T0 | <i>Specific Objectives</i> | |
| | | By the end of the sub-module unit, the trainee should be able to: | |
| | | a) explain the performance of RC coupled amplifiers | |

- b) analyze the frequency response of linear amplifiers
- c) derive the gain of an amplifier
- d) describe the operation of power amplifiers
- e) describe the operation of tuned amplifiers
- f) describe the operation of wideband amplifiers
- g) explain distortion in amplifiers
- iii) Frequency distortion
- iv) Phase distortion
- v) Non-linear distortion

Practice

18.2.2P0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) construct amplifiers
- b) verify amplifier performance

Content

- | | |
|----------|-----------------------------|
| 18.2.2T1 | RC coupled amplifiers |
| | i) Biasing |
| | ii) Stability |
| | iii) Operating Conditions |
| 18.2.2T2 | Frequency response |
| | low frequency |
| | i) Mild-band frequency |
| | ii) High frequency |
| 18.2.2T3 | Gain of amplifiers |
| | i) Graphical methods |
| | ii) H-parameter analysis |
| 18.2.2T4 | Power amplifiers |
| | i) Classes |
| | ii) Efficiency |
| | iii) Matching |
| | iv) Push-pull |
| 18.2.2T5 | Tuned amplifiers |
| | i) Tuned circuits |
| | ii) Response curves |
| | iii) Single tuned |
| | iv) Double tuned |
| | v) Stagger tuned |
| 18.2.2T6 | Wide band amplifiers |
| | i) Common base |
| | ii) Cascade |
| | iii) Frequency compensation |
| | iv) Applications |
| 18.2.2T7 | Distortion in amplifiers |
| | i) Amplitude distortion |
| | ii) Harmonic distortion |

Content

- | | |
|----------|--|
| 18.2.2P1 | Construction of amplifiers |
| 18.2.2P2 | Verification of permanence of amplifiers |

18.2.2C Competence

The trainee should have the ability to: ability to construct and verify the performance of an amplifier

Suggested teaching/Learning Activities

- Illustration
- Demonstration
- Note taking
- Observation
- Practical exercise

Suggested teaching/Learning Resources

- i) Assorted electronic components
- ii) Power supply
- iii) Breadboard/circuit board
- iv) Connecting leads /wire
- v) Oscilloscope
- vi) Signal generators
- vii) Multimeter

Suggested Evaluation Methods

- Oral tests

- Timed written tests
- Assignments
- Timed practical tests
- Project
- Project presentation

18.2.3 OPERATIONAL AMPLIFIERS

Theory

18.2.3T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) describe operation of direct coupled amplifiers
- b) explain the operation of differential amplifier
- c) state characteristics of operational amplifiers (Op-amps)
- d) analyse various operational amplifier circuits

Content

- 18.2.3T1 Direct coupled amplifiers circuit
 - limitations
- 18.2.3T2 Differential amplifier
 - i) Common Mode
 - ii) Differential Mode
 - iii) Common Mode Rejection Ratio (CMRR)
- 18.2.3T3 Characteristics of Op-amps
 - i) Input resistance
 - ii) Output resistance
 - iii) Voltage gain
 - iv) Bandwidth
 - v) Response time
- 18.2.3T4 Analysis of Op-amp circuits

- i) Inverting and non-inverting amplifier
- ii) Subtractor
- iii) Adder
- iv) Differentiator
- v) Integrator
- vi) Filters
- vii) Oscillators
- viii) Comparators

Practice

18.2.3P0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) assemble and operate op-amp circuits
- b) test o-amp circuits

Content

- 18.2.3P1 Assembling and operating o-amp circuits
- 18.2.3P2 Testing of op-amp circuits

18.2.3C Competence

The trainee should have the ability to:

- i) Assemble and operate op-amp circuits
- ii) Test op-amp circuits

Suggested teaching/Learning Resources

- Op-amp IC
- Circuit/bread board
- Power supply
- Oscilloscope
- Function generator
- Multimeter

Suggested teaching/Learning Activities

- Illustration
- Demonstration

- Note taking
 - Observation
 - Practical exercise
 - Calculations
 - Project work
- ii) Voltage shunt
 - iii) Current shunt
 - iv) Practical amplifier circuits

PRACTICE

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests
- Project

18.2.4 FEEDBACK

Theory

18.2.4T0 *Specific Objectives*

By the end of the sub-module unit, the trainee should be able to:

- a) explain principles of positive and negative feedback
- b) derive feedback equations
- c) explain effects of negative feedback on amplifier performance
- d) describe various feedback connections

Content

- 18.2.4T1 Feedback principles
- 18.2.4T2 Feedback equations
- 18.2.4T3 Effects of negative
 - i) Feedback
 - ii) Gain
 - iii) Stability
 - iv) Noise and distortions
 - v) Bandwidth
 - vi) Input and output impedances
- 18.2.4T4 Feedback
 - i) Connections

18.2.4P0 *Specific Objectives*

By the end of the sub-module unit, the trainee should be able to:

- a) verify the performance of negative feedback amplifiers
- b) construct negative feedback amplifiers

Content

- 18.2.4P1 Verify performance of negative feedback amplifiers
- 18.2.4P2 Construct negative feedback amplifiers

18.2.4C

Competence

The trainee should have the ability to:

- i) Construct feedback amplifiers
- ii) Verify performance of feedback amplifiers

Suggested teaching/Learning Resources

- Assorted electronic components
- Power supply
- Circuit/bread board
- Oscilloscope
- Signal generators
- Multimeter
- Electronic toolkit

Suggested teaching/Learning Activities

- Illustration
- Demonstration
- Note taking
- Observation
- Practical exercise
- Calculations
- Project work

- iii) Colpits
- iv) Hartley
- v) Crystal
- vi) Blocking
- vii) Derivation of frequency of oscillation

Practice

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests
- Project

18.2.5 SINUSOIDAL OSCILLATORS

Theory

18.2.5T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) explain the concept of oscillations
- b) state requirements for oscillators
- c) describe the operation of oscillator circuits

Content

18.2.5T1 Concept of oscillators

Resonance

18.2.5T2 Requirements for oscillators

- i) Feedback
- ii) Impedance

- iii) Positive feedback

18.2.5T3 Operation of oscillator circuits

- i) Tuned collector
- ii) Rc phase shift

18.2.5P0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) verify performance of oscillator circuits
- b) construct oscillator circuits

Content

18.2.5P1 Performance of oscillator circuits

18.2.5P2 Construction of oscillator circuits

18.2.5C Competence

The trainee should have the ability to:

- i) Construct oscillator circuits
- ii) Verify performance of oscillator circuits

Suggested teaching/Learning Resources

- i) Assorted electronic components
- ii) Power supply
- iii) Oscilloscope
- iv) Multimeter
- v) Electronic toolkit
- vi) Circuit/breadboard
- vii) Connecting leads/wire

Suggested teaching/Learning Activities

- Illustration
- Demonstration
- Note taking
- Observation
- Practical exercise

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests
- Project

18.2.6 WAVE SHAPING AND PULSE GENERATING CIRCUITS

Theory

18.2.6T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) describe operation of wave shaping circuits
- b) explain the operation of pulse generating circuits

Content

- | | |
|-----------------|---|
| 18.2.6T1 | Operation of wave |
| | i) Shaping circuits |
| | ii) Differentiators |
| | iii) Integrators |
| | iv) Clipping circuits |
| | v) Clamping circuits |
| 18.2.6T2 | Pulse generating circuits (discrete and ICS) |
| | i) Monostable multivibrator |
| | ii) Astable multivibrator |
| | - schmitt trigger |
| | - blocking oscillator |

Practice

18.2.6P0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) construct waveshaping and pulse generating circuits
- b) verify performance of waveshaping and pulse generating circuits

Content

18.2.6P1 Construction of waveshaping and pulse generating circuits

18.2.6P2 Performance of waveshaping and pulse generating circuits

18.2.6C Competence

The trainee should have the ability to:

- i) Construct wave shaping and pulse generating circuits
- ii) Verify the performance of wave shaping and pulse generating circuits

Suggested teaching/Learning Resources

- i) Assorted electronic components (discrete/ICS)
- ii) Power supply
- iii) Oscilloscope
- iv) Circuit/breadboard
- v) Electronic toolkit
- vi) Function generator
- vii) Connecting leads

Suggested teaching/Learning Activities

- Illustration
- Demonstration
- Note taking

- Observation
 - Practical exercise
 - Calculations
 - Project work
- 18.2.7T3 Operation of photo-devices**
- i) Photo resistor
 - ii) Photo diode
 - iii) Photo transistor
 - iv) Photovoltaic cells
 - v) Avalanche diode
 - vi) PIN diode

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests
- Project
- Project presentation

- 18.2.7T4 Drive requirements for display**
- i) LED
 - ii) LCD
 - iii) Plasma

- 18.2.7T5 Applications**

18.2.7 OPTO - ELECTRONICS

Theory

18.2.7T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) explain theory of opto-electronics
- b) explain principles of gaseous and solid lasers and masers
- c) describe the operation of photo devices
- d) explain drive requirements for the displays
- e) state application of photo devices

Content

- 18.2.7T1 Opto-electronic Theory**
- i) Interaction of radiation and matter
 - ii) Absorption, emission and transmission properties of matter
- 18.2.7T2 Principles of lasers and masers**
- i) Construction
 - ii) Operation

Practice

18.2.7P0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to construct a circuit using photo devices

Content

- 18.2.7P1 Circuit construction**
- i) Design
 - ii) Construction testing

18.2.7C Competence

The trainee should have the ability to:

- i) apply photo devices in electronic circuits
- ii) Diagnose faults in electronic devices

Suggested teaching/Learning Resources

- Photo devices
- Electrical and electronic tools and measuring instruments
- Electronic Bread board
- Copper strip boards

Suggested teaching/Learning Activities

- Illustration
- Demonstration
- Note taking
- Observation
- Practical exercise
- Calculations
- Project work
- Visits to industries

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests
- Project

19.2.0 ENGINEERING MATHEMATICS II**19.2.01 Introduction**

This module unit is designed to equip the trainee with the knowledge, skills and attitudes to apply Mathematical skills in their trade area.

The trainee will use Advanced Mathematical tables and non-programmable scientific calculator. Suggested teaching/learning activities and resources, and evaluation methods are listed at the end of the unit.

19.2.02 General Objectives

At the end of this module unit, the trainee should be able to: -

- a) Understand mathematical techniques relevant to electrical engineering
- b) Apply mathematical techniques relevant to electrical engineering
- c) Appreciate the role of Mathematics in everyday life

19.2.03 Module Unit Summary and Time Allocation**Engineering Mathematics II**

| Code | Sub-Module Unit | Content | HRS |
|-------------|---------------------------------|--|------------|
| 19.2.1 | Vector Theory I | <ul style="list-style-type: none">• Vector algebra and theorems• Dot and Cross products• Gradient, Divergence and Curl operators• Application | 10 |
| 19.2.2 | Matrices I | <ul style="list-style-type: none">• Matrix operations• Determinants• Inverse of 3x3 matrix• Solution of simultaneous equations | 8 |
| 19.2.3 | Ordinary Differential Equations | <ul style="list-style-type: none">• Formation and solution of 1st differential equations• 2nd order linear differential equations with constant coefficient• D-operator• Series solutions• Application of ordinary differential equation | 10 |

| | | | |
|-------------------|-------------------------|---|-----------|
| 19.2.4 | Partial Differentiation | <ul style="list-style-type: none"> • Definition of partial derivatives • Derivation of a function of two or more variables • Problem solving • Stationary points of functions of two variables | 8 |
| 19.2.5 | Laplace transforms | <ul style="list-style-type: none"> • Definition • Properties of Laplace transforms • Inverse transforms • Application of Taylor's theorem to obtain power series • Use of Maclaurin's theorem to obtain power series • Application of Taylor's theorem in numerical work. | 10 |
| 19.2.6 | Power series | <ul style="list-style-type: none"> • Definition of power series • Taylor's Theorem • Maclaurin's theorem • Application of Taylor's theorem • Application of Maclaurin's theorem • Application of Maclaurin's theorem in numerical work. | 6 |
| 19.2.7 | Statistics | <ul style="list-style-type: none"> • Data organization and presentation • Measures of central tendencies • Measures of dispersion • Skewness • Coefficient of skewness • Regression lines • Correlation and regression | 6 |
| 19.2.8 | Probability | <ul style="list-style-type: none"> • Definition • Laws of probability • Probability distribution • Mathematical expectation • Sampling distribution | 6 |
| Total Time | | | 64 |

| | | | |
|----------|--|----------|--|
| 19.2.1 | VECTOR S THEORY I | 19.2.2 | MATRICES I |
| | Theory | 19.2.2T0 | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: |
| 19.2.1T0 | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: a) define vector theorems b) solve problems involving the dot and cross products. c) define gradient, divergence and curl operators d) solve problems involving gradient, divergence and curl operators. | | a) perform matrix operations b) determine the determinant of a 3×3 matrix using co-factor method and Sirus rule. c) determine the inverse of a 3×3 matrix d) apply matrices in solving linear simultaneous equations in 3 unknowns. |
| | <i>Content</i> | | <i>Content</i> |
| 19.2.1T1 | Definition of a vector and scalar | 19.2.2T1 | Performing matrix operation |
| 19.2.1T2 | Distinguish between vector and scalar quantities | 19.2.2T2 | Determination of the determinant of a 3×3 matrix using: i) Co-factor method ii) Sirus Rule |
| 19.2.1T3 | Vector theorems i) Resolution of vector ii) Proof of the Ratio theorem iii) Use of the Ratio theorem iv) Dot and cross products | 19.2.2T3 | Determination of the inverse of a 3×3 matrix i) Adjoint and determinant ii) Augmented matrix and row reduction |
| 19.2.1T4 | Problems involving dot and cross products of vector | 19.2.2T4 | Solution of linear simultaneous equations in 3 unknowns. |
| 19.2.1T5 | Definition of the operators gradient, divergence and curl | | |
| 19.2.1T6 | Problems involving gradient, divergence and curl operators | | |

| | |
|--|---|
| <p>19.2.3</p> <p>ORDINARY DIFFERENTIAL EQUATIONS</p> <p>Theory</p> | <p>ii) R-L-C circuits</p> |
| <p>19.2.3T0</p> <p><i>Specific Objectives</i></p> <p>By the end of the sub-module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) Form and solve 1st order differential equation b) form and solve 2nd order linear ordinary differential equations c) apply the D- operator method to solve differential equations d) apply 1st order and 2nd order linear differential equations in electrical problems. | <p>19.2.4</p> <p>PARTIAL DIFFERENTIATION</p> <p>Theory</p> |
| <p>19.2.3T1</p> <p><i>Content</i></p> <p>Formation of 1st order linear differential equations</p> | <p>19.2.4T0</p> <p><i>Specific Objectives</i></p> <p>By the end of the sub-module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) define partial derivative of a function of two variables. b) differentiate a function of two variables or more. c) solve problems involving small changes or errors using partial derivatives. d) find stationary points of functions of two variables. |
| <p>19.2.3T2</p> <p><i>Content</i></p> <p>Solution of differential equations</p> <ul style="list-style-type: none"> i) 1st order variable separable ii) 1st order homogenous iii) 1st order linear | <p>19.2.4T1</p> <p><i>Content</i></p> <p>Definition of partial derivatives of two variables.</p> |
| <p>19.2.3T3</p> <p><i>Content</i></p> <p>2nd order by the method of determination of coefficients</p> | <p>19.2.4T2</p> <p><i>Content</i></p> <p>Differentiation of a function of two variables or more.</p> |
| <p>19.2.3T4</p> <p><i>Content</i></p> <p>solution to 2nd order differential equations</p> | <p>19.2.4T3</p> <p><i>Content</i></p> <p>Solution of problems involving small changes using partial derivatives.</p> |
| <p>19.2.3T5</p> <p><i>Content</i></p> <p>D-operator method</p> <ul style="list-style-type: none"> i) Simultaneous differential equations ii) Series method | <p>19.2.4T4</p> <p><i>Content</i></p> <p>Finding stationary points of functions of two variables.</p> |
| <p>19.2.3T6</p> <p><i>Content</i></p> <p>Application of differential equations</p> <ul style="list-style-type: none"> i) Control systems | |

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|----------|---|-----------|--|
| 19.2.5 | LAPLACE TRANSFORMS | 19.2.5TT2 | Using simple properties of Laplace transforms |
| | Theory | i) | Derivations of Laplace transforms of $F(t) e^{-at}$ |
| 19.2.5T0 | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should able to: | ii) | Statement of initial and final value theorems for simple |
| | a) define the Laplace transform of a function | iii) | Derivation of the Laplace transforms of the first and second derivatives from definition. |
| | b) use simple properties of Laplace transforms | 19.2.5T3 | Determination of the inverse Laplace transforms of simple transforms using a list of transforms and partial fractions. |
| | c) determine the inverse Laplace transforms of simple forms using partial fractions | i) | Definition of inverse Laplace transform |
| | d) use Laplace transforms to solve ordinary differential equations and simultaneous differential equations with constant coefficients and given initial conditions. | ii) | Determination of inverse Laplace transforms of simple forms using a list of standard forms. |
| | e) Apply Laplace transforms in electrical engineering | iii) | Determination of partial fractions for expressions up to degree three in the denominator including cases of linear and quadratic repeated factors. |
| | <i>Content</i> | iv) | Determination of inverse Laplace transforms of forms using partial fractions and a list of standard transforms. |
| 19.2.5T1 | Definition of the Laplace transform of a function | 19.2.5T4 | Using Laplace transforms to solve: |
| | i) Deriving the Laplace transforms of simple functions | i) | Differential equations and simultaneous |
| | ii) Laplace transform of elementary functions | | |
| | iii) Inference of linearity properties | | |
| | iv) Use of list of standard transforms | | |

| | | |
|--|--|--|
| | equations with constant coefficients and given initial conditions. | c) deduce Maclaurin's theorem from Taylor's theorem. d) apply Taylor's theorem to obtain power series e) apply Maclaurin's theorem to obtain power series f) apply Maclaurin's theorem in numerical work. |
| ii) | Application of theorem for the Laplace transforms | 19.2.6T1 |
| iii) | Evaluations of Laplace transform using a small stock of transform key pair | 19.2.6T2 |
| e ^{-xt} H(t) = $\frac{1}{P + X} - \text{Re } x \text{ Re } p$ | | |
| iv) | Application of Laplace transforms to impulse response problems. - Using transfer transforms. - Setting out initial value problems. | 19.2.6T3 19.2.6T4 |
| v) | Application of Laplace transforms to switching problems. | 19.2.6T5 19.2.6T6 19.2.6T7 |

Suggested teaching/Learning Resources

- Laplace transform reference table

19.2.6 POWER SERIES

19.2.6T0 Specific Objectives
 By the end of the sub-module unit, the trainee should be able to:
 a) explain the term power series.
 b) state Taylor's theorem without reminder.

| <i>Content</i> | |
|----------------|---|
| 19.2.6T1 | Explanation of the term power series. |
| 19.2.6T2 | Statement of Taylor's Theorem. |
| 19.2.6T3 | Deduction of Maclaurin's theorem from Taylor's theorem. |
| 19.2.6T4 | Application of Taylor's theorem to obtain power series |
| 19.2.6T5 | Use of Maclaurin's theorem to obtain power series. |
| 19.2.6T6 | Application of Taylor's theorem in numerical work. |
| 19.2.6T7 | Application of Maclaurin's theorem in numerical work. |

19.2.8 STATISTICS

19.2.8T0 Specific Objectives
 By the end of the sub - module unit, the trainee should be able to:
 a) Organize and present data coefficient

| | | |
|----------|---|---|
| | b) determine measures of central tendencies for data c) determine measures of dispersion d) define skewness e) determine the coefficient of skewness f) define regression lines g) define correlation coefficients | - Calculation of correlation |
| | 19.2.9 | PROBABILITY |
| | | Theory |
| | 19.2.9T0 | <i>Specific Objectives</i> By the end of the sub - module unit, the trainee should be able to: a) define concept of probability b) identify various types of events c) state laws of probability d) describe types of data distribution e) define Theorems of Mathematical expectations f) describe sampling methods |
| | | <i>Content</i> |
| 19.2.8T1 | Data organisation i) Frequency distributions and diagrams ii) Grouped and ungrouped | 19.2.9T1 Probability random variable |
| 19.2.8T2 | Determination of measures of central tendencies i) Mean ii) Median iii) Mode | 19.2.9T2 Types of events |
| 19.2.8T3 | Measures of dispersion i) Range ii) Mean iii) Deviations iv) Variance v) Standard deviation | 19.2.9T3 Laws of probability |
| 19.2.8T4 | Definition of skewness • Pearson's coefficient of skewness | 19.2.9T3 Theorems on expectation |
| 19.2.8T5 | Coefficient of skewness i) Negative ii) Zero iii) Positive | 19.2.9T4 Types of data distributions |
| 19.2.8T6 | Definition of regression lines | i) Poisson distribution |
| 19.2.8T7 | Definition of correlation coefficients - Calculation of regression lines | ii) Binomial distribution iii) Continuous distributions iv) Normal distribution v) T-distribution vi) Chi-Square distribution vii) Interpretation of their tables |

| | | |
|----------|---|---|
| | viii) Application of various distribution methods | - Discussion - Illustration - Demonstration |
| | ix) confidence limits of mean and difference of means | |
| | x) Tests of hypothesis | |
| | xi) Goodness of fit | |
| 19.2.9T5 | Sampling methods | |
| | i) Sampling distribution | |
| | ii) Applications | |
| | <i>Suggested teaching/Learning Activities</i> | |
| | | <i>Suggested teaching/Learning Resources</i> |
| | | - Advanced Mathematical tables - Scientific calculator |
| | | <i>Suggested Evaluation Methods</i> |
| | | - Oral tests - Timed written tests - Assignments |

20.2.0 DIGITAL ELECTRONICS

20.2.01 Introduction

This unit deals with study of circuits of signals that take only two different levels. It is intended to provide the trainee with the relevant knowledge skills and attitudes necessary to make the learner competent in design, installation and maintenance of digital equipment and devices. The trainers may use phased design projects (suitable for the level) to enhance skills and competence acquisition.

20.2.02 General Objectives

At the end of the module unit, the trainee should be able to:

- a) Understand number systems and perform binary arithmetic
- b) Design combination logic networks
- c) Design flip-flop circuits
- d) Design Register and Counter Circuits
- e) Understand the operation of data handling logic circuits
- f) Apply arithmetic circuits in electronic circuits
- g) Appreciate digital electronics as a foundation for industrial controls

20.2.03 Module Unit Summary and Time Allocation

Digital Electronics

| Code | Sub Module Unit | Content | Time Hours |
|-------------|------------------------|--|-------------------|
| 20.2.1 | Number systems | <ul style="list-style-type: none">• Number systems• Binary systems• Conversion of numbers to binary and vice versa• ‘Ones’ and ‘twos’ complements• Arithmetic• Numbers in octal• Conversion of octal numbers into other numbers and vice versa• Conversion of hexadecimal numbers to other number systems• Application of number systems | 4 |
| 20.2.2 | Binary codes | <ul style="list-style-type: none">• Importance of Binary codes• BCD arithmetic• BCD arithmetic• Binary numbers in grey code | 6 |

| | | | |
|--------|---------------------------------|--|---|
| | | <ul style="list-style-type: none"> • Alphanumeric codes • Application of alphanumeric codes. • Error detection | |
| 20.2.3 | Logic gates and Boolean algebra | <ul style="list-style-type: none"> • Operation of basic logic gates • Operation of hybrid (derived) logic gates • The Boolean algebra • Reduction of logic expression • Implementation of logic circuits | 6 |
| 20.2.4 | Combinational logic design | <ul style="list-style-type: none"> • Definition of Combinational logic network operation • Derivations from Boolean • Designing combinational logic using Boolean algebra • Designing combinational circuits using tabular methods • Logic circuits for industrial interlock systems including time delay | 6 |
| 20.2.5 | Logic families | <ul style="list-style-type: none"> • Transistor as a switch • Classifications of Logic Families • Operation of various logic families • Handling requirements of various logic Families • Interconnection of different logic families | 4 |
| 20.2.6 | Flip flops | <ul style="list-style-type: none"> • Latches • Types of flip-flops • Edge triggered • Master/slave flip-flop • Manufacturers data sheets and catalogues | 8 |
| 20.2.7 | Combinational logic circuits | <ul style="list-style-type: none"> • Definition of data handling logic circuits • Operation of data handling logic circuits • Applications • Similarities between decoder and demultiplexers | 6 |
| 20.2.8 | Sequential logic circuits | <ul style="list-style-type: none"> • Shift register operation • Serial register operation | 8 |

| | | | |
|-------------------|---------------------|--|-----------|
| | | <ul style="list-style-type: none"> • Parallel register operation • Shift register modes • Use of manufacturers data sheets and catalogues to identify registers • Operation of ripple counters • Operation of synchronous counters • Comparison between ripple and synchronous • Feedback register • Application of counters • Use of manufacturers' data book and catalogue to identify counters | |
| 20.2.9 | Arithmetic Circuits | <ul style="list-style-type: none"> • Serial Adders • Parallel adder • Serial and parallel adder • Arithmetic circuits | 6 |
| 20.2.10 | Converters | <ul style="list-style-type: none"> • Operational amplifiers as Comparator • Terminologies • Operation of DAC • Operation of ADC • Application | 6 |
| 20.2.11 | Memories | <ul style="list-style-type: none"> • Classification of memory devices • Terminologies • Operation of semiconductor RAM and ROM memory devices • Organization of ROM memory devices • Operation and organization of secondary storage memories • Mapping • Memory organization | 6 |
| Total Time | | | 66 |

20.2.1 NUMBER SYSTEMS

Theory

20.2.1T0 Specific objectives

By the end of the sub-module unit, the trainee should be able to:

- a) represent numbers in decimal
- b) represent numbers in binary
- c) convert binary numbers into other number systems and vice versa
- d) represent binary numbers into one's and two's complement
- e) perform binary arithmetic
- f) represent numbers in octal
- g) convert octal numbers into other number systems and vice versa
- h) represent numbers in hexadecimal
- i) convert hexadecimal numbers to other number systems and vice versa
- j) state the areas of application of number systems

Content

20.2.1T1 Number systems

20.2.1T2 Binary systems

20.2.1T3 Conversion of numbers to binary and vice versa

20.2.1T4 'Ones' and 'twos' complements

20.2.1T5 Arithmetic

20.2.1T6 Numbers in octal

20.2.1T7 Conversion of octal numbers into other numbers and vice versa

20.2.1T8 Conversion of hexadecimal numbers to other number systems

20.2.1T9 Application of number systems

20.2.1C Competence

The trainee should have the ability to: number systems in programming

20.2.2 BINARY CODES

Theory

20.2.2T0 Specific objectives

By the end of the sub-module unit, the trainee should be able to:

- a) explain the importance of various binary codes
- b) represent decimal numbers in binary coded decimal (BCD)
- c) perform BCD arithmetic
- d) represent binary numbers in gray code
- e) represent characters in various alphanumeric codes.
- f) Identify the use of various alphanumeric codes in digital systems
- g) explain various methods of error detection and correction

| <i>Content</i> | |
|----------------|---|
| 20.2.2T1 | Importance of Binary codes |
| 20.2.2T2 | Representation of decimal numbers in Binary Coded Decimal (BCD) |
| 20.2.2T3 | BCD arithmetic |
| 20.2.2T4 | Representation of binary numbers in gray code |
| 20.2.2T5 | Representation of characters in various alphanumeric codes |
| 20.2.2T6 | Use of alphanumeric codes in digital systems |
| 20.2.2T7 | Methods of error detection |

20.2.3 LOGIC GATES AND BOOLEAN ALGEBRA

Theory

20.2.3T0 Specific objectives

By the end of the sub module unit, the trainee should be able to:

- a) explain the operation of the basic logic gate
- b) explain the operation of hybrid (derived) logic gates
- c) understand the concepts of Boolean algebra
- d) minimize logic expressions using universal gates
- e) implement logic circuits using universal gates

Content

| | |
|----------|--|
| 20.2.3T1 | Basic Logic gates AND, OR , INVERTER |
| 20.2.3T2 | Hybrid Gates NAND, NOR, Exclusive gates |
| 20.2.3T3 | Boolean algebra |

| | |
|----------|--|
| - | Identities and Rules, De Morgans Theorems |
| 20.2.3T4 | Minimize logic expressions using: <ul style="list-style-type: none"> i) Boolean algebra ii) K-Map upto 4 variables |
| 20.2.3T5 | Implement logic circuits using <ul style="list-style-type: none"> i) NAND gates only ii) NOR gates only. |

Practice

20.2.3P0 Specific Objectives

By the end of the sub module unit the trainee should be able to:

- a) identify pin configuration of logic gate ICs
- b) mount the logic gate IC on a breadboard
- c) verify the operation of logic gates

Content

| | |
|----------|--|
| 20.2.3P1 | Identifying pin configuration |
| 20.2.3P2 | Mounting logic gate IC on a breadboard |
| 20.2.3P3 | Demonstrate operation of logic gates |

20.2.3C Competence

The trainee should have the ability to: construct and test various logic gates

Suggested teaching/Learning Activities

- Illustration
- Demonstration
- Note taking
- Practical exercise

Suggested Teaching and Learning Resources

- Digital trainer kit
- Assorted logic gate ICS
- Connecting wires
- Clock generator
- Breadboard
- DC power supply
- LED display

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests
- Project

20.2.4 COMBINATIONAL LOGIC DESIGN

Theory

20.2.4T0 Specific objectives

By the end of the sub-module unit, the trainee should be able to :

- a) define combinational logic networks
- b) design combinational logic circuits using Boolean algebra
- c) design combinational logic circuits up to 4 input variables using Karnaugh map
- d) design combinational logic circuits up to 4-input variables using tabular method.
- e) design combinational logic circuits for industrial interlock systems including time delay.

Content

- | | |
|----------|--|
| 20.2.4T1 | Combination logic & Network design |
| 20.2.4T2 | Combinational logic circuits using Boolean algebra |
| 20.2.4T3 | Combinational logic circuits up to 4 input variables using Karnaugh map |
| 20.2.4T4 | Combinational logic circuits up to 4-input variables using tabular method |
| 20.2.4T5 | Combinational logic circuits for industrial interlock systems including time delay |

Practice

20.2.4P0 Specific objectives

By the end of the sub-module unit, the trainee should be able to:

- a) use manufacturers' data sheets and catalogues to identify characteristics and pin connections of ICs.
- b) interconnected different logic families

Content

- | | |
|----------|---|
| 20.2.4P1 | Use of manufacturer's data book |
| 20.2.4P2 | Interconnection of different logic families |

20.2.4C Competences

The trainee should have the ability to: use different logics gates in electronic circuit design

| | | |
|---|----------|---|
| <i>Suggested teaching/Learning Resources</i> | | <i>Content</i> |
| <ul style="list-style-type: none"> - Logic gates - Electronic tool kit - Electrical measuring instruments - Bread board | 20.2.5T1 | <ul style="list-style-type: none"> Transistor as a switch i) BJT ii) MOSFET iii) Synchronous sequential logic |
| <i>Suggested teaching/Learning Activities</i> | 20.2.5T2 | <ul style="list-style-type: none"> Classifications of Logic Families i) BJT logic families ii) MOSFET logic families iii) SSI iv) MSI v) LSI vi) VLSI |
| | 20.2.5T3 | <ul style="list-style-type: none"> Operation of various logic families |
| <i>Suggested Evaluation Methods</i> | 20.2.5T4 | <ul style="list-style-type: none"> Ccharacteristics of various logic families in terms of i) Loading rules ii) Wired AND operation iii) Unused inputs iv) Protection v) Interfacing between logic families vi) Tri-state TTLs - Use of manufacturers Datasheets |
| 20.2.5 LOGIC FAMILIES | 20.2.5T5 | <ul style="list-style-type: none"> How to connect different logic families i) TTL-CMOS ii) MOS-TTL |
| Theory | | Practice |
| 20.2.5T0 <i>Specific objectives</i> | | 20.2.5P0 <i>Specific Objectives</i> |
| By the end of the sub-module unit, the trainee should be able to: | | By the end of the sub-module unit, the trainee should be able to: |
| <ul style="list-style-type: none"> a) explain the use of a transistor as a switch b) state classifications of logic families c) explain the general operation and characteristics of various logic families d) state the handling requirements for various logic families | | <ul style="list-style-type: none"> a) select a particular logic gate IC using data sheets or catalogs b) demonstrate the operation of logic gates ICs |

- c) interface different logic gates
- d) interconnect various logic families

Content

- 20.2.5P1 Selecting a particular logic gate IC from a catalogue
- 20.2.5P2 Demonstrating the operation of logic gate ICS
- 20.2.5P3 Interfacing different logic gates

20.2.5C Competence

The trainee should have the ability to: construct and test logic circuits from different logic families

Suggested teaching/Learning Activities

- Illustration
- Demonstration
- Note taking
- Observation
- Practical exercise
- Project work

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests
- Project

20.2.6 FLIP-FLOPS

Theory

20.2.6T0 Specific objectives

By the end of the sub module unit, the trainee should be able to:

- a) explain the operation of latches

- b) explain the operation of various flip-flop circuits.
- c) explain the operation of edge triggered flip-flops
- d) explain characteristics of master/slave flip-flops
- e) use manufacturers' data sheets and catalogues to select flip-flops.

Content

- 20.2.6T1 Explanation of operation of latches
 - i) Transistor latch
 - ii) NAND latch
 - iii) NOR latch
 - iv) 20.2.6T2Flip-flops
 - v) S-R
 - vi) J-K
 - vii) D Type
 - viii) T-type
- 20.2.6T3 Explanation operation of the following using transition tables and
 - i) wave forms:
 - ii) Edge triggered
 - iii) Master/slave flip-flop
- 20.2.6T4 Characteristics of master/slave flip flops
- 20.2.6T5 Use manufacturers data sheets and catalogues to identify:
 - i) Pin connection
 - ii) Characteristics of IC flip-flops

Practice

20.2.6P0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) select a particular flip flop IC using data sheets or catalogs

- b) demonstrate the operation of various flip flops

20.2.7 COMBINATION LOGIC DESIGN

Theory

20.2.7T0 Specific objectives

By the end of the sub-module unit, the trainee should be able to:

- a) define data handling combinational logic circuits
- b) explain the operation of combinational logic circuits
- c) describe applications combinational logic circuits
- d) state similarities between decoder and demultiplexers

Content

- 20.2.6P1 Selecting a particular flip flop IC for using data sheets or catalogues
- 20.2.6P2 Demonstrating the operation of various flip flops

20.2.6C Competence

The trainee should have the ability to: construct and test logic circuits from different flip flops.

Suggested teaching/Learning Activities

- Illustration
- Demonstration
- Note taking
- Observation
- Practical exercise

Suggested teaching/Learning Resources

- Logic circuits
- Flip flops
- Electrical measuring instruments

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests
- Project

Content

20.2.7T1 Definition of combinational logic circuits

- i) Decoders
- ii) Encoders
- iii) Multiplexers
- iv) Demultiplexers

20.2.7T2 Explanation of the operation of combinational logic circuits

- i) Decoders
- ii) Encoders
- iii) Multiplexers
- iv) Demultiplexers

20.2.7T3 Application of

- i) Decoders
- ii) Encoders

20.2.7T4 Similarities of Multiplexers and Demultiplexers

Practice

20.2.7P0 Specific Objectives

By the end of the sub - module unit, the trainee should be able to:

- a) construct various combinational logic circuits
- b) demonstrate the operation of various combinational logic circuits

Content

20.2.7P1 Constructing various combinational logic circuits

20.2.7P2 Demonstrating operation of various combinational logic circuits

20.2.7C Competence

The trainee should have the ability to: construct and test various combinational logic circuits.

Suggested teaching/Learning Activities

- Discussion
- Question and answer
- Demonstration
- Note taking
- Observation
- Practical exercise

Suggested teaching/Learning Resources

- i) Electrical measuring instruments
- ii) Electronic tool kit
- iii) Dc Power supply
- iv) Ac power supply
- v) Logic gates
- vi) Electronic components

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests
- Project

20.2.8 SEQUENTIAL LOGIC CIRCUITS

Theory

20.2.8T0 Specific objectives

By the end of the sub-module unit, the trainee should be able to :

- a) explain the basic operation of a shift register
- b) describe serial shift register operation
- c) describe parallel shift register operation
- d) explain the practical IC shift modes of operation
- e) use manufacturers data sheets and catalogues to identify ICs
- f) describe the operation of asynchronous (ripple through) counters
- g) describe the operation of synchronous counters
- h) compare synchronous with asynchronous counters
- i) describe operation of feedback register
- j) describe the applications of counters
- k) use manufacturer's data sheets and catalogues to identify and select counters.

| | <i>Content</i> | |
|-----------|--|--|
| 20.2.8T1 | Operation of a shift register using <ul style="list-style-type: none"> i) Transition tables ii) Waveforms | 20.2.8T11 Use manufacturer's data sheets and catalogues to identify: <ul style="list-style-type: none"> i) Pin connection ii) IC characteristics |
| 20.2.8T2 | Describe serial shift register operation <ul style="list-style-type: none"> i) Shift right ii) Shift left iii) Shift around | Practice |
| 20.2.8T3 | Describe parallel shift operation | 20.2.8P0 <i>Specific Objectives</i> By the end of the sub-module unit the trainee should be able to: |
| 20.2.8T4 | Explain the practical IC shift register modes <ul style="list-style-type: none"> i) SISO ii) SIPO iii) PIPO iv) PISO | a) construct various sequential logic circuits b) operate various sequential logic circuits |
| 20.2.8T5 | Use manufacturers data sheets and catalogues to identify <ul style="list-style-type: none"> i) Pin connection ii) Characteristics of IC flip-flop | <i>Content</i> |
| 20.2.8T6 | Describe the operation of the Ripple counter <ul style="list-style-type: none"> i) Modulus number ii) Stage and state numbers iii) Shortened mod iv) Decoding outputs v) Waveforms vi) Limitations | 20.2.8P1 Constructing various sequential logic circuits 20.2.8P2 Operation of various sequential logic circuits |
| 20.2.8T7 | Describe the operation of synchronous counters | 20.2.8C Competence The trainee should have the ability to: construct and test various sequential logic circuits |
| 20.2.8T8 | Compare asynchronous and synchronous counter | |
| 20.2.8T9 | Describe the operation of the feedback register <ul style="list-style-type: none"> i) Ring counter ii) Twisted ring counter iii) Random sequence generator | |
| 20.2.8T10 | Describe applications of counters | <i>Suggested teaching/Learning Activities</i> <ul style="list-style-type: none"> - Discussion - Question and answer - Demonstration - Note taking - Observation - Practical exercise - Project work |

Suggested teaching/Learning Resources

- Electrical measuring instruments
- Electronic tool kit
- Dc Power supply
- Sequential logic circuits

- Electronic components
- Assorted cables and other electrical materials

- 20.2.9T4 Description of arithmetic circuits
- Applications of adders e.g. ALU

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests
- Project

20.2.9 ARITHMETIC CIRCUITS

20.2.9T0 *Specific Objectives*

By the end of the sub-module unit, the trainee should be able to :

- a) describe the operation of a serial adder
- b) describe the operation of a parallel adder
- c) compare serial and parallel adders
- d) describe the application of arithmetic circuits

Content

- 20.2.9T1 Description of operation of serial adders
- i) Operation
 - ii) Modification to perform subtraction
 - iii) Limitation
- 20.2.9T2 Description of parallel adder
- i) Operation
 - ii) Use and operation of a look-ahead carry
- 20.2.9T3 Explanation of comparison of serial and parallel adders
- i) Operation
 - ii) Complexity

20.2.9P0 *Specific Objectives*

By the end of the sub module unit the trainee should be able to:

- a) construct various arithmetic circuits
- b) demonstrate the operation of various arithmetic circuits

Content

- 20.2.9P1 Constructing various arithmetic circuits
- 20.2.9P2 Demonstrating operation of various arithmetic circuits

20.2.9C *Competence*

The trainee should have the ability to: construct and test various arithmetic circuits.

Suggested teaching/Learning Activities

- Discussion
- Question and answer
- Illustration
- Demonstration
- Note taking
- Observation
- Practical exercise
- Project work

Suggested teaching/Learning Resources

- Electrical measuring instruments
- Electronic tool kit
- Electrical tool kit

- Dc Power supply
 - Ac power supply
 - Three phase power supply
 - Arithmetic circuits
 - Electronic components
 - Assorted cables and other electrical materials
- 20.2.10T4 Analogue to Digital Converter
 i) Types
 ii) Analysis
- 20.2.10T5 Applications

Practice

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests
- Project
- Project Report writing and presentation

20.2.10 CONVERTERS

Theory

20.2.10T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to :

- a) describe Operational Amplifier as comparator
- b) define the terminologies used in converter circuits
- c) describe the operation of DAC
- d) describe the operation of ADC
- e) explain the applications of converter circuits

Content

- 20.2.10T1 Operational Amplifier as Comparator
- 20.2.10T2 Definition of DAC's and ADC's terminologies
- 20.2.10T3 Digital to Analogue Converter
 i) Types
 ii) Analysis
 iii) Application

20.2.10P0 Specific Objectives

By the end of the sub-module unit the trainee should be able to:

- a) construct various converter circuits
- b) demonstrate operation of various converter circuits

Content

20.2.10P1 Constructing various converter circuits

20.2.10P2 Operation of various converter circuits

20.2.10C Competence

The trainee should have the ability to: construct and test various converter circuits.

Suggested teaching/Learning Activities

- Demonstration
- Note taking
- Observation
- Practical exercise
- Project work

Suggested teaching/Learning Resources

- i) Electrical measuring instruments
- ii) Electronic tool kit
- iii) Dc Power supply
- iv) Signal generators
- v) Electronic devices
- vi) Electronic components

vii) Assorted cables and other electrical materials

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests
- Project

20.2.11 MEMORIES

Theory

20.2.11T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) classify memories into various categories
- b) define memory terminologies
- c) describe the operations of semiconductor RAM and ROM memories
- d) describe the organization of semiconductor ram and ROM
- e) describe the operation and organization of secondary storage memories
- f) explain memory map
- g) describe memory organization

Content

20.2.11T1 Classification of Memories into various categories in a computer system

20.2.11T2 Stating the meaning of various memory terminologies

20.2.11T3 Description of operation of Semiconductor RAM and ROM

- i) Memory cell
- ii) Dynamic & Static memories
- iii) Erasable and non-erasable memories
- iv) Access timing of memories
- v) Memory capacity

20.2.11T4 Description of organization of Semiconductor RAM and ROM

- i) Register representation in memories
- ii) Memory timing
- iii) Memory expansion
- iv) Memory address decoding
- v) Memory pages
- vi) Cache memories
- vii) Storage capacity

20.2.11T5 Description of organization and operation of Secondary storage devices

- i) Need for secondary storage
- ii) Magnetic bubble memories
- iii) Floppy & hard disks
- iv) Recording surfaces
- v) Accessing & timing
- vi) Formats
- vii) Disk drives
- viii) Storage capacity
- ix) Hard disk
- x) CD ROM
- xi) CCD

20.2.11T6 Description of memory mapping

- i) Address decoders
- ii) Address allocation
- iii) System ROM, RAM,
I/O, Expansion
- iv) Expansion slots
- v) Timing
- vi) Pages

20.2.11T7 Description of memory organization

- i) Hierarchy
- ii) Timing
- iii) Formats
- iv) Capacity
- v) Functions

20.2.11C Competence

Ability to manage computer memories

21.2.0 ENGINEERING DRAWING AND DESIGN**21.2.01****Introduction**

Engineering drawing is a type of technical drawing that is created in accordance with standardised conventions whose purpose is to accurately and unambiguously capture all the geometric features of a product or a component. The module unit is intended to assist the trainee in developing the abilities to design, draw and interpret electrical circuit drawings, understand common electrical/electronic symbols, communicate ideas in electrical engineering and recognize related Kenya Bureau of standards specifications as well as International Standards Organization (ISO).

21.2.02**General Objectives**

At the end of the course unit, the trainee should be able to:

- a) Produce drawings in Isometric, Oblique, perspective and orthographic using computer
- b) Demonstrate understanding by correctly drafting electronic drawing /electrical installation circuits using the computer.

21.2.03**Module Unit Summary and Time Allocation****Engineering Drawing and Design**

| Code | Sub Module Unit | Content | Time Hrs |
|-------------------|------------------------------------|--|-----------------|
| 22.2.1 | Geometry | <ul style="list-style-type: none">• Plane• Solid | 6 |
| 22.2.2 | Symbols & Circuits | <ul style="list-style-type: none">• Electrical and electronics symbols• Motor connection and motor control circuits• Lighting switching arrangements• Schematic circuits | 8 |
| 22.2.3 | Design | <ul style="list-style-type: none">• Principles of PCB design• Electronic circuits | 6 |
| 22.2.4 | Electronic circuits | <ul style="list-style-type: none">• Manual sketch Processing• PCB layout drawing. | 8 |
| 22.2.5 | Computer Aided Electronic Drafting | <ul style="list-style-type: none">• Introduction to computer aided drawing• Drafting software• PCB Drawing• Making printed circuit boards• Simulation of electronic circuits | 16 |
| Total Time | | | 44 |

| | | |
|---|---|--|
| 21.2.1 GEOMETRY | | - Assignments - Timed practical tests |
| Practice | | |
| 21.2.1P0 | <i>Specific Objectives</i> By the end of the sub module unit the trainee should be able to: a) draw in plane geometry various diagram using the computer b) draw in solid geometry various diagram using the computer | |
| | <i>Content</i> | |
| 21.2.1P1 | Drawing diagram in plane geometry using computer i) Line ii) Regular polygons iii) Circles iv) hyperbola | |
| 21.2.1P2 | Drawing diagram in plane geometry using computer i) Isometric ii) Oblique | |
| 21.2.1C | Competence The trainee should have the ability to: draw geometric figures using a computer | |
| <i>Suggested teaching/Learning Activities</i> | | |
| - Illustration - Practical exercise | | |
| <i>Suggested teaching/Learning Resources</i> | | |
| Drawing instruments and materials | | |
| <i>Suggested Evaluation Methods</i> | | |
| - Oral tests | | |
| 21.2.2 SYMBOLS & CIRCUITS | | |
| Practice | | |
| 21.2.2P0 | <i>Specific Objectives</i> By the end of the sub module unit the trainee should be able to: a) identify various symbols used in electrical and electronic circuits. b) draw motor and control circuits c) draw light switching circuits | |
| | <i>Content</i> | |
| 21.2.2P1 | Identification of electronic symbols | |
| 21.2.2P2 | Drawing Motor and motor control circuits | |
| 21.2.2P3 | Drawing Light Switching Circuits - Drawing schematic circuits | |
| 21.2.2C | Competence The trainee should have the ability to: draw Motor and motor control circuits, Light Switching Circuits and electronic circuits | |
| <i>Suggested teaching/Learning Activities</i> | | |
| - Illustration - Demonstration - Practical exercise | | |
| <i>Suggested teaching/Learning Resources</i> | | |
| | | |
| <i>Suggested teaching/Learning Resources</i> | | |

- Electronic devices
- Electronic components
- Computer and computer drawing software
- Drawing instruments and materials

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

21.2.3 DESIGN

Practice

21.2.3P0 *Specific Objectives*

By the end of the sub module unit the trainee should be able to:

- a) explain the principles of PCB design
- b) correctly sketch and draw connection drawing for electronic circuits

Content

- 21.2.3P1 Principles of PCB design
21.2.3P2 Electronic circuits

21.2.3C Competence

The trainee should have the ability to: draw Electronic circuit design circuits, motor and control circuits and light switching circuits

21.2.4 ELECTRONIC CIRCUITS

Practice

21.2.4P0 *Specific Objectives*

By the end of the sub module unit the trainee should be able to:

- a) draw manual sketch of tracks (single side)
- b) construct PCB layout drawing

Content

- 21.2.4P1 Manual Processing
21.2.4P2 Drawing PCB layout

21.2.4C Competence

The trainee should have the ability to: prepare a printed circuit board

Suggested teaching/Learning Activities

- Discussion
- Demonstration

Suggested Teaching and Learning Resources

- Copper boards

Suggested Evaluation Methods

- Assignments
- Timed practical tests

21.2.5 ELECTRONIC DRAFTING

Practice

21.2.5P0 *Specific Objectives*

By the end of the sub module unit the trainee should be able to:

- a) explain the basics of computer aided drawing
- Project
- b) apply computer software in electronic drafting
- c) draw of PCB circuits
- d) develop printed circuit boards
- e) simulate electronic circuits

Content

- 21.2.5P1 Computer aided drawing
- 21.2.5P2 Using Software in electronic drafting
- 21.2.5P3 Drawing PCB Circuits
- 21.2.5P4 Developing Printed Circuit Boards
- 21.2.5P5 simulation of electronic circuits

21.2.5C Competence

The trainee should have the ability to: develop printed circuit boards

Suggested teaching/Learning

Activities

- Discussion
- Question and answer
- Demonstration
- Observation
- Practical exercise

Suggested teaching/Learning

Resources

- Electronic devices
- Electronic components
- Computer and drawing software

Suggested Evaluation Methods

- Oral tests
- Assignments
- Timed practical tests

22.2.0 INDUSTRIAL PROGRAMMABLE LOGIC CONTROLLERS

22.2.01 Introduction

The module unit is designed to equip the trainee with knowledge, skills and attitudes necessary to apply programmable logic controllers in industrial controls and measurements.

22.2.02 General Objectives

At the end of the Module Unit, the trainee should be able to:

- a) Observe safety regulations and standards that govern operation of programmable logic controllers
- b) Understand different application of industrial programmable logic controllers
- c) Maintain sequential control and data acquisition (SCADA) systems
- d) Maintain programmable logic control (PLC) systems

22.2.03 Module Unit Summary and Time Allocation

Industrial Soft Ware Engineering

| Code | Sub-Module Unit | Content | Time Hrs |
|-------------|---|---|-----------------|
| 22.2.1 | Introduction to Industrial programmable logic controllers | <ul style="list-style-type: none">• Need for industrial programmable logic controllers• Types of industrial programmable logic controllers | 8 |
| 22.2.2 | PLC Systems | <ul style="list-style-type: none">• Hardware configuration• Ladder logic programming• External peripherals• PLC maintenance | 15 |
| 22.2.3 | Supervisory Control and Data Acquisition (SCADA) | <ul style="list-style-type: none">• Definition• Human machine interface• Data acquisition• Sequential control• Data storage & archiving• Security (Access control) | 15 |
| 22.2.4 | Industrial Communication | <ul style="list-style-type: none">• Networks – LAN & WAN | 15 |

| Code | Sub-Module Unit | Content | Time Hrs |
|--------------------|------------------------|---|-----------------|
| | Network | <ul style="list-style-type: none"> • Industrial net works Topologies • Industrial net works Protocols • Network construction • Physical net work address • Network Devices | |
| 22.2.5 | Calibration Software | <ul style="list-style-type: none"> • Types of calibration software • Operation of calibration software • Device connection to software | 13 |
| Total Hours | | | 66 |

| | | |
|-----------------|--|---|
| 22.2.1 | INTRODUCTION TO INDUSTRIAL PROGRAMMABLE LOGIC CONTROLLERS | b) interpret software output c) simulates practical circuits d) install industrial software engineering systems |
| | Theory | |
| 22.2.1T0 | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: a) describe the need for industrial programmable logic controllers b) explain different types of industrial programmable logic controllers | <i>Content</i> 22.2.1P1 Programming the software 22.2.1P2 Interpreting software output 22.2.1P3 simulating practical circuits 22.2.1P4 Installing industrial software engineering systems |
| | <i>Content</i> | |
| 22.2.1T1 | Need for industrial software engineering i) Process control ii) Process monitoring | Competence The trainee should have the ability to: install, programme and simulate industrial software |
| 22.2.1T2 | Explaining types of industrial software systems i) Graphical user interface -SCADA ii) PLC programming software iii) Configuration software iv) Calibration software | <i>Suggested teaching/Learning Activities</i> <ul style="list-style-type: none">- Discussion- Illustration- Demonstration- Note taking- Observation- Practical exercise- Project work- Visits to industries |
| | Practice | |
| 22.2.1P0 | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: a) programme the software | <i>Suggested teaching/Learning Resources</i> <ul style="list-style-type: none">- Electrical measuring instruments- Electronic tool kit- Dc Power supply- Signal generators- Computer and computer software |

| | | | |
|-------------------------------------|---|----------|---|
| <i>Suggested Evaluation Methods</i> | | 22.2.2T2 | Ladder logic programming and sequential control i) Ladder logic ii) Sequence control 22.2.2T3 |
| | - Oral tests - Timed written tests - Assignments - Timed practical tests - Project | | PLC external peripherals i) Printers ii) Network cards iii) Human machine interface iv) Programmer interface |
| 22.2.2 | PROGRAMMABLE LOGIC CONTROLLER SYSTEM (PLC) | 22.2.2T4 | Maintenance procedure for PLC system i) Care and handling of PLC modules during installation ii) Care and handling of PLC module on the run iii) Planned maintenance procedure |
| | Theory | | |
| 22.2.2T0 | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: a) describe hardware configuration of a plc b) describe ladder logic programming and sequential control c) list PLC external peripherals d) explain the maintenance procedure for PLC systems | 22.2.2P0 | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: a) identify parts of a PLC system b) install PLC systems c) maintain PLC |
| | <i>Content</i> | | <i>Content</i> |
| 22.2.2T1 | Hardware configuration of a PLC i) CPU module ii) Memory iii) Analogue inputs iv) Passive inputs v) Active inputs vi) Digital input vii) Analogue outputs viii) Passive inputs ix) Active inputs x) Digital output | 22.2.2P1 | Identification output / input cards i) Central processing unit (CPU) ii) Memory cards iii) Network cards iv) Peripherals |
| | | 22.2.2P2 | Installation procedure |
| | | 22.2.2P3 | PLC maintenance |

- i) Care and handling PLC modules during installation
- ii) Care and handling of PLC modules on the run
- iii) Planned maintenance

22.2.2C Competence

The trainee should have the ability to:

- Identify parts of PLC system
- Install PLC systems
- Maintain PLC

Suggested teaching/Learning Activities

- Discussion
- Question and answer
- Illustration
- Demonstration
- Note taking
- Observation
- Practical exercise
- Project work

Suggested Teaching and Learning Resources

- Maintenance manuals
- Operation manuals
- PLC systems
- PLC peripheries
- Electronic tool kit
- Electrical tool kit
- Dc Power supply
- Signal generators
- Ac power supply
- Computer and software
- Industrial visit

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests
- Project

22.2.3 SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA)

Theory

22.2.3T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) list the application of SCADA system
- b) describe human machine interface (HMI)
- c) explain sequential control SCADA system
- d) describe data acquisition in SCADA system
- e) describe security (access) control in SCADA
- f) describe the procedure of SCADA maintenance

Content

- 22.2.3T1 Application of SCADA systems
 - i) Process monitoring
 - ii) Process control
- 22.2.3T2 SCADA System Human machine interface (HMI)
 - i) Definition of SCADA system as HMI
 - ii) Application
- 22.2.3T3 Sequential control
 - i) Definition
 - ii) Elements of sequence control
 - iii) Feedback control operation
- 22.2.3T4 SCADA data acquisition
 - i) Definition of data acquisition

| | | |
|----------|--|--|
| | <ul style="list-style-type: none"> ii) Types of data acquisition | |
| 22.2.3T5 | SCADA security / access control <ul style="list-style-type: none"> i) Definition SCADA access control ii) Objectives of SCADA access control | <ul style="list-style-type: none"> v) Log out of SCADA vi) 22.2.3P3 Maintenance vii) SCADA shut down viii) SCADA start up ix) Cleaning of SCADA equipment |
| 22.2.3T6 | SCADA maintenance <ul style="list-style-type: none"> i) Care and handling of SCADA hardware during installation ii) Care and handling of SCADA on the run iii) Planned maintenance procedure | |

Practice

22.2.3P0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) install SCADA facilities to inter-communicate with other instruments
- b) demonstrate use of SCADA system in plant monitoring and control
- c) maintain SCADA system

Content

22.2.3P1 SCADA facilities installation

- i) SCADA computer
- ii) Network cabling
- iii) Power supply
- iv) Testing

22.2.3P2 SCADA system in plant monitoring and control

- i) Naming
- ii) Trending data / receipt
- iii) Access control in SCADA
- iv) Log into SCADA

| | |
|--|--|
| | Competence The trainee should have the ability to: |
| | i) Install SCADA facilities |
| | ii) Operate SCADA system |
| | iii) Maintain SCADA system |

Suggested Teaching and Learning Resources

- Operating manual
- Maintenance manual
- SCADA
- Industrial visits

22.2.4 INDUSTRIAL COMMUNICATION NETWORK

Theory

22.2.4T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) list different types of industrial networks
- b) list types of industrial network topology
- c) list types of industrial network protocols
- d) explain physical industrial networks
- e) list network devices

Content

22.2.4T1 Industrial networks

| | | |
|----------|---|---|
| | i) Typical networks ii) Local Area Network (LAN) iii) Wide Area Network (WAN) iv) Network physical layer wiring v) Category 5 (CAT 5) and category 6 (CAT 6) cable vi) Fibre optic cable vii) Co-axial cable viii) Twisted pair ix) Half duplex x) Full duplex | c) identify industrial network protocols |
| 22.2.4T2 | Network Design i) Topology ii) Ring topology iii) STAR topology iv) Bus topology | <i>Content</i> 22.2.4P1 Industrial networks i) Typical networks ii) Network physical layer wiring |
| 22.2.4T3 | Protocols i) Ethernet ii) RS 485 iii) RS 232 i) Field bus ii) HART | 22.2.4P2 Network design topology 22.2.4P3 Protocols i) Network Devices ii) Install physical industries network |
| 22.2.4T4 | Physical industrial Networks | 22.2.4C Competence The trainee should have the ability to: install and maintain physical industrial network |
| 22.2.4T5 | Network devices i) Modems ii) Network switches iii) Terminal reflectors iv) Signal amplifiers v) Network hubs vi) Network budgees | <i>Suggested teaching/Learning Activities</i> <ul style="list-style-type: none">- Discussion- Question and answer- Illustration- Demonstration- Note taking- Observation- Practical exercise- Visits to industries |

Practice

- 22.2.4P0 *Specific Objectives*
 By the end of the sub-module unit, the trainee should be able to:
 a) identify different types of industrial network
 b) identify industrial network topology

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests
- Project
- Project Report writing and presentation

22.2.5 CALIBRATION SYSTEM

Theory

22.2.5T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) list different types of calibration software
- b) describe operation of calibration software
- c) explain different methods of device connection to the software

Content

22.2.5T1 Types

- i) Hand held calibration system
- ii) Computer based calibration

22.2.5T2 Calibration procedure

- Calibration operation by use of software

22.2.5T3 Service connection to the software

- i) Hart communication
- ii) RS232 device connection
- iii) Field bus connection

Practice

22.2.5P0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) identify different types of calibration software
- b) calibrate instruction system by use of software
- c) demonstrate how to connect device to the software

Content

- 22.2.5P1 Calibration software
 - i) Handheld calibration
 - ii) Computer based calibration software
- 22.2.5. P2 Calibrate a system using:
 - i) Hand held calibration
 - ii) Computer based calibration software
- 22.2.5P3 Device connection to the software
 - i) Hart communication
 - ii) RS232 device connection
 - iii) Field buss connection

22.2.5C Competence

The trainee should have the ability to:

- i) Operate calibration software
- ii) Connect device to the software

Suggested teaching/Learning

Activities

- Discussion
- Question and answer
- Illustration
- Demonstration
- Note taking
- Observation
- Practical exercise
- Calculations
- Project work
- Role play
- Visits to industries

Suggested Teaching and Learning

Resources

- Manuals
- Calibration software
- Computer
- Dc Power supply

- Industrial visits

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests
- Project
- Project Report writing and presentation

23.2.0 BUSINESS PLAN

23.2.01 Introduction

This module unit is designed to equip the trainee with knowledge, skills and attitudes to enable him/her prepare a business plan.

23.2.02 General Objectives

At the end of the module unit, the trainee should be able to:

- a) understand the background of intended business
- b) understand the market environment of a business
- c) understand organization and management plan
- d) appreciate the role of an operational plan
- e) prepare financial projections
- f) prepare a business plan

23.2.0 Module Unit Summary and Time Allocation

Business Plan

| Code | Sub Unit Module | Content | Time Hrs |
|-------------|-----------------------------------|---|-----------------|
| 23.2.1 | Introduction to Business Planning | <ul style="list-style-type: none">• Meaning of business plan• Purpose of a business plan• Features of a business plan• Guidelines for developing• An effective business plan | 4 |
| 23.2.2 | Business Description | <ul style="list-style-type: none">• Business name• Business location and address• Form of ownership• Type of business• Products/ services• Justification of the opportunity• The industry• Business goals and objectives• Entry and growth strategy• SWOT analysis | 6 |
| 23.2.3 | Marketing Plan | <ul style="list-style-type: none">• Customer identification• Competitor analysis• Market share• Promotion and advertising• Pricing strategy• Sales tactics• Sales target | 6 |

| | | | |
|--------------|----------------------------------|--|-----------|
| | | <ul style="list-style-type: none"> • Distribution strategy • Customer service | |
| 23.2.4 | Organization and Management Plan | <ul style="list-style-type: none"> • Organization structure • Management team • Recruitment, training and promotion • Remuneration and incentives • Licenses, permits and other requirements • Supporting services | 6 |
| 23.2.5 | Operational/ Production Plan | <ul style="list-style-type: none"> • Production facilities and capacity utilization • Production and operation strategy • Production process • Regulations affecting operations • Operational time table/production schedule | 6 |
| 23.2.6 | Financial Plan | <ul style="list-style-type: none"> • Pre-operations cost • Working capital • Cash flow projections • Pro-forma income statements • Pro-forma balance sheets • Break even analysis • Profitability ratios • Desired financing • Proposed capitalization • Potential risks | 6 |
| 23.2.7 | Presentation | <ul style="list-style-type: none"> • Business plan writing • Presentation of the business plan | 6 |
| 23.2.8 | Emerging Trends | <ul style="list-style-type: none"> • Emerging issues in business planning • Strategies in dealing with emerging issues | 4 |
| Total | | | 44 |

| | | |
|----------|---|--|
| | 23.2.1 INTRODUCTION | |
| | Theory | |
| 23.2.1T0 | <p><i>Specific Objectives</i></p> <p>By the end of the sub-module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) explain the meaning of a business plan b) explain the purposes of a business plan c) identify the features of a business plan d) describe guidelines for developing an effective business plan <p><i>Content</i></p> | <p>23.2.1P2 Guidelines for developing an effective business plan</p> <p>23.2.1C Competence</p> <p>The trainee should have the ability to:</p> <ul style="list-style-type: none"> a) Identify the features of a business plan b) Draw guidelines for developing an effective business plan |
| 23.2.1T1 | Meaning of a business plan | <p><i>Suggested teaching/Learning Activities</i></p> <ul style="list-style-type: none"> - Discussion - Question and answer - Illustration - Demonstration - Note taking - Observation - Presentations |
| 23.2.1T2 | Purposes of a business plan | |
| 23.2.1T3 | Features of a business plan | <p><i>Suggested teaching/Learning Resources</i></p> <ul style="list-style-type: none"> - Sample business plan write-ups - Text books |
| 23.2.1T4 | Guidelines for developing an effective business plan | |
| | Practice | |
| 23.2.1P0 | <p><i>Specific Objectives</i></p> <p>By the end of the sub-module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) identify the features of a business plan b) draw guidelines for developing an effective business plan <p><i>Content</i></p> | <p><i>Suggested Evaluation Methods</i></p> <ul style="list-style-type: none"> - Oral tests - Assignments - Project |
| 23.2.1P1 | Features of a business plan | <p>23.2.2 BUSINESS DESCRIPTION</p> <p>Theory</p> <p>27.3.2T0 <i>Specific Objectives</i></p> <p>By the end of the sub-module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) provide the business name |

- b) describe business location and address
 - c) discuss form of ownership
 - d) explain the type of business
 - e) describe the products offered
 - f) discuss the justification of opportunity
 - g) describe the industry
 - h) explain the goals of business
 - i) explain the entry and growth strategy
 - j) discuss SWOT analysis
- Content*

- 23.2.2.P1 create the business name
 23.2.2.P2 Form of ownership
 23.2.2.P3 Type of business
 23.2.2.P4 Products offered

- 23.2.2C Competence**
 The trainee should have the ability to:
- i) develop business names
 - ii) analyse form of ownership
 - iii) list the type of business
 - iv) examine the products offered

- Content*
- | | |
|-----------|-------------------------------|
| 23.2.2T1 | Provide the business name |
| 23.2.2T2 | Business location and address |
| 23.2.2T3 | Form of ownership |
| 23.2.2T4 | Type of business |
| 23.2.2T5 | Products offered |
| 23.2.2T6 | Justification of opportunity |
| 23.2.2T7 | The industry |
| 23.2.2T8 | The goals of business |
| 23.2.2T9 | Entry and growth strategy |
| 23.2.2T10 | SWOT analysis |

Suggested teaching/Learning Activities

- Discussion
- Question and answer
- Illustration
- Demonstration
- Note taking
- Observation
- Presentations

Suggested teaching/Learning Resources

- Sample business plan write-ups
- Text books

Suggested Evaluation Methods

- Oral tests
- Assignments
- Project

23.2.3 MARKETING PLAN

| Theory | | |
|-----------------|--|---|
| 23.2.3T0 | <p><i>Specific Objectives</i></p> <p>By the end of the sub-module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) identify customers b) describe the competitors c) determine the market share d) explain the methods of promotion and advertising e) explain the pricing strategy f) set sales target g) describe the sales tactics h) describe the distribution strategy i) describe the customer service strategy | <ul style="list-style-type: none"> a) identify potential customers b) identify the competitors c) determine the methods of promotion and advertising d) examine the factors to consider in pricing e) identify the sales tactics f) analyze the distribution strategy g) draw the customer service strategy |
| | <i>Content</i> | |
| 23.2.3T1 | Identification of customers | 23.2.3P1 Identification of customers |
| 23.2.3T2 | Competitors analysis | 23.2.3P2 Competitors analysis |
| 23.2.3T3 | Determination the market share | 23.2.3P4 Methods of promotion and advertising |
| 23.2.3T4 | Methods of promotion and advertising | 23.2.3P5 Pricing strategy |
| 23.2.3T5 | Pricing strategy | 23.2.3P7 Sales tactics |
| 23.2.3T6 | Set sales target | 23.2.3P8 Distribution strategy |
| 23.2.3T7 | Sales tactics | 23.2.3P9 Customer service strategy |
| 23.2.3T8 | Distribution strategy | |
| 23.2.3T9 | Customer service strategy | |
| Practice | | |
| 27.3P0 | <p><i>Specific Objectives</i></p> <p>By the end of the sub-module unit, the trainee should be able to:</p> | <p>Competence</p> <p>The trainee should have the ability to:</p> <ul style="list-style-type: none"> i) Identify potential customers ii) Identify the competitors iii) Determine the methods of promotion and advertising iv) Examine the factors to consider in pricing v) Identify the sales tactics vi) Analyze the distribution strategy vii) Draw the customer service strategy |

| | | |
|--|--|--|
| <i>Suggested teaching/Learning Activities</i> | <ul style="list-style-type: none"> - Discussion - Question and answer - Illustration - Demonstration - Note taking - Observation - Presentations - Field visits | <p>Content</p> <p>23.2.4T1 Organization structure 23.2.4T2 Management team 23.2.4T3 Other business personnel 23.2.4T4 Recruitment, training and promotion of personnel 23.2.4T5 Remuneration and incentives for personnel 23.2.4T6 Licenses persist and legal requirements 23.2.4T7 Support services</p> |
| <i>Suggested teaching/Learning Resources</i> | <ul style="list-style-type: none"> - Sample business plan write-ups - Text books | Practice |
| <i>Suggested Evaluation Methods</i> | <ul style="list-style-type: none"> - Oral tests - Assignments - Project | <p>23.2.4P0 Specific Objectives By the end of the sub-module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) draw organization structure b) assemble a the management team c) develop a management plan <p>Content</p> <p>23.2.4P1 Organization structure 23.2.4P2 Management team 23.2.4P3 Management plan</p> |
| 23.2.4 ORGANIZATION AND MANAGEMENT PLAN | Theory | <p>23.2.4C Competence The trainee should have the ability to:</p> <ul style="list-style-type: none"> i) Draw organization structure ii) Assemble a the management team iii) Develop a management plan |
| 23.2.4T0 Specific Objectives | <p>By the end of the sub-module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) describe the organization structure b) describe the management team c) identify other business personnel d) explain recruitment, training and promotion of personnel e) discuss remuneration and incentives for personnel f) identify licenses persist and legal requirements | <i>Suggested teaching/Learning Activities</i> |
| | | <ul style="list-style-type: none"> - Discussion |

- Question and answer
- Illustration
- Demonstration
- Note taking
- Observation
- Presentations

Suggested teaching/Learning Resources

- Sample business plan write-ups
- Text books
- Sample organisation plan

Suggested Evaluation Methods

- Oral tests
- Assignments
- Project

23.2.5 OPERATIONAL AND PRODUCTION PLAN

Theory

- 23.2.5T0 *Specific Objectives*
 By the end of the sub-module unit, the trainee should be able to:
- a) identify production facilities and capacity
 - b) develop a production and operation strategy
 - c) describe the production process of the products
 - d) discuss the regulations affecting operations
 - e) prepare operation time table/production schedule

Content

- 23.2.5T1 Production facilities and capacity

- 23.2.5T2 Develop a production and operation strategy
- 23.2.5T3 Production process of the products
- 23.2.5T4 Production process of the products
- 23.2.5T5 Regulations affecting operations
- 23.2.5T6 Prepare operation time table/production schedule

Practice

- 23.2.5P0 *Specific Objectives*
 By the end of the sub-module unit, the trainee should be able to:
- a) identify production facilities and capacity
 - b) describe the production process of the products

Content

- 23.2.5P1 Production facilities and capacity
- 23.2.5P2 Production process of the products

23.2.5C Competence

- The trainee should have the ability to:
- i) Identify production facilities and capacity
 - ii) Draw the production process of the products

Suggested teaching/Learning Activities

- Discussion
- Question and answer
- Illustration
- Demonstration
- Note taking
- Observation

- Presentations

Suggested teaching/Learning Resources

- Sample business plan write-ups
- Text books

23.2.6 FINANCIAL PLAN

Theory

- 23.2. 6T0 *Specific Objectives*
 By the end of the sub-module unit, the trainee should be able to:
- determine pre-operational costs
 - estimate working capital
 - estimate cash-flow projections
 - prepare pro-forma income statements
 - prepare pro-forma balance sheets
 - calculate break-even point
 - calculate profitability ratios
 - calculate desired financing
 - calculate proposed capitalization

Content

- 23.2. 6T1 Determination of pre operational costs
 23.2. 6T2 Estimating working capital
 23.2. 6T3 Estimating cash-flow projections
 23.2. 6T4 Preparation pro-forma income statements
 23.2. 6T5 Preparation pro-forma balance sheets

- 23.2. 6T6 Calculation break-even point
 23.2. 6T7 Calculation profitability ratios
 23.2. 6T8 Calculation desired financing
 23.2. 6T9 Calculation Proposed capitalization

Practice

- 23.2. 6T0 *Specific Objectives*
 By the end of the sub-module unit, the trainee should be able to:
- determine pre-operational costs
 - estimate working capital
 - estimate cash-flow projections
 - prepare pro-forma income statements
 - prepare pro-forma balance sheets
 - calculate break-even point
 - calculate profitability ratios

Content

- 23.2. 6T1 Determination pre-operational costs
 23.2. 6T2 Estimating working capital
 23.2. 6T3 Estimating cash-flow projections
 23.2. 6T4 Preparation pro-forma income statements
 23.2. 6T5 Preparation pro-forma balance sheets
 23.2. 6T6 Calculation break-even point
 23.2. 6T7 Calculation profitability ratios

| | |
|--|---|
| <p>23.2.6C Competence</p> <p>The trainee should have the ability to:</p> <ul style="list-style-type: none"> i) Determine pre-operational costs ii) Estimate working capital iii) Estimate cash-flow projections iv) Prepare pro-forma income statements v) Prepare pro-forma balance sheets vi) Calculate break-even point vii) Calculate profitability ratios | <p>23.2.7T0 Specific Objectives</p> <p>By the end of the sub-module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) prepare final business plan b) make a presentation of the business plan |
| <p><i>Suggested teaching/Learning Activities</i></p> <ul style="list-style-type: none"> - Discussion - Question and answer - Illustration - Demonstration - Note taking - Observation - Presentations | <p><i>Content</i></p> <p>23.2.7T1 Writing the final business plan</p> <p>23.2.7T2 Presentation of the business plan</p> |
| <p><i>Suggested teaching/Learning Resources</i></p> <ul style="list-style-type: none"> - Sample business plan write-ups - Text books - Calculator - Computer | <p>23.2.7P0 Specific Objectives</p> <p>By the end of the sub-module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) write the final business plan b) make a presentation of the business plan <p><i>Content</i></p> <p>23.2.7P1 Writing the final business plan</p> <p>23.2.7P2 Presentation of the business plan</p> |
| <p><i>Suggested Evaluation Methods</i></p> <ul style="list-style-type: none"> - Oral tests - Timed written tests - Assignments - Business plan <p>23.2.7 PRESENTATION</p> <p>Theory</p> | <p>23.2.7C Competence</p> <p>The trainee should have the ability to:</p> <ul style="list-style-type: none"> i) Write the final business plan ii) Make a presentation of the business plan <p><i>Suggested teaching/Learning Activities</i></p> <ul style="list-style-type: none"> - Discussion - Question and answer - Illustration - Demonstration - Note taking |

- Observation
- Presentations

Suggested teaching/Learning Resources

- Sample business plan write-ups
- Text books
- Calculator
- Computer

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Business plan

23.2.8 EMERGING TRENDS AND ISSUES

Theory

23.2.8T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) identify the emerging trends in business plan
- b) identify the challenges posed by the emerging trends and issues
- c) explain various ways of coping with challenges

Content

- 23.2.8T1 Emerging trends in business plan
- 23.2.8T2 Challenges posed by the emerging trends and issues
- 23.2.8T3 Ways of coping with challenges

Practice

23.2.8P0 Specific Objectives

By the end of sub-module unit, the trainee should be able to:

- a) identify emerging issues/trends
- b) report on challenges of emerging trends
- c) interpret ways of adapting to the emerging trends

Content

23.2.8P1 Identification of Emerging Issues

23.2.8P2 Reporting on challenges of emerging issues

23.2.8C Competence

The trainee should have the ability to:

- i) Write the final business plan
- ii) Make a presentation of the business plan

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Business plan

23.2.8P3 Interpreting ways of adapting to emerging trends

23.2.8C Competence

The trainee should have the ability to:

- i) Identify emerging issues/trends
- ii) Report on challenges of emerging trends

- iii) Interpret ways of adapting
to the emerging trends

Suggested Learning Resources

- Manuals
- Samples
- Relevant text books
- News papers and magazines
- Media
- Internet

24.2.0 ELECTRIC CIRCUIT ANALYSIS

24.2.01 Introduction

The module unit deals with the analyses of networks that contain electrical and electronic components, and it is designed to provide the trainee with knowledge, skills and attitude necessary in understanding the behaviour of electronic components and other circuit devices when used in electrical and electronic circuits. Upon completion of the unit, the trainee will gain knowledge necessary to construct, diagnose faults and test functional electric circuits.

24.2.02 General Objectives

At the end of the module unit, the trainee should be able to:

- a) Understand the principles of electric circuit components
- b) Analyse electrical networks
- c) Perform experiments to verify various electric circuit theories
- d) Apply network theories in solving engineering problems
- e) Observe safety regulations and standards when carrying out electrical work

24.2.03 Module Unit Summary and Time Allocation

Electric Circuit Analysis

| Code | Sub-Module Unit | Content | Time Hrs |
|-------------|----------------------------------|--|-----------------|
| 24.2.1 | Electric circuit analysis | <ul style="list-style-type: none">• Complex quantities• Single phase circuits• Circuit theories• Star delta/delta-star transformation | 6 |
| 24.2.2 | Transients | <ul style="list-style-type: none">• Growth and delay in R-C circuits• Growth and delay in R-L circuits• Calculations | 6 |
| 24.2.3 | Three phase Induction Motors | <ul style="list-style-type: none">• Construction of 3 phase induction motors• Principles of operation of three phase induction motor• Starless three phase induction motor• Characteristics of three phase induction motor• Applications of three phase induction motors | 6 |
| 24.2.4 | Three-Phase Synchronous Machines | <ul style="list-style-type: none">• Construction• Operation• Synchronization | 6 |

| | | | |
|-------------------|--------------------------|---|-----------|
| | | <ul style="list-style-type: none"> • Applications • Calculations | |
| 24.2.5 | Two Port Networks | <ul style="list-style-type: none"> • Basic passive networks • Characteristic impedance • Transmission lines • ABCD constants • Network in cascades | 4 |
| 24.2.6 | Three Phase Systems | <ul style="list-style-type: none"> • Principles of three phase • Methods of three phase • Line and phase quantities • Calculations on three • Methods of power | 6 |
| 24.2.7 | Complex wave forms | <ul style="list-style-type: none"> • Complex waveforms • Sources of harmonics • Analysis of complex waveforms • Calculations on complex waveforms • Harmonics in transformers • Problem solving | 8 |
| 24.2.8 | dc Machines | <ul style="list-style-type: none"> • Construction • Operation • Classification • Starting methods • Armature reaction • Characteristics of dc machines • Applications of dc machines | 6 |
| 24.2.9 | Single Phase Motors | <ul style="list-style-type: none"> • Construction of single phase motors • Operation of single phase motors • Characteristics of single phase motors • Application of single phase motors | 8 |
| 24.2.10 | Special Machines | <ul style="list-style-type: none"> • Construction of various special machines • Operation of various special machines • Characteristics of various special machines • Application of special machines | 4 |
| 24.2.11 | Three-Phase Transformers | <ul style="list-style-type: none"> • Construction • Operation • Characteristics • Applications • Calculations | 6 |
| Total Time | | | 66 |

| | | |
|---------------|---|--|
| 24.2.1 | ELECTRIC CIRCUIT ANALYSIS | |
| | Theory | |
| 24.2.1T0 | <p><i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) describe the principles of complex quantities b) solve single phase ac circuits using complex quantities c) solve network problems using theories d) explain the principle of star-delta and delta-star transformation | <p>Practice</p> |
| 24.2.1T1 | <p><i>Content</i> principles of complex quantities</p> <ul style="list-style-type: none"> i) Polar exponential and rectangular co-ordinates ii) Concept of impedance and admittance iii) Series and parallel resonance iv) Q factor of a coil v) Selectivity vi) Calculation of power in single phase circuits | <p><i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) perform experiments to establish the relationship between current and voltage in R-L-C series and parallel circuits b) measure Q factor of a coil c) measure power in single phase ac circuits d) build circuits to demonstrate network theorems and power transfer |
| 24.2.1T2 | single phase ac circuits | <p><i>Content</i></p> |
| | <ul style="list-style-type: none"> i) Series ii) parallel | <ul style="list-style-type: none"> 24.2.1P1 Relationship between current and voltage in R-L-C series and parallel circuit. 24.2.1P2 Q factor of a coil 24.2.1P3 Power in single phase AC circuits 24.2.1P4 Network theorems |
| 24.2.1T3 | network problems | <ul style="list-style-type: none"> i) Thevernin's theorem ii) Nortons theorem iii) Millman's theorem |
| | | <ul style="list-style-type: none"> i) Thevernin's ii) Norton's iii) Millman's iv) Maximum power transfer |
| | | 24.2.2C Competence |

The trainee should have the ability to:

- i) Measure power in AC circuits
- ii) Design electric circuits

Suggested teaching/Learning Activities

- Question and answer
- Illustration
- Demonstration
- Note taking
- Observation
- Practical exercise
- Calculations

Suggested Teaching/Learning Resources

- Bread boards
- Measuring instruments
- Electronics components
- Circuit diagrams

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

24.2.2 TRANSIENTS

Theory

24.2.2T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) explain the growth and decay in R-C circuits
- b) explain the growth and decay in the RL circuits
- c) solve problems in capacitive and inductive circuits

Content

- | | |
|----------|---|
| 24.2.2T1 | Growth and decay in R-C circuits |
| i) | Charge ad discharge curves on RC circuits |
| ii) | Equation for instantaneous voltages currents and transient currents |
| 24.2.2T2 | Growth and decay in R-L circuits |
| i) | Charge and discharge curves for R-L circuits |
| ii) | Equation for instantaneous voltages and current |
| 24.2.2T3 | Solution of problems |
| i) | Capacitive circuits |
| ii) | Inductive circuits |

Practice

- | | |
|----------|--|
| 24.2.2P0 | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should: <ul style="list-style-type: none">a) perform an experiment to pilot growth and decay curves for RC and LC circuitsb) determine the time constantsc) plot the resonance curves for LC series and parallel circuits |
|----------|--|

Content

- | | |
|----------|--|
| 24.2.2P1 | Growth and decay curves <ul style="list-style-type: none">i) RC circuitsii) RL circuits |
| 24.2.2P2 | Resonance curves <ul style="list-style-type: none">i) Series circuits |

- ii) Parallel circuits

24.2.2C Competence

The trainee should have the ability to: demonstrate transient in ac and dc circuits

Suggested teaching/Learning Activities

- Discussion
- Question and answer
- Illustration
- Demonstration
- Note taking
- Observation
- Practical exercise
- Calculations

Suggested Teaching/Learning Resources

- Bread boards
- Measuring instruments
- Electronics components
- Circuit diagrams
- *Suggested Evaluation Methods*
- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

24.2.3 THREE PHASE INDUCTION MOTORS

Theory

24.2.3T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) describe the construction of a three phase induction motor

- b) explain the principle of operation of three induction motor
- c) describe the starless three phase induction motor
- d) describe the characteristics of three phase induction motor
- e) state the applications of three phase induction motor

Content

- 24.2.3T1 Construction of three phase induction motor
 - i) Stator
 - ii) Rotor
- 24.2.3T2 Principle of operation of three phase induction motor
 - i) Production of rotating field
 - ii) Production of torque
 - iii) Slip
 - iv) Relationship between speed pole pairs and frequency
 - v) Power stages and power losses
- 24.2.3T3 Starters for:
 - i) Direct-on-line starter
 - ii) Star-delta starter
 - iii) Auto transformer starter
 - iv) Resistance starter
- 24.2.3T4 Characteristics of three phase induction motor
 - i) Torque / speed
 - ii) Torque slip
 - iii) Torque current
- 24.2.3T5 Application of three phase induction motors
 - i) Industrial / commercial
 - ii) Domestic

| | | |
|----------|---|---|
| | Practice | - Motor starters - Tools and equipments - Ac power supply - Three phase power supply |
| 24.2.3P0 | Specific Objectives By the end of the sub-module unit, the trainee should be able to: a) install three phase induction motors - starter b) trouble shoot faults in three phase motors | <i>Suggested Evaluation Methods</i> - Oral tests - Timed written tests - Assignments - Timed practical tests |
| | Content | |
| 24.2.3P1 | Three phase motor starters i) Direct on line ii) Star delta iii) Auto reverse iv) Slip-ring starter v) Auto transformer | 24.2.4 THREE PHASE SYNCHRONOUS MACHINE |
| 24.2.3P2 | Faults in three phase motors i) Short circuits ii) Open circuits iii) heating | Theory |
| 24.2.3C | Competence The trainee should have the ability to: i) Install 3 phase induction motors ii) Maintain 3 phase induction motors | 24.2.4T0 Specific Objectives By the end of the sub-module unit, the trainee should be able to: a) describe the construction of three phase synchronous machine b) explain the principles of operation of three phase synchronous machine c) explain the starting and synchronizing methods of three phase synchronous machine d) explain the characteristics of three-phase synchronous machine e) state the application of three-phase synchronous machine f) solve problems on synchronous machines |
| | <i>Suggested teaching/Learning Activities</i> | |
| | - Discussion - Illustration - Demonstration - Note taking - Practical exercise - Calculations | |
| | <i>Suggested Teaching/Learning Resources</i> | |
| | - 3 phase motors - Measuring instruments | |

| | | |
|----------|--|---|
| | <i>Content</i> | |
| 24.2.4T1 | Construction of three phase <ul style="list-style-type: none"> i) Stator ii) Rotor iii) Salient pole rotor iv) Cylindrical rotor | - Power factor implementation problems |
| 24.2.4T2 | Principle of operation of three phase synchronous machine <ul style="list-style-type: none"> i) Not self starting ii) Operation of synchronous speed only iii) Operation characteristics | Practice |
| 24.2.4T3 | Starting and synchronizing methods <ul style="list-style-type: none"> i) Pony motor starting ii) Induction starting iii) Synchronising methods iv) Lamps methods v) Dark lamp vi) Lamp in sequence vii) Synchro-scope | 24.2.4P0 <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: <ul style="list-style-type: none"> a) install 3 phase synchronous machine b) synchronise of three phase synchronous machines |
| 24.2.4T4 | Characteristics of three phase synchronous machine <ul style="list-style-type: none"> i) Operates at synchronous constant speed ii) Inherently not self starting iii) Operates at loading and logging power factor iv) V-curves characteristics | 24.2.4T1 3-phase synchronous machine <ul style="list-style-type: none"> i) Induction starting ii) Pony motor starting |
| 24.2.4P5 | Application of three phase synchronous machine <ul style="list-style-type: none"> - Constant speed drive - Improvement of power factors | 24.2.4T2 Synchronization of three phase synchronous machine <ul style="list-style-type: none"> i) Lamps method ii) Dark lamp iii) Lamps in sequence iv) Synchroscope method |
| 24.2.4T6 | Problems on three phase synchronous machine | 24.2.4C Competence The trainee should have the ability to: install and test three phase synchronous machine |
| | | <i>Suggested teaching/Learning Activities</i> |
| | | <ul style="list-style-type: none"> - Discussion - Illustration - Demonstration - Note taking - Practical exercise - Calculations - Visits to industries |

| | | |
|--|---|--|
| <i>Suggested Teaching / Learning Resources</i> | <ul style="list-style-type: none"> - 3 phase synchronous machines - Synchroscope - Lamps - Tools and equipment - Measuring instruments | <ul style="list-style-type: none"> i) Symmetrical T-circuit ii) Symmetrical π circuit iii) Insertion loss iv) Logarithmic ratios |
| <i>Suggested Evaluation Methods</i> | <ul style="list-style-type: none"> - Oral tests - Timed written tests - Assignments - Timed practical tests | <p>24.2.5T3 Equivalent circuits on transmission line</p> <ul style="list-style-type: none"> i) Short transmission lines ii) Medium length lines |
| 24.2.5 TWO PORTS NETWORKS | Theory | <p>24.2.5T4 ABCD constants</p> <ul style="list-style-type: none"> i) Evaluation of ABCD constant ii) Characteristics impedance |
| | | <p>24.2.5T5 Network in cascade</p> <p>Practice</p> |
| 24.2.5T0 Specific Objectives | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: | <p>24.2.5P0 <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) construct passive networks b) demonstrate impedance characteristics |
| | <ul style="list-style-type: none"> a) describe basic passive networks b) analyse characteristics impedance of network circuits c) analyse equivalent circuits on transmission line d) derive ABCD constant e) explain network in cascade | <p>Content</p> <p>24.2.5P1 Construction of passive networks</p> <ul style="list-style-type: none"> i) π-networks ii) T-networks iii) Lattice networks iv) Balanced T-networks |
| | | <p>24.2.5P2 Impedance characteristics of network circuits</p> <ul style="list-style-type: none"> i) Symmetrical T-circuit ii) Symmetrical π circuit |
| <i>Content</i> | 24.2.5C Competence | <p>The trainee should have the ability to:</p> <ul style="list-style-type: none"> i) Apply two port networks to solve problems in electric circuits ii) circuits |
| <p>24.2.5T1 Basic passive networks</p> <ul style="list-style-type: none"> i) π networks ii) T-networks iii) Lattice networks iv) Balanced T-network <p>24.2.5T2 Characteristics impedance of network circuits</p> | | |

- iii) Teaching / Learning Resources
- iv) Electronics components
- v) Tools
- vi) Bread board
- vii) Measuring instruments
- e) explain methods of power measurement in three phase balanced systems

Suggested teaching/Learning Activities

- Discussion
- Illustration
- Demonstration
- Note taking
- Practical exercise
- Calculations
- Visits to industries

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

24.2.6 THREE PHASE SYSTEMS

Theory

24.2.6T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) explain the principles of three phase generation
- b) describe various methods of three phase connections
- c) explain the difference between line and phase quantities
- d) solve problems on three phase balanced systems

Content

24.2.6T1 Principles of three phase generation

- i) Three phase windings
- ii) Rotating magnetic field
- iii) Electromagnetic induction
- iv) Waveforms

24.2.6T2 Methods of three phase connections

- i) Star connection
- ii) Delta connection

24.2.6T3 Line and phase quantities in three phase star and delta connected loads

24.2.6T4 Calculations on three phase balanced systems

24.2.6T5 Methods of power measurement

- i) One wattmeter method
- ii) Two wattmeter method

Practice

24.2.6P0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) demonstrate three phase generation
- b) measure active reactive and apparent power

Content

24.2.6P1 Three phase generation

| | | |
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| | i) Star ii) Delta | By the end of the sub-module unit, the trainee should be able to: |
| 24.2.6P2 | Power measurements i) One wattmeter method ii) Two wattmeter method | a) explain the complex waveform b) describe the sources of harmonics c) analyse the effects of harmonics in single phase circuits d) explain the effects of harmonics in three phase transformers e) solve problems on complex waveforms |
| 24.2.6C | Competence The trainee should have the ability to: i) Install three phase circuits ii) Measure power in three phase circuits | |

Suggested teaching/Learning Activities

- Discussion
- Illustration
- Demonstration
- Note taking
- Practical exercise
- Calculations

Suggested Teaching/Learning Resources

- Charts
- Generator set
- Oscilloscope
- Watt meters

Suggested teaching/Learning Activities

- Discussion
- Illustration
- Demonstration
- Note taking
- Practical exercise
- Calculations

24.2.7 COMPLEX WAVEFORMS

Theory

24.2.7T0 Specific Objectives

| | <i>Content</i> |
|-----------|---|
| 24.2. 7T1 | Complex waveforms i) Definitions ii) Fundamental iii) Harmonics iv) Complex waveforms v) Sketch vi) Even harmonics vii) Odd harmonics |
| 24.2. 7T2 | Sources of harmonics i) Rectifier circuits ii) Valve circuits iii) Transistor circuits iv) Iron-cored coils v) Generators |
| 24.2. 7T3 | Effects of harmonics in single phase circuits i) Selective resonance ii) Third harmonics and triplets iii) RMS values iv) Power and power factor |
| 24.2. 7T4 | Effects of harmonics in three phase transformers i) Star-delta connection ii) Delta-star connection iii) Tertiary connection iv) Harmonic contents in phase and line values |

| | | |
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| | for various connections | |
| 24.2. 7T5 | Solution of problems on complex waveforms i) Harmonic contents ii) RMS values iii) Line and phase values | a) describe the construction of dc machines b) explain the principle of operation of dc machines c) describe the classification of dc machines d) describe the operation of face plate starter e) explain armature reaction and commutation f) describe the characteristics of the machines g) state the applications of dc machines |
| | Practice | <i>Content</i> |
| 24.2. 7P0 | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: a) display complex waveforms b) demonstrate the effects of harmonics | 24.2. 8T1 Construction of dc machines i) Yoke ii) Main poles iii) Field/magnetizing coils iv) Armature v) Commutator vi) Brushes and brush gear vii) Bearings |
| 24.2. 7P1 | <i>Content</i> Display of complex waveforms i) Rectifier circuits ii) Valve circuits iii) Transistor circuits iv) generators | 24.2. 8T2 Principle of operation of dc machine |
| 24.2.7P2 | Effects of harmonics i) single phase circuits ii) transformers | 24.2. 8T3 Classification of dc machines i) Separately excited ii) Self excited iii) Long compound iv) Short compound |
| | <i>Suggested Learning Resources</i> <ul style="list-style-type: none">- Generator sets- Electronic circuits- Measuring instruments- Charts | 24.2. 8T4 Face-plate starter i) Need ii) Protective devices iii) Operation |
| 24.2.8 | DC MACHINES | 24.2. 8T5 Armature reaction and commutation |
| | Theory | 24.2.8T6 Characteristics of dc machines i) Generators ii) Motors |
| 24.2. 8T0 | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: | |

| | | |
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| 24.2. 8T7 | Application of dc machines | <i>Suggested Evaluation Methods</i> |
| | Practice | - Oral tests - Timed written tests - Assignments - Timed practical tests |
| 24.2. 8P0 | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: a) demonstrate the operation of dc machines b) install and operate a face-plate starter | 24.2.9 |
| | <i>Content</i> | SINGLE PHASE MOTORS |
| 24.2.8P1 | Dc machines operation - Separately excited - Self excited | 24.2. 9T0 |
| 24.2.8P2 | Installation and operation of face-plate starter | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: a) describe the construction of single phase motors b) explain the principle of operation of single phase ac motors c) describe the characteristics of single phase ac motors d) state the application of single phase ac motors |
| 24.2.8C | Competence - The trainee should have the ability to: install and test dc machines | |
| | <i>Suggested teaching/Learning Activities</i> | <i>Content</i> |
| | - Discussion - Illustration - Demonstration - Note taking - Practical exercise - Calculations | 24.2. 9T1 Construction of single phase ac motors i) Stator ii) Rotor |
| | <i>Suggested Teaching/Learning Resources</i> | 24.2. 9T2 Principles of operation of single phase ac motors i) Split phase ii) Capacitor start iii) Shaded pole iv) Repulsion induction motor v) Universal motor |
| | - Dc generators - Dc motors - Face plate starter - Measuring instruments - Charts - Dismantling tools | 24.2. 9T3 Characteristics of single phase ac motors |

- i) Torque/speed characteristics
 - ii) Split phase
 - iii) Capacitor start
 - iv) Capacitor run
 - v) Shaded pole
 - vi) Repulsion induction motor
 - vii) Universal motor
- 24.2. 9T4 Applications of single phase motors

Practice

- 24.2.9P0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
- a) identify the main parts of a single phase ac machine
 - b) install and test single phase motors

Content

- 24.2. 9P1 Parts of a single phase ac motor
- i) Stator
 - ii) Rotor
 - iii) Commutators
 - iv) Brushes
- 24.2. 9P2 Installation and testing of single phase ac motors

24.2.9C Competence

The trainee should have the ability to: install and test single phase ac motors

Suggested teaching/Learning Activities

- Discussion
- Illustration
- Demonstration
- Note taking
- Calculations

Teaching/Learning Resources

- Single phase motors
- Motor starter
- Charts
- Measuring instruments
- *Suggested Evaluation Methods*
- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

24.2.10 SPECIAL MACHINES

Theory

- 24.2. 10T0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
- a) describe the construction of various special machines
 - b) explain the principle of operation of various special machines
 - c) explain the characteristics of various special machines
 - d) state the applications of various special machines

Content

- 24.2. 10T1 Construction of special machines
- i) Amplidyne and metadynes
 - ii) Linear motors
 - iii) Stepper motors
 - iv) Series motors
 - v) Universal motors

| | | |
|---|--|-----------------|
| 24.2. 10T2 | Principle of operation of special machines | iv) Note taking |
| i) | Amplidyne and metadynes | |
| ii) | Linear motors | |
| iii) | Stepper motors | |
| iv) | Series motors | |
| v) | Universal motors | |
| 24.2. 10T3 | Characteristics of special machines | |
| 24.2. 10T4 | Application of special machines | |
| Practice | | |
| 24.2. 10P0 | <i>Specific Objectives</i> By the end of the sub - module unit, the trainee should be able to demonstrate the principles of operation of various special machines | |
| <i>Content</i> | | |
| 24.2. 10P1 | Principles of operation of special machines | |
| i) | Stepper motor | |
| ii) | Linear motor | |
| iii) | Servo motor | |
| 24.2.10C Competence | The trainee should have the ability to: | |
| i) | identify various special machines | |
| ii) | demonstrate the operation of various special machines | |
| iii) | Calculations | |
| <i>Suggested teaching/Learning Activities</i> | | |
| i) | Discussion | |
| ii) | Illustration | |
| iii) | Demonstration | |
| <i>Suggested Teaching/Learning Resources</i> | | |
| - | Various special machines | |
| - | Measuring instruments | |
| - | Charts | |
| - | Manuals | |
| <i>Suggested Evaluation Methods</i> | | |
| - | Oral tests | |
| - | Timed written tests | |
| - | Assignments | |
| - | Timed practical tests | |
| 24.2.11 | THREE PHASE TRANSFORMERS | |
| Theory | | |
| 24.2. 11T0 | <i>Specific Objective</i> By the end of the sub - module unit, the trainee should be able to: | |
| a) | describe the construction of three phase transformer | |
| b) | explain the principle of operation of three phase transformer | |
| c) | explain the three phase transformer characteristics | |
| d) | state applications of three phase transformers | |
| <i>Content</i> | | |
| 24.2. 11T1 | Construction of three phase transformer | |
| i) | Primary windings | |
| ii) | Secondary windings | |
| iii) | Iron core types | |
| 24.2. 11T2 | Principle of operation of three phase transformer | |
| i) | Current and voltage | |

- ii) Turns ratio
 - iii) Relationship between primary and secondary values
 - iv) Transformer E.M.F equation
 - v) Star-delta/delta-star connections
- 24.2.11T3 Characteristics
- i) Transformer on load
 - ii) Efficiency test
 - iii) Open circuit test and short circuit test
 - iv) Iron and copper losses
- 24.2.11T4 Application of three phase transformers

- Demonstration
- Note taking
- Practical exercise
- Calculations

Suggested Teaching/Learning Resources

- 3 phase transformers
- Measuring instruments
- Charts

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

Practice

- 24.2.11P0 *Specific Objectives*
 By the end of the sub-module unit, the trainee should be able to:
- a) demonstrate the operation of three phase transformers
 - b) test three phase transformers

Content

- 24.2.11P1 operation of three phase transformers
- 24.2.11P2 tests on three phase transformer

- 24.2.11C **Competence**
 The trainee should have the ability to: install and test three phase transformers

Suggested teaching/Learning Activities

- Discussion
- Illustration

25.2.0 ELECTRICAL PROTECTION AND SERVICES FOR BUILDINGS

25.2.01 Introduction

This module unit is designed to equip the trainee with knowledge, skills and attitudes appropriate for carrying out electrical installation design work, protection of buildings from electrical related dangers, installation of special electrical wiring systems and utility services. A trainee who successfully completes this module unit will be equipped to work in the construction industry as a site foreman.

25.2.02 General Objectives

At the end of this module unit the trainee should be able to;

- a) Design electrical installation works
- b) Interpret parts of building structure for utility and electrical services
- c) Understand the requirements for lightning protection
- d) Select a suitable wiring system for special ambient conditions
- e) Appreciate the need for quality control in electrical installations
- f) Observe the IEE regulation requirements and standards for electrical installation

25.2.03 Module Unit Summary and Time Allocation

Electrical Installation Technology II

| Code | Sub-Module Unit | Content | Time Hrs |
|-------------|------------------------|---|-----------------|
| 25.2.1 | Corrosion Protection | <ul style="list-style-type: none">• Process of electrostatic corrosion• Methods of corrosion protection• Precaution to prevent corrosion• Regulations and codes of practice | 8 |
| 25.2.2 | Lightning Protection | <ul style="list-style-type: none">• Definition of terms• Types of lightning strokes• Effects of lightning strokes• Factors necessary to consider when designing for lightning protection• Components of lightning protection system | 6 |

| | | | |
|-------------------|-----------------------------------|---|-----------|
| | | <ul style="list-style-type: none"> • Tests to be carried out on lightning protection • Maintenance required • Application of lightning protection system | |
| 25.2.3 | Special Installation | <ul style="list-style-type: none"> • Flame proof installations • Damp and electrostatic areas • Temporary installations • Caravan sites • Agricultural installations • Relevant IEE regulation | 12 |
| 25.2.4 | Illumination | <ul style="list-style-type: none"> • Law of inverse squares • Terms used in illumination • Types of lamps • Design of lighting schemes • Relevant IEE regulation | 20 |
| 25.2.5 | Building Services | <ul style="list-style-type: none"> • Building structure • Accommodating electrical services in building • Utility services | 8 |
| 25.2.6 | Installation planning and designs | <ul style="list-style-type: none"> • Factors determining choice of wiring systems • Determining final sub circuits • Rating of cables and devices • Distribution diagram • Layout of lightning and power points • Wiring systems layout • Relevant IEE regulations, codes of practice and catalogues | 12 |
| Total time | | | 66 |

| | | |
|----------|---|---|
| 25.2.1 | CORROSION PROTECTION | |
| | Theory | |
| 25.2.1T0 | <i>Specific Objectives</i> | ii) Prevention of contact between dissimilar metals iii) Soldering operation iv) Protection of metal sheaths of cables and metal conduct fittings where they come in contact with lime, cement. |
| | By the end of the sub-unit, the trainee should be able to: | 25.2.1T4 Applications of regulations and code of practices requirements to prevent corrosion |
| | a) describe the process of electrolytic corrosion b) explain the methods of corrosion protection c) state precautions to prevent corrosion d) supply the regulations and code of practice requirement to prevent corrosion | |
| | <i>Content</i> | |
| 25.2.1T1 | Description of the process of electrolytic corrosion | 25.2.1P0 <i>Specific Objectives</i> By the end of the sub-unit, the trainee should be able to: |
| | i) Susceptible metals ii) Corrosive environment (electrolyte conditions) iii) Electrolysis process | a) carry out installation for corrosion protection b) apply precautionary measure to prevent corrosion |
| 25.2.1T2 | Explanation of the methods of corrosion protection | 25.2.1P1 <i>Content</i> |
| | i) Cathodic protection ii) Sacrificial anode iii) Power impressed (impressed current) | Carrying out installation of equipment for corrosion protection |
| 25.2.1T3 | Statement on precautions to prevent corrosion i) Painting (bituminised paints) over surfaces liable to corrosion | i) Artificial anode ii) Impressed current method |
| | | 25.2.1P2 Application of precautionary measure to prevent corrosion |
| | | i) Bituminous paints on metallic surfaces liable to corrosion |
| | | ii) Prevention of contact between two dissimilar metals |

| | | |
|-----------------|--|---|
| | (copper and aluminium) | |
| 25.2.1C | Competence | |
| | The trainee should have the ability to: | |
| | i) Install corrosion protection equipment | c) explain the effects of lightning strokes |
| | ii) Apply precautionary measure to prevent corrosion | d) explain factors considered for lightning protection |
| | | e) describe the component of lightning protection system |
| | | f) explain the tests to be carried out on lightning protection system |
| | | g) explain the maintenance required for lightning protection system |
| | | h) state the areas of applications of lightning protection system. |
| | <i>Teaching/Learning Resources</i> | |
| | - Electrodes | |
| | - Tool kit | |
| | - Measuring instruments | |
| | - Industrial visits | |
| | <i>Suggested teaching/Learning Activities</i> | |
| | - Discussion | |
| | - Illustration | |
| | - Demonstration | |
| | - Note taking | |
| | - Practical exercise | |
| | <i>Suggested Evaluation Methods</i> | |
| | - Oral tests | |
| | - Timed written tests | |
| | - Assignments | |
| | - Timed practical tests | |
| 25.2.2 | LIGHTNING PROTECTION | |
| | Theory | |
| 25.2.2T0 | Specific Objectives | |
| | By the end of the sub-unit, the trainee should be able to: | |
| | a) define terms used in lightning protection | |
| | b) describe types of lightning strokes and | |
| | | <i>Content</i> |
| | | 25.2.2T1 Definition of terms used in lightning protection system |
| | | i) Air termination |
| | | ii) Down conductors |
| | | iii) Zone of protection |
| | | iv) Earth electrode |
| | | v) Arresters |
| | | 25.2.2T2 Description of types of lightning strokes |
| | | i) Direct strokes – (Stroke A) |
| | | ii) Indirect strokes – (Stroke B) |
| | | iii) Combinational strokes (Stroke A, B and C) |
| | | 25.2.2T3 Explanation of the effects of lightning strokes |
| | | i) Damage to buildings, properties and transmission lines |
| | | ii) Death to human beings and livestock |

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| | iii) Fire risks | b) perform tests on lightning protection system |
| 25.2.2T4 | Explanation of factors considered for lightning protection for a building | c) carry out maintenance required for lightning, protection system. |
| i) | Building structure | |
| ii) | Occupancy | |
| iii) | Building structure | |
| 25.2.2T5 | Description of component of lightning protection system | <i>Content</i> |
| i) | Air termination (vertical & horizontal conductors) | Installation work of lightning protection system in: |
| ii) | Down conductors | i) Buildings |
| iii) | Test points | ii) Farm installation |
| iv) | Earth electrode | iii) Transmission systems |
| 25.2.2T6 | Explanation of tests carried out on lightning protection system | 25.2.2P2 |
| i) | Continuity | Performing tests on lightning protection system |
| ii) | Effectiveness of earthing | i) Earth continuity tests |
| 25.2.2T7 | Explanation of maintenance required for lightning protection systems | 25.2.2P3 |
| i) | Corrosion protection | Carrying out maintenance work on lightning protection system |
| ii) | Joints and terminations | i) Corrosion protection |
| 25.2.2T8 | Statement on application of lightning protection systems | ii) Test point, joints and terminations |
| i) | Buildings | |
| ii) | Farm installation | |
| iii) | Transmission systems | |

Practice

25.2.2P0 *Specific Objectives*
 By the end of the sub-unit, the trainee should be able to:
 a) carry out installation of lightning protection system

25.2.2C **Competence**
 The trainee should have the ability to:
 i) Install lightning protection system
 ii) Maintain lightning protection system

Teaching/Learning Resources

- Simulation of lightning strokes
- Tests equipment
- Electrical tool kit

| | | |
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| <i>Suggested teaching/Learning Activities</i> | <ul style="list-style-type: none"> - Discussion - Illustration - Demonstration - Note taking - Practical exercise | <ul style="list-style-type: none"> ii) Requirements for metal conduct wiring systems |
| | 25.2.3T21 | Damp and electrostatic areas <ul style="list-style-type: none"> i) Definition of damp situation ii) Wiring systems in damp situation iii) Electrostatic areas iv) Methods of minimizing electrostatic charges |
| | 25.2.3T22 | Relevant Regulations |
| | 25.2.3T31 | Temporary Installation <ul style="list-style-type: none"> Definition of temporary installations |
| | 25.2.3T32 | Relevant Regulations <ul style="list-style-type: none"> i) Special requirement for temporary wiring systems ii) Requirements of distribution systems on construction sites iii) Testing of the installation |
| | 25.2.3T41 | Caravan Sites <ul style="list-style-type: none"> i) Difference between caravan and caravan site |
| | 25.2.3T42 | Regulation Requirements <ul style="list-style-type: none"> i) Protection requirements ii) Testing and inspection iii) Wiring systems and requirements |
| | 25.2.3T51 | Agricultural Installation <ul style="list-style-type: none"> Sources of danger |
| | 25.2.3T52 | Relevant Regulation Requirements <ul style="list-style-type: none"> i) Fitting and accessories ii) Wiring between buildings iii) Earthing |
| 25.2.3T11 | Flame Proof Installation <ul style="list-style-type: none"> i) Classification of hazardous area ii) Flammable gases iii) Flame proof equipment iv) Intrinsically safe equipment | |
| 25.2.3T12 | Relevant Regulations <ul style="list-style-type: none"> i) Requirements for cables | |

- iv) Cable wiring systems and their requirements

Practice

25.2.3P1 Specific Objectives

By the end of this sub-module unit, the trainee should be able to:

- a) carry out electrical installation of various special installations
- b) perform tests and inspections on the various special installations

Content

25.2.3P11 Electrical installations in hazardous areas:

- i) Flame-proof installation
- ii) Damp and electrostatic areas
- iii) Agricultural and horticultural installation
- iv) Temporary installation
- v) Caravan sites
- vi) Electric fencing
- vii) Wiring between buildings
- viii) Connection of low voltage equipment

25.2.3P12 Tests and inspection on the various special installations

- i) Main switch gear
- ii) Effectiveness of earthing
- iii) Circuit continuity

25.2.3C Competence

The trainee should have the ability to:

- i) Carry out electrical installation work in hazardous areas
- ii) Perform tests and inspection of wiring systems in hazardous areas

Suggested Teaching/Learning Resources

- Flame proof equipment
- Intrinsically safe equipment
- Testing equipment (multimedia & megger)
- Electrical tool kit.

Suggested teaching/Learning Activities

- Discussion
- Illustration
- Demonstration
- Note taking
- Practical exercise

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

25.2.4 ILLUMINATION

Theory

25.2.4T0 Specific Objectives

By the end of this sub-module unit, the trainee should be able to:

- a) state the laws of lightning
- b) define terms used in illumination
- c) calculate for light requirements for a given area

- d) discuss various types of electric luminaires as sources of light
 - e) apply the relevant IEE regulations in lighting design work
- viii) Low – pressure mercury – vapour lamp
- ix) Neon tubes
- 25.2.4T4 Calculations for illumination

Content

- 25.2.4T1 Laws of lightning
- Inverse square law
 - i) The cuisine law
- 25.2.4T2 Definition of terms used in illumination
- i) Luminous intensity
 - ii) Luminance
 - iii) Illumination
 - iv) Lumen
 - v) Lux
 - vi) Candela
 - vii) BZ classification
 - viii) Colour rendering
 - ix) Flicker
 - x) General lightning
 - xi) Local lightning
 - xii) Localized lightning
 - xiii) General diffuse
 - xiv) Glare
 - xv) Maintenance factor
 - xvi) Utilization factor
 - xvii) Reflection factor
- 25.2.4T3 Electric luminaires
- Incandescent filament lamps
 - i) Carbon filament lamps
 - ii) Tungsten filament lamps
 - iii) Gas filled tungsten filament lamps
 - iv) Coiled – coil filament lamps
 - v) Arc lamps
 - vi) Discharge lamps
 - vii) Sodium – vapour lamp

Practice

- 25.2.4P0 *Specific Objectives*
- By the end of this sub-module unit, the trainee should be able to:
- a) apply relevant regulations in the installation, repair and maintenance of electric luminaires
 - b) design lightning schemes

Content

- Repair and maintenance of electric luminaires
- Design of lightning schemes
- i) Light control
- ii) Calculation of illumination by the lumen method

Suggested teaching/Learning Resources

- Electrical measuring instruments
- Electrical tool kit
- Ac power supply
- Drawing instruments and materials
- Assorted cables and other electrical materials
- Assorted electric luminaires

Suggested teaching/Learning Activities

- Discussion

| | |
|---|--|
| <ul style="list-style-type: none"> - Illustration - Demonstration - Note taking - Practical exercise <p><i>Suggested Evaluation Methods</i></p> <ul style="list-style-type: none"> - Oral tests - Timed written tests - Assignments - Timed practical tests - Project - Project Report writing and presentation | <p>25.2.5T3</p> <p>Explanation of utility services in buildings</p> <ul style="list-style-type: none"> i) Water system ii) Water supply iii) Water distribution iv) Water treatment v) Sanitation vi) Discharge vii) Sanitary appliances viii) Trays and water seats ix) Layout x) Drainage system |
|---|--|

25.2.5 BUILDING SERVICES

| | Theory | Practice |
|----------|---|--|
| 25.2.5T0 | <p><i>Specific Objectives</i></p> <p>By the end of the sub-unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) describe different types of building structures b) explain electrical services in building c) explain utility services in buildings <p><i>Content</i></p> <p>25.2.5T1 Description of types of building structures</p> <ul style="list-style-type: none"> i) Substructures ii) Super structures iii) Walls and roofs iv) Windows and doors v) Floors and ceilings vi) Stairs and staircases vii) Finish and decoration <p>25.2.5T2 Explanation of electrical services in buildings</p> <ul style="list-style-type: none"> i) Ducts and channels ii) Trunkings and conducts iii) Chases and manholes | <p>25.2.5P0</p> <p><i>Specific Objectives</i></p> <p>By the end of the sub-unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) install electrical services in building b) carry out maintenance work for the electrical services in buildings <p><i>Content</i></p> <p>25.2.5P1 Installation of electrical services in buildings</p> <ul style="list-style-type: none"> i) Erection of trunking and conduit works ii) Construction of ducts and channels system iii) Installation and wiring of water heater systems and control <p>25.2.5P2 Carry out maintenance work for electrical services in building</p> <ul style="list-style-type: none"> i) Trunking and conduit ii) Water heaters and control |

25.2.5C Competence

The trainee should have the ability to:

- i) Carry out installation of electrical services in buildings
- ii) Carry out maintenance work for electrical services in buildings

Teaching/Learning Resources

- i) Building services
- ii) Electrical tools and instruments

25.2.6 INSTALLATION PLANNING AND DESIGN

Theory

25.2.6T0 Specific Objectives

By the end of this sub-module unit, the trainee should be able to:

- a) explain factors considered when selecting a wiring system for a given installation
- b) determine final sub circuits for a given installation
- c) determine the ratings of cables, control and protective devices
- d) design layout of all power points on architectural drawings of a given installation
- e) draw distribution program for a given three phase installation
- f) determine the layout for the wiring system used in an installation
- g) apply relevant regulations and codes of

practice in carrying out a given design installation.

Content

- 25.2.6T1 Factors determining choice of wiring systems
- 25.2.6T2 Determining final sub-circuits
 - i) Lighting sub-circuits
 - ii) Circuits for socket-outlets
 - iii) Circuits for fluorescent and discharge lamps
 - iv) Circuits for machinery motors
 - v) Grouping sub-circuits in contribution boards
 - vi) Balancing of single phase sub-circuits on three-phase supplies
- 25.2.6T3 Rating of cables and devices
 - i) Determination of cable sizes for final sub-circuits
 - ii) Calculation of cable sizes for mains and sub-mains
 - iii) Application of rating factors
 - iv) Application of diversity factors
 - v) Calculation of voltage drops on cables
 - vi) Determination of ratings of control and protective devices
- 25.2.6T4 Layout lighting and power points
 - i) Lighting points
 - ii) Socket outlets
 - iii) Switching arrangements for lamps

| | | |
|----------|---|--|
| | <ul style="list-style-type: none"> iv) Switching arrangements for machines v) Distribution boards vi) Labeling of circuits and loads | specifications |
| 25.2.6P2 | | Estimate quantities of materials required for electrical works from the design |
| 25.2.6C | Competence | |
| | The trainee should have the ability to: | |
| | <ul style="list-style-type: none"> - Carry out electrical installation design for a given architectural design and specifications - Estimate quantities of materials required for electrical works from the design | |
| 25.2.6T5 | <p>Distribution diagram</p> <ul style="list-style-type: none"> i) Intake point equipment ii) Connection of distribution boards iii) Labeling iv) 25.2.6T6 <p style="text-align: center;">Wiring System Layout</p> <ul style="list-style-type: none"> v) Cable runs vi) Conduit runs vii) Trunking/duct runs viii) Number of cables in conduit/trunking/duct ix) (Apply space factor) | |
| 25.2.6T7 | Apply relevant regulations and codes of practice | |
| | Practice | |
| 25.2.6P0 | Specific Objectives By the end of this sub-module unit, the trainee should be able to: <ul style="list-style-type: none"> a) design electrical installation for given architectural drawings and specification b) estimate quantities of materials required for electrical works from the design | |
| | Content | |
| 25.2.6P1 | Design electrical installation for a given architectural design and | |

Suggested teaching/Learning Activities

- Discussion
- Illustration
- Demonstration
- Note taking
- Practical exercise
- Calculations
- Project work

Suggested Teaching and Learning Resources

- Architectural designs and specifications
- Take off sheets
- Drafting pens various sizes
- Tracing papers
- Electrical symbol templates
- Letter and number templates various sizes
- Lighting catalogues with photometric data
- Equipment catalogues
- IEE regulations book
- Interior lighting design code

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests
- Project
- Project Report writing and presentation

26.2.0 ELECTRICAL POWER GENERATION AND TRANSMISSION

26.2.1 Introduction

This module unit is designed to provide the trainee with knowledge, skills and attitudes required to understand the application and operation of power systems including the generation, transmission and distribution of electric energy.

26.2.2 General Objectives

At the end of this module unit the trainee should be able to;

- a) Operate various power generation plants
- b) Observe safety in the work place
- c) Ensure efficiency in power generation and utilization
- d) Install, service and repair generation plant, overhead and underground distribution networks

26.2.2 Module Unit Summary and Time Allocation

Electrical Power Systems

| Code | Sub Module Unit | Content | Time Hrs |
|-------------|---------------------------|---|-----------------|
| 26.2.1 | Power generation | <ul style="list-style-type: none">• Types of generating stations• Typical layout for generating stations• Operation of generating | 12 |
| 26.2.2 | Excitation systems | <ul style="list-style-type: none">• Types of excitation schemes• Operation of exciters | 10 |
| 26.2.3 | Economics of power supply | <ul style="list-style-type: none">• Generating costs• Load development• Economical conductor cross section area | 10 |
| 26.2.4 | Power factor improvement | <ul style="list-style-type: none">• Causes of low power factor• Effects of low power factor• Methods of improving power factor• Location of power factor improvement equipment• Calculation on power factor improvement | 16 |
| 26.2.5 | Overhead transmission | <ul style="list-style-type: none">• Conductor materials for transmission lines• Transmission line supports | 16 |

| | | | |
|-------------------|---------------------|---|-----------|
| | | <ul style="list-style-type: none"> • Transmission line insulators • String efficiency • Methods of improving line efficiency • Insulator failures and tests • Derivation of line constraints (R-L-C) | |
| 26.2.6 | Under ground cables | <ul style="list-style-type: none"> • Insulating materials for underground cables • Cable conductor materials for underground cables • Types of under ground cables • Underground cable faults • Methods of locating underground cable faults • Calculations on underground cable parameters | 10 |
| 26.2.7 | Switch gear | <ul style="list-style-type: none"> • Symmetrical faults • Short circuit currents • Operating principles of various types of circuit breakers • Principle of arc extinction in circuit breakers • High Rupturing Capacity switches HRC fuses | 14 |
| Total Time | | | 88 |

| | | |
|---------------|---|--|
| 26.2.1 | POWER GENERATION | By the end of the sub-module unit, the trainee should be able to: |
| | Theory | c) Sketch layouts for various generating d) Operate in a power generating station |
| 26.2.1T0 | <i>Specific Objectives</i> | By the end of the sub-module unit, the trainee should be able to: d) describe various types of generating stations e) describe typical layouts of generating stations plants f) outline the operation of generating stations. |
| | <i>Content</i> | 26.2.1P1 Layout of generating stations i) Hydro ii) Thermal iii) Diesel iv) Gas v) Nuclear vi) Geothermal vii) Magneto-hydro |
| 26.2.1T1 | Types of generating stations | 26.2.1P2 Operating sequence of generating stations i) Hydro ii) Thermal iii) Diesel iv) Gas v) Nuclear vi) Geothermal vii) Magneto-hydro |
| 26.2.1T2 | Typical layouts of generating stations plants | 26.2.1C Competence The trainee should have the ability to: i) Draw power station schematics ii) Carry out operating sequence for generating stations in model form |
| 26.2.1T3 | Operation of generating stations | <i>Suggested Teaching/Learning Resources</i> - Power station model - Overhead projector - Field visit to various power generating stations |
| 26.2.1P0 | <i>Specific Objectives</i> | |

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

26.2.2 EXCITATION SYSTEMS

Theory

26.2.2T1 Specific Objectives

By the end of the sub-module, the trainee should be able to:

- a) draw the schematic diagram of various machine excitation schemes
- b) explain the operation of machine excitation schemes

Content

26.2.2T2 Drawing the schematic diagram of excitation schemes

- i) Direct current pilot exciter
- ii) Direct current pilot exciter

26.2.2T3 Explaining the operation of the excitation schemes

- i) Magnetic amplifier
- ii) Thyristor amplifier
- iii) Brushless excitation

Practice

26.2.2P Specific Objectives

By the end of the sub-module, the trainee should be able to:

- a) draw schematic diagrams for various excitation schemes

- b) connect and operate various excitation schemes

Content

26.2.2P1 Drawing the schematic diagrams of excitation schemes

- i) Direct current pilot exciter
- ii) Direct current main exciter

26.2.2C Competence

The trainee should have the ability to:

- i) Draw schematic diagrams of excitation schemes
- ii) Connect and operate pilot exciter and main exciter

Suggested teaching/Learning Activities

- Discussion
- Illustration
- Demonstration
- Note taking
- Visits to industries

Suggested Teaching/Learning Resources

- Visit a power station
- Model power station

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

26.2.3T ECONOMICS OF POWER SUPPLY

Theory

26.2.3T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) explain generating costs in power generation and supplies
- b) describe the concept of load development
- c) derive the economical cross-sectional area of a transmission line

Content

26.2.3T1 Explaining the cost of generating and supply

- i) Capital investment
- ii) Interest and depreciation
- iii) Fixed cost
- iv) Semi-fixed cost
- v) Running cost

26.2.3T2 Describing load development in a power system

- i) Variable load on a power station
- ii) Load curves
- iii) Load factors and diversity factor
- iv) Base load
- v) Peak load and peak lopping
- vi) Interconnected grid system

26.2.3T3 Deriving the expression for the most economical cross-sectional area

- i) Annual cost of capital outlay

- ii) Annual cost of energy lost
- iii) Application of the Kelvin's law

Practice

26.2.3P0 Specific Objectives

By the end of the sub-module unit, the learner should be able to:

- d) draw load curves
- e) simulate load curves on a load chart
- f) determine the factors associated with power plant development

Content

26.2.3P1 Drawing and simulating the load curves

- i) Daily load curve
- ii) Monthly load curve
- iii) Yearly load curve

26.2.3P2 Determining factors associated with power plant development

- i) Load factor
- ii) Diversity factor
- iii) Plan capacity factor

26.2.3C Competence

The trainee should have the ability to:

- i) Simulate load curves in order to verify load factors and units generated in a power station

Suggested teaching/Learning Activities

- Discussion
- Illustration
- Demonstration

- Visits to industries
- Note taking

Suggested Teaching/Learning Resources

- KWH meter
- KVA meter

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments

26.2.4 POWER FACTOR IMPROVEMENT

Theory

- 26.2.4P0 *Specific Objectives*
 By the end of the sub-module, the trainee should be able to:
- a) state causes of low power factor
 - b) describe the effects of low power factor to the system
 - c) explain the methods of improving the power factor
 - d) explain the need to identify a suitable location for the installation of power factor improvement/correction equipment
 - e) apply power factor improvement knowledge to solve problems

Content

- 26.2.4T1 Stating the causes of low power factor
- i) Induction motors

- ii) Line transformers
- iii) Industrial heating furnaces

- iv) Arc lamps

- 26.2.4T2 Describing the effect of low power factor
- i) Greater copper loss
 - ii) Large copper loss
 - iii) Poor voltage regulation
 - iv) Large KVA equipment rating
 - v) Reduced handling capacity of the system

- 26.2.4T3 Explaining methods of improving power factor
- i) Static capacitors
 - ii) Synchronous condensers
 - iii) Phase advances

- 26.2.4T4 Explaining the location of power factor improvement equipment
- i) Capacitors
 - ii) Synchronous condensers
 - iii) Phase advances

- 26.2.4T5 Applying power factor knowledge to solve problems
- i) Power triangle
 - ii) Leading KVAR

Practice

- 26.2.4. P0 *Specific Objectives*
 By the end of the sub-module, the trainee should be able to:
- a) connect power factor improvement equipment
 - b) design power factor improvement schemes

Content

26.2.4P1 Power factor improvement equipment

- i) Static capacitors
- ii) Synchronous condensers

iii) Phase advances

26.2.4P2 Designing power factor improvement schemes

- i) Static capacitors

- ii) Synchronous condensers

- iii) Phase advances

26.2.4C Competence

The trainee should have the ability to:

- i) Connect power factor improvement equipment
- ii) Design power factor improvement schemes

Suggested teaching/Learning Activities

- Discussion
- Illustration
- Demonstration
- Note taking
- Practical exercise
- Calculations
- Project work

Suggested Teaching/Learning Resources

- Capacitors
- Synchronous motors
- Induction motors

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

26.2.5

OVERHEAD TRANSMISSION LINES

Theory

Specific Objectives

By the end of the sub-unit, the learner should be able to:

- a) describe various conductor materials used in the construction of transmission lines
- b) describe various line supports used in transmission system
- c) explain the different types of insulators used in transmission lines
- d) carry out string efficiency calculations
- e) explain methods of improving string efficiency
- f) describe the insulator failures and their tests
- g) derive the line constants ($R-L-C$)

Content

Describing the various conductor materials

- i) Copper
- ii) Aluminium
- iii) Steel – cored aluminium
- iv) Galvanized steel

- v) Cadmium copper
- 26.2.5. T2 Describing various line supports
- Wooden poles
 - Steel tubular poles
 - Reinforced concrete poles
 - Steel towers
- 26.2.5T3 Explaining different types of insulators
- Pin type
 - Strain type
 - Suspension insulator
- 26.2.5T4 Performing string efficiency calculation
- Voltage distribution
 - String efficiency
- 26.2.5T5 Explaining methods used to improve string efficiency
- Use of longer cross-arms
 - Insulator grading
 - Guard ring
- 26.2.5T6 Describing the insulator failures and tests
- Flash over test
 - Puncture test
 - Porosity test
 - Mechanical test
- 26.2.5T7 Derivation of the line constants
- Resistance (R)
 - Inductance (L)
 - Capacitance (C)

Practice

26.2.5P0 Specific Objectives

By the end of the sub-module, the learner should be able to:

- draw diagrams of different types of insulators

- construct a model transmission line
- perform an experiment to calculate string efficiency
- perform insulator performance tests

Content

- 26.2.5P1 Drawing diagrams of insulators
- Pin type
 - Strain type
 - Suspension
- 26.2.5P2 Constructing a model transmission line
- Line conductors
 - Line supports
 - Insulators
- 26.2.5P3 Experiment on string efficiency
- Insulators
 - String efficiency
- 26.2.5P4 Insulator performance test
- Flash-over test
 - Puncture test
 - Porosity test
 - Mechanical test

Competence

The trainee should have the ability to:

- Construct model transmission lines
- Perform insulator performance test

Suggested Teaching/Learning Resources

- Different samples of insulator
- Different samples of line conductors

| | | |
|----------|--|---|
| 26.2.6 | UNDER GROUND CABLES | i) Belled ii) Shielded iii) Oil filled iv) Pressure cables |
| | Theory | 26.2.6T4 Explanation of cable faults |
| 26.2.6T0 | <i>Specific Objectives</i> | i) Open-circuit fault ii) Short-circuit fault iii) Earth fault |
| | By the end of the sub-module, the trainee should be able to: | 26.2.6T5 Explaining the procedure of locating the cable fault |
| | a) explain different types of insulating material for underground cables b) explain cable conductor materials c) describe the construction of different types of underground cables d) explain the types of cable faults e) explain the procedure of locating cable faults f) solve problem involving underground cables parameters | 26.2.6T6 Solving problems involving underground cables i) Dielectric stress ii) Thermal resistance |
| | Content | Suggested teaching/Learning Resources |
| 26.2.6T1 | Explanation of insulating materials | <ul style="list-style-type: none"> - Electrical tool kit - Electrical measuring instruments - Assorted cables and other electrical materials |
| | i) Vulcanized rubber ii) Poly vinyl chloride (PVC) iii) Polythene iv) Paper | Suggested teaching/Learning Activities |
| 26.2.6T2 | Explaining the cable conductor materials | <ul style="list-style-type: none"> - Discussion - Illustration - Demonstration - Note taking - Practical exercise |
| | i) Copper ii) Aluminium | Suggested Evaluation Methods |
| 26.2.6T3 | Describing the construction of underground cables | <ul style="list-style-type: none"> - Oral tests - Timed written tests - Assignments - Timed practical tests |

| | | | |
|----------|--|--|---|
| 42.2.7 | SWITCH GEAR | | |
| | Theory | | |
| 26.2.7T0 | <p><i>Specific Objectives</i></p> <p>By the end of the sub-module the trainee should be able to:</p> <ul style="list-style-type: none"> a) explain the occurrence of symmetrical faults b) describe types of short circuit currents c) describe various types and operating principles of circuit breakers d) explain the methods of electric arc extinction e) describe the High Rupturing Capacity (HRC)Fuses | <ul style="list-style-type: none"> iii) Sulphur hexafluoride iv) Vacuum circuit breakers | |
| 26.2.7T1 | <p><i>Content</i></p> <p>The symmetrical fault</p> <ul style="list-style-type: none"> i) Insulation failure ii) Mechanical injury iii) Short-circuit KVA | 26.2.7T4 | <p>Methods of arc extinction</p> <ul style="list-style-type: none"> i) High resistance method ii) Current zero (low resistance method) |
| 26.2.7T2 | <p>Types of short-circuits</p> <ul style="list-style-type: none"> i) Between single phase and earth ii) Between phase and phase iii) Between two phases and earth iv) Between all three phases v) Between all three phases and ground | 26.2.7T5 | <p>Types of fuses</p> <ul style="list-style-type: none"> i) Low voltage fuses ii) High-rupturing capacity (H.R.C) iii) Cartridge iv) Liquid type |
| 26.2.7T3 | <p>Types and operating principles of circuit breakers</p> <ul style="list-style-type: none"> i) Oil circuit breakers ii) Air-blast circuit breakers | | <p>Practice</p> <p><i>Specific Objectives</i></p> <p>By the end of the sub-module, the trainee should be able to:</p> <ul style="list-style-type: none"> a) simulate the occurrence of symmetrical faults in a model power system b) perform short-circuit tests c) verify the circuit breaker performance characteristics from oscillogram d) verify the operating characteristics of HRC fuses |
| | | | <p><i>Content</i></p> <p>Simulation of the occurrence of symmetrical fault</p> <ul style="list-style-type: none"> i) Insulation failure ii) Mechanical injury |
| | | 26.2.7P1 | <p>Performing short-circuit tests</p> <ul style="list-style-type: none"> i) Phase and earth ii) Phase and phase |
| | | 26.2.7P2 | |

- iii) Two phases and earth
 - iv) All three-phases
 - v) All three phases and earth
- 26.2.7P3 Verification of the circuit breaker performance characteristics
- i) Oscillogram
- 26.2.7P4 Verification of the operating characteristics of HRC fuses
- i) HRC fuses

26.2.7C Competence

- The trainee should have the ability to:
- i) Simulate symmetrical fault
 - ii) Perform short-circuit test

Suggested Teaching/Learning Resources

- Circuit breakers
- HRC fuses
- Oscilloscope

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

**DIPLOMA IN ELECTRICAL AND
ELECTRONIC ENGINEERING**

POWER OPTION

MODULE III

MODULE III – INDUSTRIAL MACHINES AND CONTROLS

Introduction

Module III is designed for all trainees who meet the entry requirements for the Diploma in Electrical Engineering Module III which include the completion of Module II or any other equivalent and approved course. The Module is intended to impart knowledge skills and attitudes that will meet the needs of the industry in the areas of electrical installation design, repair, maintenance and servicing of microprocessor systems.

The trainees are also expected to acquire generic skills which will make them adapt to the dynamic world of work.

General Objectives

At the end of Module, the trainee should be able to:

- a) Understand the concepts of Electrical and electronic systems
- b) Carry out electrical installations design
- c) Maintain electrical installation systems, micro controllers, power systems, machines and electronic equipment
- d) Estimate, tender and supervise Electrical and Electronic works
- e) Understand the management and of industrial organizations and other institutions.
- f) Analyse and maintain overhead power transmission lines.

Key Competence

At the end of Module, the trainee should have the ability to:

- i) Install, service and maintain micro controllers
- ii) Estimate and tender for electrical services
- iii) Manage electrical power generation, transmission and distribution lines
- iv) Install, service and maintain electrical machines and machine controls

The units covered in this module are:

Code Module Unit

- 27.3.0 Engineering Mathematics III
- 28.3.0 Microcontroller Technology
- 29.3.0 Industrial Organisation and Management
- 30.3.0 Microprocessor Systems
- 31.3.0 Estimating, Tendering and Engineering Service Contracts
- 32.3.0 Trade Project
- 33.3.0 Electromagnetic Fields Theory
- 34.3.0 Machines and utilisation
- 35.3.0 Electrical Power Transmission and Distribution
- 36.3.0 Power Electronics

| 27.3.0 | ENGINEERING MATHEMATICS III | | | | | | | | | | | | | | | | | | |
|--|--|--|-----------------|-------------|------------------------|----------------|-----------------|--------|----------------|---|----|--------|--------------------|--|----|--------|------------------|--|----|
| 27.3.0.1 | <p>Introduction</p> <p>This module unit is designed with knowledge, skills and attitudes needed by the trainee in order to enhance his performance in other analytical areas of study in his trade and at the same time acquire a firm foundation for further training.</p> <p>The trainee will need Advanced Mathematical tables and non-programmable scientific calculator. At the end of this unit is a list of Suggested teaching/learning activities, resources, and evaluation methods suitable for the unit. The list is not exhaustive and the trainers may explore other suitable methods.</p> | | | | | | | | | | | | | | | | | | |
| 27.3.02 | <p>General Objectives</p> <p>At the end of this module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) Understand mathematical techniques relevant to electrical and electronic engineering trade. b) Apply mathematical techniques in the trade and in every day life. | | | | | | | | | | | | | | | | | | |
| 27.3.03 | <p>Module Unit Summary and Time Allocation</p> <p>Engineering Mathematics III</p> | | | | | | | | | | | | | | | | | | |
| <table border="1"> <thead> <tr> <th>Code</th> <th>Sub-Module Unit</th> <th>Content</th> <th>Time Hrs</th> </tr> </thead> <tbody> <tr> <td>27.3.1</td> <td>Fourier Series</td> <td> <ul style="list-style-type: none"> • Definition of Fourier series • Determination of Fourier series for period 2π to T • Fourier series for odd and even functions • Numerical harmonics </td> <td>14</td> </tr> <tr> <td>27.3.2</td> <td>Multiple integrals</td> <td> <ul style="list-style-type: none"> • Definition of multiple integrals • Determination of areas and volumes using double angle integrals • Application of double integrals in polar and cylindrical coordinates • Solution of problems using triple integrals </td> <td>16</td> </tr> <tr> <td>27.3.3</td> <td>Vector Theory II</td> <td> <ul style="list-style-type: none"> • The Green's theorem • Application of Green's theorem • Statement of two distinct but closely related physical interpretation of Green's theorem • Extension of Green's theorem to Stoke's theorem </td> <td>24</td> </tr> </tbody> </table> | | | | Code | Sub-Module Unit | Content | Time Hrs | 27.3.1 | Fourier Series | <ul style="list-style-type: none"> • Definition of Fourier series • Determination of Fourier series for period 2π to T • Fourier series for odd and even functions • Numerical harmonics | 14 | 27.3.2 | Multiple integrals | <ul style="list-style-type: none"> • Definition of multiple integrals • Determination of areas and volumes using double angle integrals • Application of double integrals in polar and cylindrical coordinates • Solution of problems using triple integrals | 16 | 27.3.3 | Vector Theory II | <ul style="list-style-type: none"> • The Green's theorem • Application of Green's theorem • Statement of two distinct but closely related physical interpretation of Green's theorem • Extension of Green's theorem to Stoke's theorem | 24 |
| Code | Sub-Module Unit | Content | Time Hrs | | | | | | | | | | | | | | | | |
| 27.3.1 | Fourier Series | <ul style="list-style-type: none"> • Definition of Fourier series • Determination of Fourier series for period 2π to T • Fourier series for odd and even functions • Numerical harmonics | 14 | | | | | | | | | | | | | | | | |
| 27.3.2 | Multiple integrals | <ul style="list-style-type: none"> • Definition of multiple integrals • Determination of areas and volumes using double angle integrals • Application of double integrals in polar and cylindrical coordinates • Solution of problems using triple integrals | 16 | | | | | | | | | | | | | | | | |
| 27.3.3 | Vector Theory II | <ul style="list-style-type: none"> • The Green's theorem • Application of Green's theorem • Statement of two distinct but closely related physical interpretation of Green's theorem • Extension of Green's theorem to Stoke's theorem | 24 | | | | | | | | | | | | | | | | |

| | | | |
|-------------------|-------------------|--|-----------|
| | | <ul style="list-style-type: none"> • Application of Stoke's theorem • Application of Stoke's theorem • Application of Gauss's Theorem • Extension of Green's theorem to Gauss's theorem; • Application of Gauss's theorem • Definition of conservative vector fields • Application of conservative vector fields • Use of surface integrals • Application of surface integrals • Statement of Maxwell's equation in the modern analysis using divergence and curl. • Definition of Pointing Theorem • Identification of Faraday's law as embodied by Maxwell's Equations • Line and surface integrals • Green's theorem, Stoke's theorem and Divergence theorem • Application | |
| 27.3.4 | Matrices II | <ul style="list-style-type: none"> • Definition of Eigen values and Eigen vectors • Calculation of Eigen values and Eigen vectors • Definition • Explanation of function of matrices • Definition of Jordan form of a matrix • Definition of transition matrix | 12 |
| 27.3.5 | Numerical methods | <ul style="list-style-type: none"> • Application of iterative methods to solve equations • Applications of interpolation and extrapolation • Definition of interpolations and extrapolations | 12 |
| 27.3.6 | Complex variables | <ul style="list-style-type: none"> • Functions of complex variables • Derivatives of analytic functions • Cauchy- Riemann equation | 10 |
| Total Time | | | 88 |

| | | | |
|----------|---------------|--|---------------------------|
| | 27.3.1 | FOURIER SERIES | |
| | | Theory | |
| 27.3.1T0 | | <i>Specific Objectives</i> | |
| | | By the end of the sub - module unit, the trainee should able to: | |
| | a) | define the Fourier series of a function | |
| | b) | determine the Fourier series for a periodic function of period 2π and expanded to period T. | |
| | c) | determine the Fourier series for a non-periodic function for the range 2π and extended to T. | |
| | d) | determine the Fourier series for odd and even function | |
| | e) | find the numerical harmonics | |
| | | <i>Content</i> | |
| 27.3.1T1 | | Definition of Fourier series for a function | |
| 27.3.1T2 | | Determination of the Fourier series for periodic function of period 2π and extended to T. i) Mathematical definition ii) Graphical illustration iii) Periodic properties of cosine and sine functions | |
| 27.3.1T3 | | Determination of Fourier series of a non periodic functions i) Explain that a non-periodic function | |
| | | cannot, in general, be expanded in | |
| | ii) | Fourier series | |
| | iii) | Description of how a function can be expanded. | |
| | iv) | Graphical illustration of the function | |
| 27.3.1T4 | | Determination of the Fourier series for non-periodic functions over a given range $x \geq 0 < x < 5$ | |
| 27.3.1T5 | | Determination of Fourier series for odd and even functions and the half-range series i) Definition of odd and even functions ii) Calculation of numerical harmonics and its application. | |
| | | 27.3.2 | MULTIPLE INTEGRALS |
| | | Theory | |
| 27.3.2T1 | | <i>Specific Objectives</i> | |
| | | By the end of the sub - module unit the trainee should be able to: | |
| | a) | define multiple integrals | |
| | b) | use double integrals to find areas and volumes | |
| | c) | apply double integrals in polar and cylindrical coordinates | |
| | d) | use of triple integrals in solving problems | |
| | | <i>Content</i> | |
| 27.3.2T1 | | Definition of Double integrals and Triple integrals | |

| | | | |
|-------------------------------|--|-----------|--|
| 27.3.2T2 | Using double integrals to find areas and volumes. | 27.3.3T1 | Green's theorem |
| 27.3.2T3 | Apply double and triple integrals in polar, cylindrical and spherical coordinates | 27.3.3T2 | i) Statement ii) Proof |
| 27.3.2T4 | Use of triple integrals in solving problems | 27.3.3T3 | Application of Green's theorem to line integrals |
| 27.3.3 VECTOR FIELD II | | | Statement of two distinct but closely related physical interpretation of Green's theorem |
| THEORY | | | i) Unit tangent vector ii) Unit normal vector |
| 27.3.3 | <i>Specific Objectives</i> By the end of the sub-module, the trainee should be able to: | 27.3.3T4 | Extension of Green's theorem to Stoke's theorem |
| a) | proof Green's theorem | 27.3.3T5 | Application of Stoke's theorem |
| b) | apply Green's theorem to line integrals | 27.3.3T6 | Application of Gauss's Theorem |
| c) | state two distinct but closely related physical interpretations of Green's theorem. | 27.3.3T7 | Extension of Green's theorem to Gauss's theorem; |
| d) | extend Green's theorem to Stoke's theorem. | 27.3.3T8 | Application of Gauss's theorem |
| e) | apply Stoke's theorem. | 27.3.3T9 | Definition of conservative vector fields |
| f) | apply Gauss's theorem. | 27.3.3T10 | Application of conservative vector fields |
| g) | define conservative vector fields | | iii) Potential energy |
| h) | apply conservative vector fields. | | iv) Kinetic energy |
| i) | use surface integral | | v) Work |
| j) | apply surface integral | 27.3.3T11 | Use of surface integrals |
| k) | state Maxwell's equations in the modern analysis using divergence and curl. | 27.3.3T12 | Application of surface integrals |
| l) | identify Faraday laws as embodies by Maxwell's equations. | | i) Flux |
| m) | classify solutions of Maxwell's equations. | | ii) Area |
| n) | define pointing theorem | 27.3.3T13 | Statement of Maxwell's equation in the modern analysis using divergence and curl. |
| | | i) | $\frac{e^3}{2+}$ |

| | | | |
|-----------|--|----------|---|
| 27.3.3T14 | Identification of Faraday's law as embodied by Maxwell's Equations | 27.3.4T5 | Definition <ul style="list-style-type: none"> i) Similarity transformation ii) Properties of similarity transformation iii) Exponential and meaning iv) Logarithms of matrices |
| 27.3.3T15 | Definition of Pointing Theorem <ul style="list-style-type: none"> i) Application of Pointing Theorem | 27.3.4T6 | Definition of transition matrix <ul style="list-style-type: none"> v) Properties of continuous time transition matrix for a linear time varying system. |
| 27.3.4 | MATRICES II | 27.3.5 | NUMERICAL METHODS |
| 27.3.4T0 | <i>Specific Objectives</i> By the end of the sub-module unit the trainee should able to: <ul style="list-style-type: none"> a) define Eigen values and Eigenvectors of a matrix b) calculate Eigen values and Eigenvectors of a matrix c) define the Jordan form of a matrix d) explain the meaning of function of a matrix e) define transform action matrix f) define transition matrix | 27.3.5 | Theory |
| | <i>Content</i> | 27.3.5T0 | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should able to: <ul style="list-style-type: none"> a) define interpolation and extrapolation b) apply interpolation and extrapolation c) apply iterative methods to solve equations |
| 27.3.4T1 | Definition of Eigen values and Eigen vectors <ul style="list-style-type: none"> i) Eigen values ii) Eigenvectors iii) Characteristic polynomials iv) Distinct Eigen values v) Normalized Eigen vectors | 27.3.5T1 | <i>Content</i> Definition of interpolations and extrapolations |
| 27.3.4T2 | Calculation of Eigen values and Eigen vectors | 27.3.5T2 | Applications of interpolation and extrapolation |
| 27.3.4T3 | Definition of Jordan form of a matrix | 27.3.5T3 | Application of iterative methods to solve equations |
| 27.3.4T4 | Explanation of function of matrices | | |

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|---------------|---|--|
| | i) Newton-Raphson method ii) Newton-Gregory method | 27.3.6T3 Definition of Analytic (regular) functions 27.3.6T4 Definition of Cauchy-Riemann equations |
| 27.3.6 | COMPLEX VARIABLES | <i>Suggested Teaching/Learning Activities</i> |
| | Theory | <ul style="list-style-type: none"> - Discussion - Illustration - Demonstration - Note taking |
| 27.3.6T0 | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: | <i>Suggested teaching/Learning Resources</i> |
| | <ul style="list-style-type: none"> a) define a function of a complex variable b) differentiate a function of a complex variable c) define Analytic (regular) functions d) derive Cauchy-Riemann equations | <ul style="list-style-type: none"> - Advanced Mathematical tables - Scientific calculator |
| | <i>Content</i> | <i>Suggested Evaluation Methods</i> |
| 27.3.6T1 | Definition of function of a complex variable | <ul style="list-style-type: none"> - Oral tests - Timed written tests - Assignments |
| 27.3.6T2 | Differentiation of a complex function | |

28.3.0 MICROCONTROLLER TECHNOLOGY

28.3.01 Introduction

This module unit is aimed at providing the trainee with theoretical and practical understanding of automating processes and use of digital computers in control systems. Trainees taking this module unit require to have covered engineering control systems.

This module unit is competency based with careful integration of the theory and practice.

28.3.02 General Objectives

At the end of the module unit, the trainee should be able to:

- a) Understand the operating principles of process control systems
- b) Apply the operating principles of sequential control systems in industrial engineering systems.
- c) Understand the operating principles of digital control systems
- d) Program Robots

28.3.03 Module Unit Summary and Time Allocation

Microcontroller Technology

| Code | Sub-module unit | Content | Time Hrs |
|-------------|--|---|-----------------|
| 28.3.1 | Introduction to Microcontroller Technology | <ul style="list-style-type: none">• Elements of Microcontroller Architecture• Microcontroller series• Family members of Microcontroller series | 4 |
| 28.3.2 | Process Control Systems | <ul style="list-style-type: none">• Need for process control• Process control terms• Block diagram of process control• Control modes• Implementation of controllers• Functions of Actuators• Types of actuators | 10 |
| 28.3.3 | Sequential Control Systems | <ul style="list-style-type: none">• Description of sequential control systems• Time delay units• Application of Decoders/ Encoders in sequential control• Practical interlock systems• Programmable logic controllers (PLC's) | 10 |

| | | | |
|-------------------|-------------------------|---|-----------|
| | | <ul style="list-style-type: none"> • Application of flow chart and ladder diagrams programming methods • Applications of PLCs in functional and practical systems | |
| 28.3.4 | Digital Control Systems | <ul style="list-style-type: none"> • Basic digital methods • Computer data logging • Human machine interface (HMI) • Applications of digital computer | 6 |
| 28.3.5 | Robots fundamentals | <ul style="list-style-type: none"> • Definition of a robot • Types of Robots • Elements of Robotic systems • Need for Robots • Robotic classification • Functions of control systems in Robots • Robots's Performance Capabilities Specifications • Key Features of Robots • Programming methods | 6 |
| 28.3.6 | Robots programming | <ul style="list-style-type: none"> • Programming methods • Robot programming functions • Robot programming environment • Programming activities • Basic types of robot programming languages • On-line and off-line programming languages | 8 |
| Total time | | | 44 |

| | | | |
|---------------|--|---------------|---|
| 28.3.1 | INTRODUCTION TO MICROCONTROLLER TECHNOLOGY | 28.3.2 | PROCESS CONTROL SYSTEMS |
| | Theory | | Theory |
| 28.3.1T0 | <i>Specific Objectives</i> By the end of the sub - module unit, the trainee should able to: a) explain the elements of a microcontroller architecture b) describe various microcontroller series c) explain the family members of a microcontroller series | 28.3.2T0 | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: a) explain the need for process control b) explain process control terms c) explain block diagram of process control d) explain controller modes e) describe implementation of controllers f) explain functions of actuators g) distinguish between different types of actuators |
| | Content | | Content |
| 28.3.1T1 | Elements of a microcontroller architecture i) CPU ii) RAM iii) ROM/EPROM iv) Input / Output ports v) Timers / Counters | 28.3.2T1 | Need for process control i) Safety ii) Quality iii) Environment iv) Economics |
| 28.3.1T2 | Microcontroller series i) Intel 8048 ii) Intel 8051 iii) Intel 8096 iv) NEC 7800 v) Intel 8044 | 28.3.2T2 | Process control terms i) Lag time ii) Dead time iii) Dead band iv) Set point v) Error signal vi) Transient vii) Measured variable viii) Controlled variable ix) Variable range x) Control parameter range |
| 28.3.1T3 | 8051 Microcontroller family members i) 8032 AH ii) 8751 AH iii) 80C32 iv) 8052 v) 8032 | | |

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| | xi) Offset | a) implement the control modes using OP-amps |
| 28.3.2T3 | Block diagram of process control | b) tune a three term controller |
| 28.3.2T4 | Control modes On/off i) Proportional ii) Integral iii) Differential iv) Proportional +integral (PI) v) Proportional +differential (PD) vi) Proportional +integral + differential (PID) vii) Tuning of PID-Ziegler-Nichols method | c) dismantle and assemble a typical pneumatic control valve |
| 28.3.2T5 | Implementation of controllers i) Pneumatic On/off controllers ii) Electrical On/off controllers iii) Pneumatic PID controllers iv) Electronic PID controllers v) Computer or PLC processor | <i>Content</i> 28.3.2P1 Implementation of control modes i) Two position ii) P-I iii) P-D iv) P-I-D v) Tuning a three term controller vi) Ziegler Nichols method vii) Controller settings |
| 28.3.2T6 | Functions of Actuators | 28.3.2P2 Tuning a three term controller |
| 28.3.2T7 | Types of actuators i) Solenoid ii) Digital stepper motor drives iii) Stepper motor drives iv) IC L298 v) IC SAA1027 vi) Pneumatic vii) Hydraulic | 28.3.2P3 Dismantling and assembling a Pneumatic control valve |
| | Practice | |
| 28.3.2P0 | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: | <i>Suggested teaching/Learning Activities</i> - Discussion - Illustration - Demonstration - Note taking - Practical exercise - Visits to industries |
| | | <i>Suggested Learning Resources</i> - Selected controllers and actuators |

| | |
|---|---|
| - Reference books | h) apply PLC's to practical systems |
| - Field visits | |
| - Electrical measuring instruments | |
| - Electronic tool kit | 28.3.3T1 Sequence control |
| - Dc Power supply | 28.3.3T2 Time delay units <ul style="list-style-type: none"> i) Control relays ii) Digital iii) Analogue |
| - Signal generators | 28.3.3T3 Application of decoders/encoders <ul style="list-style-type: none"> -Identification |
| - Ac power supply | 28.3.3T4 Practical interlock systems <ul style="list-style-type: none"> i) Solenoid ii) Limit switches iii) Control relays iv) Digital v) Analogue |
| - Electronic devices | 28.3.3T5 Internal architecture of Programmable Logic Controllers (PLC) <ul style="list-style-type: none"> i) Input/ Output channels ii) Memories iii) Types of Programmable Logic Controllers iv) Moeller v) Mitsubishi vi) Eaton vii) Siemens |
| - Electronic components | 28.3.3T6 Flow chart and ladder diagram programming methods |
| - | 28.3.3T7 Application of PLCs |
| Suggested Evaluation Methods | |
| - Oral tests | |
| - Timed written tests | |
| - Assignments | |
| - Timed practical tests | |
| 28.3.3 SEQUENTIAL CONTROL SYSTEMS | |
| Theory | |
| 28.3.3T0 Specific Objectives | |
| By the end of the sub-module unit, the trainee should be able to : | |
| a) describe sequential control | |
| b) explain time delay units | |
| c) apply decoders/encoders in sequential control | |
| d) explain practical interlock system control | |
| e) describe the Programmable Logic Controllers | |
| f) explain the various types of Programmable Logic Controllers | |
| g) apply Flow chart and ladder diagram programming methods | |
| Content | |
| 28.3.3T1 Sequence control | |
| 28.3.3T2 Time delay units <ul style="list-style-type: none"> i) Control relays ii) Digital iii) Analogue | |
| 28.3.3T3 Application of decoders/encoders <ul style="list-style-type: none"> -Identification | |
| 28.3.3T4 Practical interlock systems <ul style="list-style-type: none"> i) Solenoid ii) Limit switches iii) Control relays iv) Digital v) Analogue | |
| 28.3.3T5 Internal architecture of Programmable Logic Controllers (PLC) <ul style="list-style-type: none"> i) Input/ Output channels ii) Memories iii) Types of Programmable Logic Controllers iv) Moeller v) Mitsubishi vi) Eaton vii) Siemens | |
| 28.3.3T6 Flow chart and ladder diagram programming methods | |
| 28.3.3T7 Application of PLCs | |
| Practice | |
| 28.3.3P0 Specific Objectives | |
| By the end of the sub-module unit, the trainee should be able to: | |
| a) apply Flow chart and ladder diagram programming methods | |

| | | |
|---|--|---|
| | b) write programs for PLC's c) apply PLC's to practical systems | - Assignments - Timed practical tests |
| | | 28.3.4 DIGITAL CONTROL SYSTEMS |
| | <i>Content</i> | <i>Theory</i> |
| 28.3.3P1 | Application of flow charts and ladder diagram i) Flow chart ii) Ladder diagram iii) Developing programs | 28.3.4T <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: a) explain the application of digital methods to solve problems b) use computer application to provide data logging c) describe human machine interface(HMI) d) explain the application of digital computers in process control |
| 28.3.3P2 | Writing programs for PLC's i) Programmes techniques for multiplexing ii) Limited channel iii) Running several programmes simultaneously | |
| 28.3.3P3 | Applying PLC's i) Mimic diagrams ii) Alarm condition iii) Latch system | |
| 28.3.3C Competence | Content The trainee should have the ability to: program a PLC | <i>Content</i> |
| | | 28.3.4T1 Basic digital methods i) Single and multiple alarms ii) Digital control using logic circuits for system iii) Interactive multivariable control |
| | | 28.3.4T2 Computer data logging i) Data logger ii) Multiplexer iii) ADC, address lines, console |
| | | 28.3.4T3 iv) Computer supervisory Human machine interface (HMI) |
| | | 28.3.4T4 Applications of Digital computer i) Temperature |
| <i>Suggested teaching/Learning Activities</i> | - Discussion - Illustration - Demonstration - Note taking - Practical exercise - Visits to industries | |
| <i>Suggested Learning Resources</i> | - Selected PLC's - Reference books - Field visits | |
| <i>Suggested Evaluation Methods</i> | - Oral tests - Timed written tests | |

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|----------------|---|---|
| | <ul style="list-style-type: none"> ii) Remote position control iii) Stepper motor | <ul style="list-style-type: none"> - Timed written tests - Assignments - Timed practical tests |
| | Practice | 28.3.5 FUNDAMENTALS OF ROBOTS |
| 28.3.4P0 | <p><i>Specific Objectives</i></p> <p>By the end of the sub-module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) Solve industrial control problems using digital methods b) Use computers in industrial process control | <p>Theory</p> <p><i>Specific Objectives</i></p> <p>By the end of the sub-module unit , the trainee should be able to:</p> <ul style="list-style-type: none"> a) define a robot b) explain the types of robots c) explain the elements of robotic system d) explain the need for using robots e) classify robots f) describe the functions of control system in robots g) describe the performance capability of a robot h) outline the features of a robot i) use various robot programming methods |
| 28.3.4P1 | solution of industrial controls problems | |
| 28.3.4P2 | computer applications in industrial process controls | |
| 28.3.4C | Competence | |
| | The trainee should have the ability to: install a and maintain a SCADA system | |
| | <i>Suggested teaching/Learning Activities</i> | |
| | <ul style="list-style-type: none"> - Discussion - Illustration - Demonstration - Note taking - Practical exercise - Visits to industries | <p><i>Content</i></p> <p>28.3.5T1 Definition of a robot</p> <p>28.3.5T2 Types of robots</p> <ul style="list-style-type: none"> i) Manual ii) Semi Automatic iii) Automatic <p>28.3.5T3 Elements of a Robotic System</p> <ul style="list-style-type: none"> i) Components of robot manipulator ii) Control system iii) Computer system <p>28.3.5T3 Needs for using robots</p> <ul style="list-style-type: none"> i) Degree of freedom |
| | <i>Suggested Learning Resources</i> | |
| | <ul style="list-style-type: none"> - SCADA computer - Reference books - Field visits | |
| | <i>Suggested Evaluation Methods</i> | |
| | <ul style="list-style-type: none"> - Oral tests | |

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| | <ul style="list-style-type: none"> ii) Roll iii) Pitch iv) Drive systems v) Pneumatic actuator systems vi) Hydraulic actuator systems vii) Electric actuator systems | <i>Content</i> |
| 28.3.5T5 | Functions | 28.3.5P1 Elements of a robotic system |
| | <ul style="list-style-type: none"> i) Generating the path of motion for the manipulator ii) Feedback devices iii) Co-ordinate transformation iv) Safety controls v) Interfaces vi) Robot control through non-servo operation vii) Servo-controlled robots | <ul style="list-style-type: none"> i) Drives ii) Sensors iii) Microcontroller chips iv) Actuators v) Motors vi) Arm |
| 28.3.5T6 | Performance | 28.3.5P2 Assembling a Robotic element |
| | <ul style="list-style-type: none"> i) Capabilities Specifications ii) Axes of motion iii) Work envelope iv) Speed v) Accelerometer | |
| 28.3.5T7 | Key Features of Robots | 28.3.5C Competence The trainee should have the ability to: assemble robots |
| | <ul style="list-style-type: none"> i) Quality ii) Serviceability iii) Safety iv) Modularity v) Dexterity | |
| 28.3.5T8 | Programming methods | <i>Suggested teaching/Learning Activities</i> |
| | Practice | <ul style="list-style-type: none"> - Discussion - Illustration - Demonstration - Note taking - Practical exercise - Visits to industries - Timed practical tests |
| 28.3.5P0 | <i>Specific Objectives</i> | <i>Suggested Learning Resources</i> |
| | By the end of the sub-module unit, the trainee should be able to: | <ul style="list-style-type: none"> - Reference books - Field visits Drives - Sensors - Microcontroller chips - Actuators - Motors - Arm - Electronic tool kit - Dc Power supply |
| | <ul style="list-style-type: none"> a) identify elements of a robotic system b) assemble the robotic elements | <i>Suggested Evaluation Methods</i> |

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|-----------------|--|--|
| 28.3.6 | PROGRAMMING OF ROBOTS | i) Basic ii) C++ iii) AVR studio |
| | Theory | 28.3.6P6 On-line and off-line programming languages |
| 28.3.6T0 | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: a) explain programming methods b) describe robot programming functions c) describe robot programming environment d) describe robot programming activities e) describe basic types robot programming languages f) describe on-line and off-line programming languages | Practice 28.3.6P0 <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to develop simple programs to manipulate robots |
| | <i>Content</i> | <i>Content</i> 28.3.6P1 Programming methods i) Guiding ii) Teach pedant iii) Off-line programming |
| | | 28.3.6C Competence The trainee should have the ability to: develop simple robot program |
| | | <i>Suggested teaching/Learning Activities</i> <ul style="list-style-type: none">- Discussion- Illustration- Demonstration- Note taking- Practical exercise- Visits to industries- Timed practical tests |
| | | <i>Suggested Learning Resources</i> <ul style="list-style-type: none">- Reference books- Field visits |
| | | <i>Suggested Evaluation Methods</i> <ul style="list-style-type: none">- Oral tests- Timed written tests- Assignments |
| 28.3.6P1 | Programming methods i) Guiding ii) Teach pedant iii) Off-line programming | |
| 28.3.6P2 | Robot programming functions i) World modeling ii) Path generation iii) Sensing iv) Programming support | |
| 28.3.6P3 | Robot programming environment | |
| 28.3.6P4 | Programming activities | |
| 28.3.6P5 | Basic types of robot programming languages | |

29.3.0 INDUSTRIAL ORGANIZATION AND MANAGEMENT**29.3.01 Introduction**

The module unit is designed to enable the trainee develop knowledge, skills, attitudes and the necessary competence required for enhancing management practices, leadership , interactive and supervisory skills in work places and related environments. The module unit trainee is also expected to understand the economic factors affecting the enterprise they are in and how to tackle them.

29.3.02 General Objectives

At the end of the module unit, the trainee should be able to;

- a) Understand the development of management systems
- b) Discuss the significance of management in enterprises
- c) Apply production management practices in the real world of work
- d) Appreciate the need for inculcating management principles for harmony in the work environment
- e) Manage Organizations effectively
- f) Apply relevant qualitative techniques to solve management problems

29.3.03 Module Unit Summary and Time Allocation**Industrial Organisation and Management**

| Code | Sub Module Unit | Content | Time Hrs |
|-------------|------------------------|---|-----------------|
| 29.3.1 | Economics | <ul style="list-style-type: none">• Definition of the term economics• The concept of economics• The concept of production• Relationship between value, utility and production• Division of labour, specialization, automation and mechanization | 4 |
| 29.3.2 | Trade | <ul style="list-style-type: none">• The concept of demand supply, price, trade demand, supply curves.• Demand, supply and price• The concept of money• The role of banks and financial institutions• Role of international trade and foreign exchange | 4 |

| | | | |
|--------|---------------------------------|--|---|
| | | <ul style="list-style-type: none"> • The role of the world bank, IMF and other development partners | |
| 29.3.3 | Business Law | <ul style="list-style-type: none"> • Business Law and Company Law • Liabilities of Business • Contracts and the Law of contracts • Legal position of a business • Bankruptcy of a business and winding up | 4 |
| 29.3.4 | Management Principles | <ul style="list-style-type: none"> • Definition of Management • Concept of Management • History and Evolution of management • Types of management • Functions of management • Organization of functions of management • Advantages and Disadvantages of organization management • Basic principles of organizations • The concept of authority, responsibility and accountability • Management By Objectives | 6 |
| 29.3.5 | Project Planning and Management | <ul style="list-style-type: none"> • Project management • Project planning • Critical Path Analyses • Costing • Resource Loading and scheduling in a project • Project activity costing and base lining • Project progress • Project Commissioning | 8 |
| 29.3.6 | Office Administration | <ul style="list-style-type: none"> • The Office • Functions of an office • Office Equipment • Office Organization & Administration | 4 |
| 29.3.7 | Production Management | <ul style="list-style-type: none"> • Production Planning activities. • Product development • Quality of a product control • Statistical Quality control • Control charts and sampling features | 8 |

| | | | |
|-------------------|----------------------------|---|-----------|
| | | <ul style="list-style-type: none"> • Inspection • Procedure for material procurement and stores • Work study • Features and constraints of a Production Plant • Plant location • Types of production • Plant layout | |
| 29.3.8 | Plant Maintenance | <ul style="list-style-type: none"> • Importance of maintenance of plant and organization • Benefits of planned maintenance • Effective maintenance requirements | 6 |
| 29.3.9 | Human Resource Management | <ul style="list-style-type: none"> • Structures of human resource management • Recruitment and selection of employees • Sources of stress at work places and stress management • The role of trade unions | 8 |
| 29.3.10 | Finance and Budgeting | <ul style="list-style-type: none"> • Financial control methods • Elements of costs • Budgeting control • Accounting procedures • Sales strategies | 8 |
| 29.3.11 | Result Oriented Management | <ul style="list-style-type: none"> • Result oriented management (ROM) • Result Oriented Agreement (ROA) and Specific Measurable Acceptable Relevant Traceable (SMART) management • Steps in ROM • Comparison of ROM, RBM and RBL • Performance Contracts | 6 |
| Total Time | | | 66 |

29.3.1 ECONOMICS

Theory

29.3.1T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) define the term economics
- b) explain the concept of economics
- c) discuss the concept of production
- d) discuss the term utility and value and recognize their relevance to production
- e) discuss the basic factors of production
- f) explain and discuss the concept of, division of labour, specialization mechanization and automation in production

Content

29.3.1T1 Definition of Economics

- i) Identify a definition of economics
- ii) State a standard definition of economics and discuss it.

29.3.1T2 The concept of Economics

- i) Relate the origins and need for economics
- ii) Recognize the universal nature of economics

29.3.1T3 Production

- i) Discuss the concept of production

- ii) Explain and relate the different types and levels of production

29.3.1T4 Utility and Value

- i) Define and explain the terms; utility, value
- ii) Recognize relevance of utility and value in production.

29.3.1T5 Factors of production

- i) Define and explain what factors of production are
- ii) State the main factors of production.
- iii) Discuss the main factor of production and their features

29.3.1T6 Division of labour and specialization

- i) Discuss and explain the origins and need for division of labour.
- ii) Define and discuss specialization
- iii) Discuss the merits and demerits of division of labour and specialization.
- iv) Discuss mechanization and automation of production as consequences of specialization.
- v) Trends in the automation of production and their effects.

Suggested teaching/Learning Activities

- Discussion
- Illustration
- Note taking

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments

29.3.2 TRADE

Theory

29.3.2T0 Specific objectives

By the end of the sub-module unit, the trainee should be able to:

- a) discuss the concepts of demand, supply, and price trade
- b) relate and explain how demand and supply vary with price.
- c) recognize the need for trade
- d) discuss the concept of money
- e) recognize the role of banks and financial institutions
- f) recognize the roles and the need for international trade and foreign exchange
- g) discuss the roles and functions of the world bank, IMF and other development partners

Content

29.3.2T1 Demand, Supply, Price Trade

29.3.2T2 Demand and Supply Curves

- i) Draw and discuss the demand curve

ii) Draw and discuss the supply curve

iii) Discuss the conditions under which the demand and supply curves apply.

iv) Discuss the conditions under which the demand and supply curves do not apply.

29.3.2T3 Need for Trade

- i) Discuss the historical origins of trade
- ii) Discuss the different types of trade

29.3.2T4 Money

- i) Discuss and define the term money.
- ii) Discuss the origins of money and what can constitute it.

29.3.2T5 Banks and Financial Institutions

- i) Discuss the role of banks in general.
- ii) Discuss the role of the central bank.
- iii) Discuss the role of commercial banks.
- iv) Discuss the types and role of financial institutions.

29.3.2T6 International Trade and Foreign Exchange

- i) Discuss international trade and the need for it.
- ii) Discuss the concept of foreign exchange

29.3.2T7 The roles and functions of the World Bank and IMF and their Effect on national economics.

| | | |
|----------|---|--|
| 29.3.3 | BUSINESS LAW | |
| | Theory | |
| 29.3.3T0 | <i>Specific Objectives</i> | |
| | <p>By the end of the sub-module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) differentiate between business law and company law. b) discuss the liabilities of business. c) discuss the various aspects of contracts and the law of contract d) discuss the legal position of business e) explain bankruptcy of Business and Winding up. | |
| | <i>Content</i> | |
| 29.3.3T1 | Business Law V/s Company Law | |
| | <ul style="list-style-type: none"> - Discuss and relate business law with company law | |
| 29.3.3T2 | Liabilities of Business | |
| | <ul style="list-style-type: none"> i) The obligations of business to share holders ii) The obligations of business to employees iii) The obligations of business to creditors iv) The obligations of business to other businesses. v) The obligations of business to the government | |
| 29.3.3T3 | Contract Law | |
| | <ul style="list-style-type: none"> i) Recognize the concept of contract in law | |
| | | |
| | ii) Requirements for valid contract. | |
| | iii) Methods of executing a contract (General Management) | |
| 29.3.3T4 | Legal position of a business | |
| 29.3.3T5 | Bankruptcy and winding up | |
| | Competence | |
| | The trainee should have the ability to: apply business law in self employment or in the formal employment | |
| | <i>Suggested teaching/Learning Activities</i> | |
| | <ul style="list-style-type: none"> - Discussion - Illustration - Note taking | |
| | <i>Suggested Evaluation Methods</i> | |
| | <ul style="list-style-type: none"> - Oral tests - Timed written tests - Assignments | |
| | MANAGEMENT PRINCIPLES | |
| | Theory | |
| 29.3.4T0 | <i>Specific Objectives</i> | |
| | By the end of the sub - module unit, the trainee should be able to: | |
| | <ul style="list-style-type: none"> a) define the term management b) discuss the concept of management. c) discuss the history and evolution of management. d) describe types of management | |

| | | |
|--|----------|---|
| e) state the functions of management | 29.3.4T5 | Statement of functions of management |
| f) discuss the need for the organizing function of management. | | i) Planning ii) Organizing iii) Implementing or motivating iv) Controlling |
| g) illustrate typical organization management charts. | 29.3.4T6 | Need for the organizing function |
| h) state the advantages and disadvantages of organization management. | 29.3.4T7 | Illustration of the typical organization charts - Tall and flat organization charts. |
| i) describe the basic principles of organization | 29.3.4T8 | Advantages and disadvantages of organization management. |
| j) explain the concept of authority, responsibility and accountability | 29.3.4T9 | Description of the basic principals of organization - Departmentation - Informal organizations - Roles - Synergy - Grapevine and its effects |
| k) describe Management By Objectives (MBO) | | |

Content

| | | | |
|----------|--|-----------|---|
| 29.3.4T1 | Definition of the term 'management' | 29.3.4T10 | Explanation of the concept of authority, responsibility, accountability, and delegation i) Power Vs authority ii) Effective delegation |
| 29.3.4T2 | The concept of management i) Administration ii) Ruling iii) Leading | | |
| 29.3.4T3 | The history and evolution of management i) Pioneers ii) Fredrick Taylor iii) Henry Fayol iv) Elton Mayo v) Peter Drucker vi) H. Konntz | 29.3.4T11 | Description of the management by objectives (M.B.O) i) Definition of M.B.O. ii) Advantages iii) Disadvantages iv) Limitations of M.B.O. |
| 29.3.4T4 | Types of management i) Democratic or participative ii) Despotic iii) Laissez-faire iv) Task orient v) human oriented | | |

Suggested teaching/Learning Activities

- Discussion
- Illustration
- Note taking

Suggested Evaluation Methods

| | | | |
|---|---|-----------------|---|
| | <ul style="list-style-type: none"> - Oral tests - Timed written tests - Assignments | | <ul style="list-style-type: none"> v) The programmer vi) The benefits of project management vii) Improved communications viii) Prediction of potential problem areas ix) Systems integration. x) Tighter control. xi) Better planning. |
| 29.3.5 PROJECT PLANNING AND MANAGEMENT | | | |
| | Theory | | |
| 29.3.5T0 Specific objectives | By the end of the sub - module unit, the trainee should be able to: | | |
| | <ul style="list-style-type: none"> a) discuss project management overview b) explain project planning needs c) apply critical path analysis in project planning d) discuss resource loading and scheduling in project planning e) discuss project activity costing and base lining f) prepare a project progress report g) explain project commissioning process | 29.3.5T2 | <ul style="list-style-type: none"> i) Choice of required equipment ii) Performance specifications iii) Planning Cycle iv) Project Plan - Activities v) Project Plan - Relationships |
| | | 29.3.5T3 | Critical path analysis |
| | | | <ul style="list-style-type: none"> i) Early Date Computations ii) Late Date Computations iii) Float Computations |
| | | 29.3.5T4 | Resource loading requirements |
| | | | <ul style="list-style-type: none"> i) Resource Allocation Overview ii) Fixed Time Scheduling iii) Fixed Resource Scheduling iv) Project Summarization |
| | | 29.3.5T5 | Activity costing |
| | | | <ul style="list-style-type: none"> i) Activity Costing Overview ii) Base lining |
| | | 29.3.5T6 | Project progress reporting |
| | | | <ul style="list-style-type: none"> i) Project progress ii) actual start date iii) actual finish date |

- iv) percent complete
 - v) duration left
 - vi) work done
 - vii) Trend Analysis
 - viii) Work Package Costing
 - ix) Earned Value Computations
- 29.3.5T7 Commissioning**
- i) Handing over obligations
 - ii) Spare parts availability

Suggested teaching/Learning Activities

- Discussion
- Illustration
- Note taking

Suggested Teaching and Learning Resources

A sample case study in their area of specialization.

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments

29.3.6 OFFICE ADMINISTRATION

Theory

29.3.6T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) define and discuss the term office
- b) discuss the basic functions of an office
- c) recognize and discuss the need and use of the

- various types of office equipment.
- d) discuss the basic principles of office organization and administrations

Content

- 29.3.6T1 Office**
- i) Define and discuss the term office.
 - ii) Discuss the need of having an office.
- 29.3.6T2 Functions of an office**
- i) Identify and discuss the basic functions of an office.
 - ii) Discuss the effective use of the various pieces of office equipment.
- 29.3.6T3 Office organization and administration**
- i) discuss the order of a secretary in an office.
 - ii) discuss the duties of other office personnel.
 - iii) discuss the layout and organization of various types and classes of offices.
- 29.3.6T4 Principles of office organization and administration**

29.3.6C Competence

The trainee should have the ability to: manage a middle level management office

Suggested teaching/Learning Activities

- Discussion
- Illustration
- Note taking

| | |
|--|---|
| <ul style="list-style-type: none"> - Role play - Industrial attachment - Industrial visit <p><i>Suggested Evaluation Methods</i></p> <ul style="list-style-type: none"> - Oral tests - Timed written tests - Assignments | <p>29.3.7T1</p> <p>i) explain the need for proper plant layout.</p> <p><i>Content</i></p> <p>Identification of various activities in production planning</p> <ul style="list-style-type: none"> i) Routing ii) Estimating iii) Scheduling iv) Dispatching and progress v) line balancing <p>29.3.7T2</p> <p>Description of Statistical Quality Control (SQC)</p> <ul style="list-style-type: none"> i) Meaning of SQC ii) Merits and demerits of SQC iii) The process of SQC in manufacturing <p>29.3.7T3</p> <p>Demonstration of the use of sampling and control charts</p> <ul style="list-style-type: none"> i) Sampling ii) Population iii) Population standard deviation iv) The process of SQC in manufacturing v) Distributions vi) Binomial vii) Poisson viii) Normal ix) Acceptance sampling x) Producer risk xi) Consumer risk xii) Acceptance quality level xiii) Lot tolerance. xiv) Multiple sampling xv) Gantt charts xvi) Preparation xvii) Advantages and disadvantages xviii) Limitations xix) Networks |
| <p>29.3.7 PRODUCTION MANAGEMENT</p> <p>Theory</p> <p>29.3.7T0 <i>Specific Objectives</i></p> <p>By the end of the sub-module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) identify various activities in production, planning. b) discuss the process of product development c) discuss the various concepts of quality of a product d) describe statistical quality control e) demonstrate the use of control charts and sampling features. f) discuss inspection g) explain the procedures for material procurement and stores. h) discuss work study i) describe the features and constraints of production plants. j) discuss the process of choosing the location of a plant. k) state various types of production | |

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|----------|--|----------|---|
| | xx) Critical Path Analysis (CPA) features | 29.3.7T7 | viii) Destructive simulation. |
| | xxi) PERT features | | Explanation of the procedures for material procurement and stores |
| | xxii) Identification of critical activities. | | i) Procedures |
| | xxiii) Crashing and decompression in cost control of project | | ii) Classification of materials used in production |
| 29.3.7T4 | xxiv) Computer use in OPM and PERT | | iii) Role of purchasing department |
| | Discussion of the process of product development | | iv) Role of the store and its functions |
| | i) Stages in product design. | | v) Stores personnel roles and duties |
| | ii) Manufacturing specification | | vi) Stores stationery |
| | iii) Process layout | | vii) Bin cards |
| | iv) Product specification | | viii) Stock control cards |
| 29.3.7T5 | Discussion of the various concepts of quality of a product | | ix) Stock print outs |
| | i) Definition of quality | | x) Computer use in stores |
| | ii) Usefulness of product | | xi) Material handling |
| | iii) Aesthetics | | xii) Stores layout |
| | iv) Material | 29.3.7T8 | Discussion of work study |
| | v) Brand name | | i) Concept of work study |
| | vi) Control charts | | ii) The works of Frank and Lillian and Gilbreath |
| | vii) Assignable causal effects | | iii) Work measurement |
| | viii) Random causal effects | | iv) Calculations of actual time, normal time, Standard time and rating. |
| | ix) Variable charts | | v) Allowances of time |
| | x) Attribute charts | | vi) Scrap rates |
| 29.3.7T6 | Inspection | | vii) Efficiency factors |
| | i) Meaning and need for inspection | | viii) Method study |
| | ii) Types of inspection | | ix) Recording techniques |
| | iii) Inwards | | x) Analyzing techniques |
| | iv) Outwards or final | | xi) Effective implementation method study |
| | v) Centralized | | |
| | vi) Patrol | | |
| | vii) Testing schemes | | |

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| 29.3.7T9 Description of the features and constraints of production plants | <ul style="list-style-type: none"> - Timed written tests - Assignments |
| i) Features ii) Effects of various types of plants on iii) Environment iv) Local economy v) Social outlook of the local community vi) Government vii) Constraints | 29.3.8 PLANT MAINTENANCE |
| 29.3.7T10 Discussion of the process of choosing the location of a plant | Theory |
| i) Steps ii) Weighting and ranking methods | 29.3.8T0 <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: a) appreciate the importance of maintenance of plant and its organization. b) discuss the benefits of planned-preventive maintenance c) describe the requirements for an effective maintenance programme |
| 29.3.7T11 Settlement of the various types of production. | <i>Content</i> |
| i) Job ii) Batch iii) Flow iv) Other | 29.3.8T1 Plant Maintenance Organization |
| 29.3.7T12 Explanation for the need for proper plant layout | i) Discuss the various aspects of maintenance and types of maintenance and repair schemes. |
| i) Technical requirements ii) Legal requirements | ii) Discuss the general organization of the maintenance department of a large plant i.e. the necessary sections and personnel |
| 29.3.7C Competence | iii) Discuss the basic economics and philosophy of modern maintenance of plan. |
| The trainee should have the ability to: manage a production line | iv) Discuss the need for setting up maintenance and repair policies. |
| <i>Suggested teaching/Learning Activities</i> | <ul style="list-style-type: none"> - Discussion - Illustration - Note taking - Role play - Industrial attachment - Industrial visit |
| <i>Suggested Evaluation Methods</i> | <ul style="list-style-type: none"> - Oral tests |

- v) Classify the various maintenance assets.
- vi) Describe the various maintenance cost control.
- vii) Planned-Preventive maintenance
- viii) Define preventive maintenance and contrast it with other types of maintenance
- 29.3.8T2 Benefits and costs of preventive maintenance**
- i) Discuss the procedure of setting up and implementing a preventive maintenance scheme for plant
 - ii) Discuss the significance of inspection in planned=preventive maintenance and the determination of the frequency of the inspections
 - iii) Discuss the requirements of having standardized parts and equipment in the plant and the benefit of having adequate stocks of parts
 - iv) Discuss the necessary planning records which should be kept
 - v) Requirements of an effective maintenance programme
 - vi) Models used in maintenance management
 - vii) Reliability
 - viii) Maintainability
 - ix) Availability
 - x) Current Maintenance Strategies
 - xi) Business-centered Maintenance (BCM)
 - xii) Total Productive Maintenance (TPM)
 - xiii) Reliability-centered Maintenance (RCM)
 - xiv) Computerized Maintenance Management Systems (CMMS)
 - xv) Basic Elements of a CMMS
 - xvi) Implementation of a CMMS
- 29.3.8T2 Requirements for an effective maintenance programme**

29.3.8C Competence

The trainee should have the ability to: design and implement maintenance programmes in an industry

Suggested teaching/Learning Activities

- Discussion
- Illustration
- Note taking
- Role play
- Industrial attachment
- Industrial visit

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments

29.3.9 HUMAN RESOURCE MANAGEMENT

Theory

- 29.3.9T0 *Specific objectives*
By the end of the sub-module unit, the trainee should be able to:
- a) understand the structures of human resource management
 - b) understand the recruitment & selection procedures of personnel
 - c) identify sources of stress at work places and understand structures of stress management
 - d) explain the role of trade unions in industry

Content

- 29.3.9T1 Human Resource
 - i) Management
 - ii) Personnel Policies
 - iii) Organization of personnel
 - iv) Interviews
- 29.3.9T2 Recruitment
Training & staff development
- 29.3.9T3 Stress Management
 - i) Sources of stress
 - ii) Symptoms of stress
 - iii) Personnel coping strategies
 - iv) Organization responses to stress avoidance
 - v) Harassment at work places
 - vi) Counseling at work

- 29.3.9T4 Trade Unions
 - i) Types of trade unions
 - ii) Employers association
 - iii) Work place representation
 - iv) Employer participation
 - v) Collective agreement
 - vi) Trade disputes
 - vii) Picketing
 - viii) Ballots
 - ix) Employment contract
 - x) Redundancy
 - xi) Industrial courts

29.3.9C Competence

The trainee should have the ability to: manage human resource

Suggested teaching/Learning Activities

- Discussion
- Illustration
- Note taking
- Role play
- Industrial attachment
- Industrial visit

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments

29.3.10 FINANCE AND BUDGETING

Theory

- 29.3.10T0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
a) explain financial control methods

- b) describe elements of costs
- c) explain budgeting control
- d) describe accounting procedures
- e) explain sales strategies

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments

29.3.11 RESULT ORIENTED MANAGEMENT

Theory

Content

- 29.3.10T1 Explain financial control methods
- 29.3.10T2 Elements of cost
 - Material
 - i) Labour cost
 - ii) Overhead cost
 - iii) Direct cost
- 29.3.10T3 Budgeting control
 - i) Planning
 - ii) Control
 - iii) Forecasting
- 29.3.10T4 Accounting procedures
 - i) Loss / profit
 - ii) Balance sheet
 - iii) Cash flow statements
- 29.3.10T5 Sales strategies
 - i) Promotion
 - ii) Competition
 - iii) Marketing
 - iv) Advertisement

Specific objectives

- By the end of the sub-module unit, the trainee should be able to:
- a) describe result oriented management
 - b) describe result oriented agreement and SMART
 - c) describe the steps in result oriented management
 - d) compare Results Oriented Management with Value Based Management and Results Based Leadership
 - e) discuss performance contracts

29.3.10C Competence

The trainee should have the ability to: manage business finances

Suggested teaching/Learning Activities

- Discussion
- Illustration
- Note taking
- Role play
- Industrial attachment
- Industrial visit

Content

- 29.3.11T1 Description of result oriented management
- 29.3.11T2 Description of result oriented agreement and SMART
 - i) Result oriented agreements
 - ii) SMART- Specific, Measurable, Acceptable, Relevant and Traceable
- 29.3.11T3 Steps in result oriented management

| | | |
|-----------|--|---|
| | <ul style="list-style-type: none"> i) Setting long term goals ii) Translating long term goals into strategic business unit goals and individual goals iii) Obtaining result oriented agreements iv) Implementation v) Periodic appraisals, progress control and adjustments vi) Comparison | The trainee should have the ability to: focus on results at work places and in life |
| 29.3.11T4 | Results oriented management and value based management <ul style="list-style-type: none"> - Results oriented management and results based leadership | <p><i>Suggested teaching/Learning Activities</i></p> <ul style="list-style-type: none"> - Discussion - Note taking - Industrial attachment - Industrial visit |
| 29.3.11T5 | Performance contracts | <p><i>Suggested Teaching / Learning Resources</i></p> <ul style="list-style-type: none"> - A case study of performance contracts in the Kenyan situation. |

29.3.11C Competence

30.3.0 MICROPROCESSOR SYSTEMS

30.3.01 Introduction

The module unit is intended to provide the trainees with theoretical and practical skills for selection, installation and maintenance of microelectronics, micro-computers and micro processor based systems. Trainees undertaking this course will be expected to have covered digital electronics in module II of this course.

30.3.02 General Objectives

At the end of the module unit, the trainee should be able to;

- a) Understand the concepts of a microprocessor system.
- b) Programme a microprocessor system
- c) Write and implement micro processor programs.
- d) Diagnose faults in microprocessor systems

30.3.03 Module Unit Summary and Time Allocation

Microprocessors Systems

| Code | Sub Module Unit | Content | Time Hrs |
|-------------|---|--|-----------------|
| 30.3.1 | Microprocessor Architecture | <ul style="list-style-type: none">• Organization of data registers• Operation of machine cycle | 4 |
| 30.3.2 | Introduction to Assembly Language Programming | <ul style="list-style-type: none">• Machine cycle• Instruction format• Data Transfer instruction programming• Data Manipulation• Input/Output Instructions• Machine control Instructions• Transfer of Control• Assembler Directives• Addressing Modes• Application programs | 8 |
| 30.3.3 | Input/output Methods | <ul style="list-style-type: none">• Operation of memory mapped input/output• Programmed (memory Mapped) input/output• Hand shake controlled input/output• Polled input/output | 6 |
| 30.3.4 | Interrupts | <ul style="list-style-type: none">• Need for interrupt• Operation of the interrupts | 6 |

| | | | |
|-------------------|--|--|-----------|
| | | <ul style="list-style-type: none"> • Types of interrupts • Applications of interrupts | |
| 30.3.5 | Direct Memory Access | <ul style="list-style-type: none"> • Need for DMA • Operation of DMA • Operation of DMA controller | 6 |
| 30.3.6 | Interfacing Devices | <ul style="list-style-type: none"> • Computer Internal interface input/output devices • Serial and parallel ports | 8 |
| 30.3.7 | Tools in assembly language programming | <ul style="list-style-type: none"> • Introduction to tools for assembly language programming • Procedure for documentation | 4 |
| 30.3.8 | Control Structures architecture | <ul style="list-style-type: none"> • Programming control Levels • Micro programmed control units | 4 |
| 30.3.9 | Micro-computer Development | <ul style="list-style-type: none"> • Development aids • Concepts, Features and Facilities • Application of development aids in system development | 4 |
| 30.3.10 | Microprocessor Applications | <ul style="list-style-type: none"> • Applications of microprocessors | 4 |
| 30.3.11 | Microprocessor fault diagnosis | <ul style="list-style-type: none"> • Types of faults • Fault diagnosis equipment • Fault finding methods | 8 |
| Total Time | | | 66 |

| | |
|---|---|
| 30.3.1 MICROPROCESSOR ARCHITECTURE | |
| Theory | |
| 30.3.1T0 Specific Objectives | |
| By the end of the sub - module unit, the trainee should be able to: | |
| a) describe the organization of data registers | d) describe the instructions in data manipulation group |
| b) explain the operation of machine cycle | e) describe the input and output instructions |
| c) | f) describe the machine control instructions |
| | g) describe transfer of control instructions in programming |
| | h) explain the need and use of assembly directives |
| | i) explain various addressing modes |
| | j) write application programs |
| Content | |
| 30.3.1T1 Description of organization of data registers | |
| i) Instruction register | 30.3.2T1 Content |
| ii) Programme counter | Machine Cycle |
| iii) Store address register | i) Definition |
| iv) General purpose | ii) Fetch |
| v) Accumulator | iii) Decode |
| vi) Stack pointer | iv) Execute |
| vii) Arithmetic and logic unit | v) Time diagram |
| viii) Status register | 30.3.2T2 Instruction format |
| | i) Label |
| | ii) Opcode |
| | iii) Operand |
| | iv) Comment |
| 30.3.1T2 Explanation of operation of machine cycle | |
| | 30.3.2T3 Data Transfer |
| | 30.3.2T4 Data Manipulation |
| | 30.3.2T5 Input/Output Instructions |
| | 30.3.2T6 Machine control Instructions |
| | 30.3.2T7 Transfer of instructions |
| | v) Branch instructions |
| | vi) Status register/ flag register |
| | vii) Subroutines |
| | viii) Parameter passing |
| | ix) Stack operations |
| | 30.3.2T8 Assembly directives |
| | i) Standard |
| | ii) Macros |
| | iii) Conditional |
| Theory | |
| 30.3.2T0 Specific Objectives | |
| By the end of the sub - module unit, the trainee should be able to: | |
| a) describe a machine cycle | |
| b) explain instruction format | |
| c) describe data transfer instructions in programming | |

30.3.2T9 Addressing modes

- i) Register
- ii) Register indirect
- iii) Immediate
- iv) Absolute
- v) Relative
- vi) Indexed
- vii) Implied
- viii) Direct
- ix) Bit
- x) Implied
- xi) Stack addressing

30.3.2T10 Application programs

Practice

30.3.2P0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) write machine code programs using instruction sets
- b) hand coding and input machine code programs

Content

30.3.2P1 Writing machine code programs

- i) Machine coding
- ii) Inputting a machine code program
- iii) Running the programs

30.3.2C Competence

The trainee should have the ability to: write machine code programs for application in microprocessor systems

Suggested teaching/Learning Activities

- Discussion
- Illustration
- Demonstration

- Note taking
- Practical exercise

Learning Aids/Resources

- Microprocessor training kits
- Assorted microprocessors
- Internet
- Text books

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests
- Project

30.3.3 INPUT/OUTPUT TECHNIQUE

Theory

30.3.3T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) describe the operation of memory mapped input/output
- b) describe the operation of programmed input/output
- c) describe the operation of handshake controlled input/output
- d) describe the operation of polled input/output

Content

30.3.3T1 Memory mapped input/output

30.3.3T2 Programmed input/output

30.3.3T3 Handshake controlled input/output

30.3.3T4 Polled input/output

30.3.3C Competence

The trainee should have the ability to: perform inputs to a programmable controller

Suggested teaching/Learning Activities

- Discussion
- Illustration
- Demonstration
- Note taking
- Project work
- Visits to industries

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments

30.3.4 INTERRUPTS

Theory

30.3.4T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) explain the need for interrupt
- b) describe an interrupt operation
- c) describe operation of various types
- d) explain application of interrupts

Content

- 30.3.4T1 Need for interrupt
- 30.3.4T2 Operation of Interrupt
- 30.3.4T3 Description of the various Types of interrupts
 - i) Vectored

- ii) Polled
- iii) Hand wired
- iv) Peripheral Interrupt Controller (PIC)

- v) Masked

30.3.4T4 Applications of interrupts

- i) Single user
- ii) Multi programming
- iii) Polling
- iv) DMA
- v) Job scheduling

30.3.4C Competence

The trainee should have the ability to use interrupts

Suggested teaching/Learning Activities

- Discussion
- Illustration
- Demonstration

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Project

30.3.5 DIRECT MEMORY ACCESS

Theory

30.3.5T1 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) explain the need for Direct Memory Access (DMA)
- b) describe the DMA operation
- c) describe the operation of DMA controller

| | | |
|---------------|---|---|
| | <i>Content</i> | - Illustration - Visits to industries |
| 30.3.5T1 | Explanation of the need of DMA | |
| 30.3.5T2 | Description of operation of DMA | <i>Suggested teaching/Learning Resources</i> |
| 30.3.5T3 | Operation of DMA controller <ul style="list-style-type: none"> i) Burst Mode ii) Cycle Stealing iii) Transparent | - Programmable Logic controller |
| 30.3.6 | INTERFACING DEVICES | <i>Suggested Evaluation Methods</i> |
| | Theory | - Oral tests - Timed written tests - Assignments - Timed practical tests |
| 30.3.6T1 | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: <ul style="list-style-type: none"> a) describe the internal structure of input /output (I/O) computer interfacing devices b) describe the serial and parallel ports | 30.3.7 TOOLS IN ASSEMBLY LANGUAGE PROGRAMMING |
| | <i>Content</i> | Theory |
| 30.3.6T1 | Internal I/O computer interface devices <ul style="list-style-type: none"> i) operation of typical I/O chip ii) components of I/O chips | 30.3.7T0 <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: <ul style="list-style-type: none"> a) describe tools used in assembly language programming b) explain the procedure of documentation |
| 30.3.6T2 | Serial and parallel ports <ul style="list-style-type: none"> i) Serial controller ii) Communication interface devices <ul style="list-style-type: none"> - UART - ACIA - RS 232/422 - IEE/488 | <i>Content</i> |
| | <i>Suggested teaching/Learning Activities</i> | 30.3.7T1 Description of assembly language Tools <ul style="list-style-type: none"> i) The editor ii) Assembler iii) Programmer iv) Compiler v) Loader etc |
| | - Discussion | 30.3.7T2 Explanation of Documentation Procedure <ul style="list-style-type: none"> i) Comments ii) Printing iii) Downloading iv) Linking |

| | | | |
|--|-------------------------------------|---|---|
| | | | <ul style="list-style-type: none"> ii) Micro-programmed computers iii) One-chip computers |
| <i>Suggested teaching/Learning Activities</i> | | | |
| <ul style="list-style-type: none"> - Discussion - Illustration - Visits to industries | 30.3.9 | MICRO-COMPUTER DEVELOPMENT SYSTEMS | |
| <i>Suggested teaching/Learning Resources</i> | | | Theory |
| <ul style="list-style-type: none"> - Programmable Logic controller | 30.3.9T0 | <i>Specific Objectives</i> | <p>By the end of the sub-module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) explain the various development aids for microcomputers b) define concepts features and facilities of system development c) apply development aids in system developments |
| 30.3.8 CONTROL STRUCTURES | | <i>Content</i> | |
| | | 30.3.9T1 | <p>Explanation of development aids</p> <ul style="list-style-type: none"> i) Hardware ii) Micro-processor system iii) EPROM programmes iv) UV eraser v) Software programmes |
| | 30.3.8T0 <i>Specific Objectives</i> | | <p>By the end of the sub-module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) describe the various control levels b) explain micro-programmed controllers |
| | | 30.3.9T2 | <p>Definition of Concept, feature and facilities</p> <ul style="list-style-type: none"> i) Need ii) Types of operating systems iii) Functions iv) Applications |
| | 30.3.8T1 <i>Content</i> | | |
| 30.3.8T1 Description of Control levels | | 30.3.9T3 | <p>Application of the various system development aids</p> <ul style="list-style-type: none"> • use hardware and software development aids |
| <ul style="list-style-type: none"> i) Instruction sequencing ii) instruction interpretation iii) hard wire control iv) C.P.U. control unit | | | |
| 30.3.8T2 Explanation of Micro – programmed Controller | | | |
| <ul style="list-style-type: none"> i) Micro-programmed control | | | |

| | | |
|---|-----------|---|
| <i>Suggested teaching/Learning Activities</i> | 30.3.10 | MICROPROCESSOR FAULTY DIAGNOSIS |
| <ul style="list-style-type: none"> - Discussion - Illustration - Visits to industries | | Theory |
| <i>Suggested teaching/Learning Resources</i> | 30.3.10T0 | <i>Specific Objectives</i> |
| <ul style="list-style-type: none"> - Programmable Logic controller - Computers | | <p>By the end of the sub-module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) identify faults in microprocessor systems b) describe operation of fault finding equipment c) explain methods of fault location in microprocessor systems |
| <i>Suggested Evaluation Methods</i> | 30.3.10T1 | <i>Content</i> |
| <ul style="list-style-type: none"> - Oral tests - Timed written tests - Assignments - Timed practical tests | | <p>Identification of Faults</p> <ul style="list-style-type: none"> i) Timing ii) Earthing iii) Noise iv) Contact bounce v) Races vi) Constructional Faults vii) Wire wrap viii) Printed circuit board (PCB) ix) Internal & external faults |
| 30.3.10 MICROPROCESSOR APPLICATIONS | 30.3.10T2 | <i>Content</i> |
| Theory | | <p>Fault Finding Equipment</p> <ul style="list-style-type: none"> i) Logic probes ii) Current tracer iii) Cathode ray oscilloscope (CRO) iv) Logic comparator v) Logic pulser vi) Logic analyser vii) Signature analyser viii) Bench mark tests ix) Automatic test equipment |
| 30.3.10T0 Specific Objectives | | |
| <p>By the end of the sub-module unit, the trainee should be able to apply the microprocessor to solve various industrial problems</p> | | |
| <i>Content</i> | | |
| <p>30.3.10T1 Application of the microprocessor in</p> <ul style="list-style-type: none"> i) Traffic lights ii) Weighing machines iii) Level control iv) Timing etc. | | |

- x) ROM test programs
- xi) RAM test programs
- xii) Fault location assignments
- Timed written tests
- Assignments
- Timed practical tests

30.3.10T3 Fault Finding methods

Practice

30.3.10P0 *Specific Objectives*

By the end of the sub-module unit, the trainee should be able to:

- a) identify fault finding equipments using microprocessor systems
- b) perform fault tracing and repair in microprocessor systems

Content

30.3.10P1 Fault finding equipments

30.3.10P2 Fault tracing and repair

30.3.10C Competence

The trainee should have the ability to: trouble shoot and repair faults in microprocessor systems

Suggested teaching/Learning

Activities

- Discussion
- Illustration
- Visits to industries

Suggested teaching/Learning

Resources

- Programmable Logic controller
- Computers
- Microprocessor unit

Suggested Evaluation Methods

- Oral tests

**31.3.0 ESTIMATING, TENDERING AND ENGINEERING
SERVICES CONTRACTS**

31.3.01 Introduction
This module unit is designed to equip the trainee with knowledge, skills and attitudes necessary to understand the concept of contracting, estimating and tendering for a project, administration and execution of contract works. Knowledge of electrical installation and electrical installation design is a prerequisite to this module unit.

31.3.02 General Objectives
At the end the module unit, the trainee should be able to:
a) Discuss the legal requirements for contracts and their effects.
b) Outline the estimating and tendering process.
c) Understand principles of contracting.
d) Appreciate the need for having a structured administration of contract works
e) Apply standards and rules applicable to specific contracts.
f) Manage a construction site

31.3.03 Module Unit Summary and Time Allocation

**Estimating, Tendering and Engineering
Services Contract**

| Code | Sub Module Unit | Content | Time Hrs |
|-------------|------------------------|---|-----------------|
| 31.3.1 | Law | <ul style="list-style-type: none">• Sources of law• Law of contract• Law of tort | 10 |
| 31.3.2 | Contracts | <ul style="list-style-type: none">• Types of contracts• Contracts documents• Clauses in the documents• Important clauses in contract documents | 12 |
| 31.3.3 | Estimating | <ul style="list-style-type: none">• Methods of measurement for electrical works• Extraction of information from documents• Labour elements in an estimate• Overhead costs elements | 8 |

| | | | |
|-------------------|---------------------------------|--|-----------|
| 31.3.4 | Tendering | <ul style="list-style-type: none"> • The tendering process • Types of tenders | 10 |
| 31.3.5 | Supplies of Materials | <ul style="list-style-type: none"> • Materials, scheduling and programmes • Cash and trade discounts | 8 |
| 31.3.6 | Works Planning and Control | <ul style="list-style-type: none"> • Bar charts • CPA networks | 8 |
| 31.3.7 | Site control and Administration | <ul style="list-style-type: none"> • Work measurement procedures • Site meetings preparations • Conducting site meetings • Site meeting documentation and document storage | 10 |
| Total Time | | | 66 |

| | | |
|----------|---|--|
| 31.3.1 | LAW | |
| | Theory | |
| 31.3.1T0 | <i>Specific Objectives</i> | |
| | <p>By the end of the sub-module unit, the trainee should able to:</p> <ul style="list-style-type: none"> a) explain sources of law b) explain law of contracts c) explain law of tort | |
| | <i>Content</i> | |
| 31.3.1T1 | Sources of law | |
| | <ul style="list-style-type: none"> i) Common law ii) Custom iii) Judicial precedent iv) Legislation v) Equity | |
| 31.3.1T2 | Law of contracts | |
| | <ul style="list-style-type: none"> i) Formation of contract ii) Nature and essentials of a valid contract iii) Capacities of the parties to enter into a contract. iv) Interpretation and proof of contracts v) Discharge of contracts the remedies for breach of contract vi) Sales of goods act, as applicable to contract work vii) Position between empor and vendor viii) Need for: ix) Construction of contract x) Content of contract xi) Issue and respect of instructions | |
| 31.3.1T3 | The law of tort | |
| | <ul style="list-style-type: none"> - Nature - Nuisance - Trespass - Negligence - Vicarious liability and liability for sub-contracts | |
| 31.3.1C | Competence | |
| | <p>The trainee should have the ability to: apply various types of laws in life in electrical contracts jobs</p> | |
| | <i>Suggested teaching/Learning Activities</i> | |
| | <ul style="list-style-type: none"> - Discussion - Demonstration - Note taking | |
| | <i>Suggested teaching/Learning Resources</i> | |
| | <ul style="list-style-type: none"> - The law of Kenya | |
| | <i>Suggested Evaluation Methods</i> | |
| | <ul style="list-style-type: none"> - Oral tests - Timed written tests - Assignments | |

| 31.3.2 CONTRACTS | | Relevant Recognized professional body. |
|-------------------------|---|--|
| | Theory | 31.3.2T4 |
| 31.3.2T0 | <p><i>Specific Objectives</i></p> <p>By the end of the sub-module unit, the trainee should able to:</p> <ul style="list-style-type: none"> a) explain types of contracts b) describe various contract documents c) explain contract clauses d) explain important clauses in the contract documents | <p>Important Contract clauses</p> <ul style="list-style-type: none"> i) Obligation inherent in the contract ii) Commencement of work iii) Extension of time iv) Disturbance of progress v) Variations vi) Claims vii) Certificates viii) Final certificates ix) completion |
| | <i>Content</i> | 31.3.2C Competence |
| 31.3.2T1 | <p>Types of contract</p> <ul style="list-style-type: none"> i) Lump sum ii) BOQ iii) Package deal iv) Cost reimbursement | <p>The trainee should have the ability to: engage into electrical contractual jobs</p> |
| 31.3.2T3 | <p>Contract documents</p> <ul style="list-style-type: none"> i) Agreement and schedule of conditions of building contract sanctioned by Relevant recognized professional bodies. ii) Agreement and schedule of conditions of building (without quantities) sanctioned by relevant recognized professional bodies. iii) Agreement and schedule of conditions of building sub-contract sanctioned by | <p><i>Suggested teaching/Learning Activities</i></p> <ul style="list-style-type: none"> - Discussion - Demonstration - Note taking <p><i>Suggested teaching/Learning Resources</i></p> <ul style="list-style-type: none"> - The law of Kenya - Sample contractual documents <p><i>Suggested Evaluation Methods</i></p> <ul style="list-style-type: none"> - Oral tests - Timed written tests - Assignments |

| | | |
|----------------|---|---|
| 31.3.3 | ESTIMATING | contracts for labour, materials and payment. |
| Theory | | |
| 31.3.3T0 | <i>Specific Objectives</i> | <p>By the end of the sub - module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) describe the methods of measurement and estimating for electrical engineering work b) explain methods of extracting quantities from enquiry documents c) explain the significance of labour and material elements in the build-up of an estimate d) describe the methods of assessing all support resources in order to calculate overhead costs e) describe other methods of responding to enquiries and meeting respective instructions |
| <i>Content</i> | | |
| 31.3.3T1 | Methods of measurement and estimation for electrical engineering | <p>i) Need for careful examinations of drawings, specifications, bills of quantities and forms of contract</p> <p>ii) The liabilities of accepting onerous conditions in sub-</p> |
| 31.3.3T2 | Methods of extracting quantities from enquiry documents | <p>i) Processes of taking off quantities of materials and labour abstracting and billing, using drawings and specifications</p> <p>ii) Importance of examining a bill of quantities against relevant design and enquiry documents</p> <p>iii) Construction and description of a simple form of estimate</p> <p>iv) Comparison of standard forms of estimate sheet in commercial use</p> |
| 31.3.3T3 | Significance of labour and material elements in the build-up of an estimate | <p>i) Factors affecting the allocation of labour</p> <p>ii) Methods of calculating labour input to carry out work in a specified time</p> |

| | | |
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| | <ul style="list-style-type: none"> iii) Methods of allocating labour to an estimate iv) Possible constraints in labour allocation v) Methods of calculating an average labour team, for estimating purposes, and limitation of this method vi) Calculate day work rates from given data vii) Methods and condition of material purchases viii) Examples of typical application of discounts ix) Methods of dealing with preliminaries | <ul style="list-style-type: none"> i) Take off electrical materials from electrical design drawings ii) Estimate the cost of an electrical installation |
| 31.3.3T4 | <p>Methods of assessing all support resources in order to calculate overhead costs</p> <ul style="list-style-type: none"> i) List and explain office overheads ii) List and explain site overheads iii) assessment of overheads iv) Allocation of overheads to the estimate | <p><i>Suggested teaching/Learning Activities</i></p> <ul style="list-style-type: none"> - Discussion - Demonstration - Note taking <p><i>Suggested teaching/Learning Resources</i></p> <ul style="list-style-type: none"> - Take off sheets - Electrical installation designs |
| 31.3.3T5 | <p>Description of other methods of responding to enquiries and meeting respective instructions;</p> <ul style="list-style-type: none"> i) Simple estimate and order ii) Cost plus iii) Day-work iv) Damage | <p><i>Suggested Evaluation Methods</i></p> <ul style="list-style-type: none"> - Oral tests - Timed written tests - Assignments - Practical material take off and preparation of bill of quantities |
| 31.3.3C | <p>Competence The trainee should have the ability to:</p> | <h3>31.3.4T0 TENDERING</h3> <p>Theory</p> <p>31.3.4T0 <i>Specific Objectives</i> By the end of the sub-module unit the trainee should able to:</p> <ul style="list-style-type: none"> a) explain tendering process. b) explain types of tendering <p>Content</p> <p>31.3.4T1 Tendering process</p> <ul style="list-style-type: none"> i) Invitation to tender ii) Compilation of tender documents iii) Acceptance of tenders |

| | | |
|----------|---|---|
| | <ul style="list-style-type: none"> iv) Compilation of approved tender v) Tender box vi) Advantages vii) Disadvantages | |
| 31.3.4T2 | <p>Types of tendering</p> <p>open</p> <ul style="list-style-type: none"> i) Competitive ii) Selective iii) Negotiated contracts iv) Package deals | <ul style="list-style-type: none"> a) explain the procedure for material schedules and programmes ordering and associated documentation b) explain cash and trade discounts |
| 31.3.4C | Competence The trainee should have the ability to: <ul style="list-style-type: none"> i) Interpret tender documents ii) Tender for a job | <i>Content</i> |
| 31.3.5T1 | Procedure for preparation of material schedules and programmes for ordering | <ul style="list-style-type: none"> i) Procedure for preparation of material schedules ii) Supply procedure iii) Quotations iv) Purchase orders v) Delivery notes vi) Invoices vii) Debit and credit notes viii) Statements of account ix) Specifications x) Bill of quantities and schedule of rates xi) Responsibility for xii) Breakages xiii) Defects |
| | <i>Suggested teaching/Learning Activities</i> | 31.3.5T2 Cash and trade discounts |
| | <ul style="list-style-type: none"> - Discussion - Demonstration - Note taking | 31.3.5C Competence The trainee should have the ability to: order materials using the right procedure |
| 31.3.5 | SUPPLIES OF MATERIALS | <i>Suggested teaching/Learning Resources</i> |
| | Theory | <ul style="list-style-type: none"> - Oral tests - Timed written tests - Assignments - Practical tendering work |
| 31.3.5T0 | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should able to: | <i>Suggested teaching/Learning Resources</i> |

- Sample materials supply documents
- i) Explain procedure for maintaining records of variation

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments

31.3.6T0 WORKS PLANNING & CONTROL

Theory

31.3.6T0 Specific Objectives

By the end of the sub-module unit the trainee should able to prepare a programme of works

- ii) Explain procedure for preparation of day work sheets
- iii) Describe procedure for measuring work on site including assessment of percentage completion
- iv) Explain the use of site measurement in the above for determination of valuations and variations

31.3.7T2 Procedures for site meetings

- i) The convener of site meetings
- ii) Notification
- iii) The parties that should attend site meetings

31.3.6T1 Content

- Programme of works
- i) Bar charts
 - ii) CPA networks

31.3.7T3 Meeting procedures

31.3.7T4 Site meeting documentation

31.3.7 SITE CONTROL AND ADMINISTRATION

Theory

31.3.7T0 Specific Objectives

By the end of the sub-module unit, the trainee should able to:

- a) explain the procedures for site measurement
- b) explain the procedures for site meetings preparation
- c) conduct site meeting
- d) appropriately document and store site documents

31.3.7C Competence

The trainee should have the ability to: manage a site

Suggested teaching/Learning Activities

- Discussion
- Demonstration
- Note taking
- Field visits
- Role play on site meeting

Suggested teaching/Learning Resources

- Construction sites
- Sample site meetings minutes
- Work measurement sample sheets and records

Content

- 31.3.7T1 procedures for site measurement

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Practical tendering work

32.3.0 TRADE PROJECT

32.3.01 Introduction

The module unit is designed to enable the trainee apply theory, practical competence and knowledge gained in the training institutions, industrial attachment and the informal training to produce high quality, reliable and functional products and research reports.

The project should be based on the trade area and may take one or more of the following forms:

- a) Design and construction
- b) Investigation in a course related subject
- c) Institutional or industrial based research

The trainee will work independently but under the supervision of her/ his trainers. The time allocated to this unit is for the purpose of trainee-trainer contact during consultations, monitoring and evaluation. Trainees will need to commit adequate time to the project in order to gain the necessary skills and also meet the objectives of the Module unit.

32.3.02 General Objectives

At the end of this module unit, the trainee should be able to:

- a) Gather technical information diligently
- b) Design an item in the trade area taking into consideration preferred design methods
- c) Construct the designed with industrial quality finesse
- d) Carry out investigations or research work diligently
- e) Compile a project report
- f) Write technical reports clearly with correct interpretation of initial objectives

32.3.03 Module Unit Summary and Time Allocation

Trade Project

| Code | Sub-Module Unit | Content | Time Hrs |
|-------------|------------------------|--|-----------------|
| 32.3.1 | Technical Information | <ul style="list-style-type: none">• Sources of technical information• Gathering procedures | 6 |
| 32.3.2 | Design | <ul style="list-style-type: none">• Design procedures• Design aids• Design methods | 4 |

| | | | |
|--------------|-------------------------------------|---|-----------|
| 32.3.3 | Construction | <ul style="list-style-type: none"> • Construction considerations • Construction tools • Product finishes | 12 |
| 32.3.4 | Investigation and Research Projects | <ul style="list-style-type: none"> • Investigation and research | 8 |
| 32.3.5 | Compilation of Project Report | <ul style="list-style-type: none"> • Compilation of project report | 6 |
| 32.3.6 | Technical Reports | <ul style="list-style-type: none"> • Layout of technical report • Preparation of technical reports | 8 |
| Total | | | 44 |

| | | |
|----------------|---|---|
| 32.3.1 | TECHNICAL INFORMATION | <p><i>Suggested teaching/Learning Resources</i></p> <ul style="list-style-type: none"> - Books - Magazines - Technical journals - Manuals, catalogues and application data sheets - Industrial and research reports |
| | Theory | |
| 32.3.1T0 | <i>Specific Objectives</i> | <p>By the end of the sub-module unit, the trainee should be able to:</p> <ul style="list-style-type: none"> a) discuss sources of technical information b) describe procedures for gathering technical information |
| | <i>Content</i> | |
| 32.3.1T1 | Sources of technical information | <p>32.3.2</p> <p><i>DESIGN</i></p> <p>Theory</p> |
| | i) Books | <p>32.3.2T0</p> <p><i>Specific Objectives</i></p> <p>By the end of the sub-module unit, the trainee should be able to:</p> |
| | ii) Magazines | <ul style="list-style-type: none"> a) use proper design procedures to develop a product design b) use design aids c) apply preferred methods for design |
| | iii) Technical journals | <p><i>Content</i></p> <p>32.3.2T1</p> <p>Design development</p> |
| | iv) Manuals, catalogues and application data sheets | <ul style="list-style-type: none"> i) Objectives of design ii) Specifications iii) Block diagram iv) Block schematic diagrams v) Circuit diagrams vi) Wiring diagrams vii) Calculated and preferred values of components viii) Special considerations ix) Cost |
| | v) Industrial and research institutions | |
| | vi) Consultations | |
| 32.3.1T2 | Gathering procedures | |
| | i) Note taking | |
| | ii) Photocopying | |
| | iii) Reading | |
| | iv) Video and photo shooting | |
| 32.3.1C | Competence | |
| | The trainee should have the ability to: identify sources of information | |
| | <i>Suggested teaching/Learning Activities</i> | |
| | - Discussion | |
| | - Illustration | |
| | - Note taking | |

| | | |
|----------|-------------------------------------|---|
| | x) Operational manual | b) use correct tools for the construction |
| 32.3.2T2 | Design aids | c) make a high quality stem finish |
| | i) Theoretical knowledge of subject | |
| | ii) Suitable computer packages | |

| | |
|----------|--------------------------|
| 32.3.2T3 | Preferred methods |
| | i) Module arrangement |
| | ii) Assembly arrangement |

32.3.2C Competence

The trainee should have the ability to: come up with a product design

Suggested teaching/Learning Activities

- Discussion
- Illustration
- Note taking
- Practice on design

Suggested teaching/Learning Resources

- Sample designs
- Sample projects

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Project

32.3 CONSTRUCTION

Practice

| | |
|----------|---|
| 32.3.3P0 | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: |
| | a) make correct construction considerations for a given design |

| | |
|----------|---|
| 32.3.3P1 | <i>Content</i> Construction considerations |
| | i) Choice of materials |
| | ii) Layout of components, modules assembly and controls |
| | iii) Wiring |
| | iv) Interconnection |
| | v) Production of printed circuit boards (PCB's) |
| | vi) Step by step construction |
| | vii) Testing and test points |
| | viii) Calibration |
| | ix) Reliability |

| | |
|----------|--|
| 32.3.3P2 | x) Construction of devices e.g. coils, transformers, casings etc |
| | xii) Labeling |
| | Construction tools |
| | i) Tools used for the construction |
| | ii) Proper use of tools |
| | iii) Instruments |

| | |
|----------|----------------------|
| 32.3.3P3 | Finishes |
| | i) PCB's |
| | ii) Assembly |
| | iii) Wiring |
| | iv) Mechanical parts |
| | iv) Casing |
| | v) Labeling |

32.3.3C Competence

The trainee should have the ability to: construct a functional electrical/mechanical item

Suggested teaching/Learning Activities

- Discussion
- Illustration
- Note taking
- Practice on design

Suggested teaching/Learning Resources

- Sample designs
- Sample projects

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Project

32.3.4 INVESTIGATION AND RESEARCH PROJECT

Practice

32.3.4P0 *Specific Objective*
By the end of the sub module unit, the trainee should be able to explain investigation and research procedures.

Content

32.3.4P1 Investigation and research

- i) Objectives
- ii) Information and data gathering
- iii) Procedures
- iv) Presentation
- v) Findings
- vi) Conclusions

32.3.4C Competence

The trainee should have the ability to: undertake investigative and research projects

Suggested teaching/Learning Activities

- Discussion
- Illustration
- Data collection
- Data analysis

Suggested teaching/Learning Resources

- Sample project reports

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Projects

32.3.5 COMPIRATION OF PROJECT REPORT

Practice

32.3.5P0 *Specific Objective*
By the end of the sub-module unit, the trainee should be able to compile a project report

Content

32.3.5P1 Compilation of Project Report

| | | |
|----------------|--|--|
| | | <ul style="list-style-type: none"> - Sample trade projects |
| 32.3.6 | TECHNICAL REPORTS | <i>Suggested Evaluation Methods</i> |
| | Practice | <ul style="list-style-type: none"> - Oral tests - Timed written tests - Assignments - Projects |
| 32.3.6P0 | <i>Specific Objectives</i> | |
| | By the end of the sub-module unit, the trainee should be able to: | |
| | <ul style="list-style-type: none"> a) outline the layout of a technical report b) write a good technical report | |
| | <i>Content</i> | |
| 32.3.6P1 | Layout of technical report | |
| | <ul style="list-style-type: none"> i) Subject title ii) Objectives iii) Specifications iv) Background information v) Resources vi) Design / findings vii) Conclusions / recommendations | |
| 32.3.6P2 | Presentation | |
| | <ul style="list-style-type: none"> i) Flow of ideas ii) Content iii) Communication iv) Appearance of written work | |
| 32.3.6C | Competence | |
| | The trainee should have the ability to: | |
| | <ul style="list-style-type: none"> i) Write technical reports ii) Compile a project report iii) Construct a trade related project | |
| | <i>Suggested Teaching/learning Resources</i> | |
| | <ul style="list-style-type: none"> - Sample project reports - Sample technical reports | |

33.3.0

ELECTROMAGNETIC FIELDS THEORY

33.3.01

Introduction

The module unit is designed to impart knowledge skills and attitudes necessary to understand the application of electromagnetic fields in practical situations and in general design of electrical, magnetic and electromagnetic circuits

33.3.02

General Objectives

At the end of the module unit, the trainee should be able to;

- a) Analyse the concepts of electromagnetic field theory
- b) Appreciate the need for electromagnetic field theory in electrical and magnetic circuits
- c) Apply electromagnetic fields theory in solving electromagnetic circuits

33.3.03

Module Unit Summary and Time Allocation

Electromagnetic Fields Theory

| Code | Sub-Module Unit | Content | Time Hrs |
|-------------|---------------------------------------|---|-----------------|
| 33.3.1 | Introduction to Electromagnetic Waves | <ul style="list-style-type: none">• Sources of Electromagnetic radiation• Electromagnetic Detectors• Application of electromagnetic waves | 2 |
| 33.3.2 | Electrodynamics | <ul style="list-style-type: none">• Terms used in electrostatics• Electric field about an infinitely long line• Terms used in Magnetostatics• Magnetic field about an infinitely long line | 8 |
| 33.3.3 | Maxwell's Equation | <ul style="list-style-type: none">• Maxwell's equation• Instantaneous vector equations• Properties of electromagnetic waves• Displacement current density | 12 |
| 33.3.4 | Properties Of Electromagnetic Waves | <ul style="list-style-type: none">• Electromagnetic waves terms• Properties of an electromagnetic wave• Properties of an electromagnetic wave in various media• Electromagnetic Shielding | 10 |

| | | | |
|-------------------|--|--|-----------|
| | | <ul style="list-style-type: none"> • Skin Effect of electromagnetic waves | |
| 33.3.5 | Energy and Momentum in the Electromagnetic Field | <ul style="list-style-type: none"> • The Energy Conservation Theorem - Poyntings' Theorem • Momentum Flux • Electromagnetic Energy Flow | 12 |
| Total Time | | | 44 |

| | | |
|----------|--|--|
| 33.3.1 | INTRODUCTION TO ELECTRO -MAGNETIC WAVES | electromagnetic wavelengths |
| | Theory | <i>Content</i> |
| 33.3.1T0 | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: a) explain sources of electromagnetic radiation b) analyse the detectors used in electromagnetic radiations c) explain the application of electromagnetic waves | 33.3.1P1 Electromagnetic radiation i) Long wave lengths ii) Visible light iii) Short wavelengths 33.3.1P2 Determination of electromagnetic wavelengths - Photometric/radiometric detection |
| 33.3.1T1 | <i>Content</i> Sources of Electromagnetic radiation i) Long wavelengths ii) Visible light iii) Short wavelengths | 33.3.2 ELECTRODYNAMICS |
| 33.3.1T2 | Detectors of Electromagnetic radiation radiations | Theory |
| 33.3.1T3 | Applications of electromagnetic waves | 33.3.2T0 <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: a) explain terms used in electrostatics b) analyse the electric field intensity about an infinitely long line c) explain terms used in magnetostatics d) analyse the magnetic field intensity about an infinitely long line |
| | Practice | <i>Content</i> |
| 33.3.1P0 | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: a) determine electromagnetic radiation b) use detectors to determine | 33.3.2T1 Terms used in electrostatics i) Electric field Intensity , E ii) Electric flux ψ iii) Electric flux density, D 33.3.2T2 Electric field about an infinitely long line using i) Coulombs Law ii) Gauss' Law |

| | | |
|-----------------|--|--|
| 33.3.2T3 | Terms used in Magnetostatics i) Magnetic field strength, B ii) Magnetic flux density, H iii) Magnetic flux, Φ | 33.3.2P3 Verification of the Laws associated with magnetic field intensity i) Ampere circuit Law ii) Biot Savart law iii) Faraday's law |
| 33.3.2T4 | Magnetic field about an infinitely long line using i) Ampere's circuit law ii) Biot-Savart Law iii) Faraday's Law | 33.3.2P4 Verification of laws associated with electric field intensity i) Coulombs law ii) Gauss law |
| 33.3.2T5 | Faraday's Law and its significance in time varying magnetic field | 33.3.3 MAXWELL'S EQUATION |
| Practice | | Theory |
| 33.3.2P0 | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: a) Measure magnetic circuit parameters b) Plot the B-H curve and hence draw the Hysteresis loop c) Verify the laws associated with magnetic field intensity about infinitely long line d) Verify the laws associated with electric field intensity about an infinitely long line | 33.3.3T0 <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: a) describe Maxwell's equations in differential and integral forms b) analyse the Maxwell's equations to derive the instantaneous vector field theorem c) explain the properties of electromagnetic waves d) describe the displacement current density of parallel plate capacity |

| | <i>Content</i> | <i>Content</i> |
|----------|--|--|
| 33.3.2P1 | Measurement of magnetic circuit parameters | 33.3.3T1 Maxwell's equations i) Gauss' law for the electric field |
| 33.3.2P2 | Determination of B-H curve i) The Hysteresis Loop - Reversal method - Step by step method | ii) Gauss' law for the magnetic field iii) Ampere' law iv) Faraday's law |

| | | | | |
|--|----------|--|----------|--|
| | 33.3.3T2 | analyses of Maxwell's equation to derive the instantaneous vector equation | 33.3.4 | PROPERTIES OF ELECTROMAGNETIC WAVES |
| | | - Instantaneous vector equation | | Theory |
| | 33.3.3T3 | Properties of electromagnetic waves | 33.3.4T0 | <i>Specific Objectives</i> |
| | | i) Propagation constant Γ | | By the end of the sub-module unit the trainee should be able to: |
| | | ii) Attenuation constant α | a) | explain terms used in Electromagnetic waves |
| | 33.3.3T4 | Displacement current density of parallel plate capacitors | b) | describe Properties of an electromagnetic waves |
| | | - Phase constant β | c) | analyse the properties of electromagnetic waves in various media |
| | | | d) | explain the principles of Electromagnetic Shielding |
| | | | e) | describe the skin effect in electromagnetic waves |
| | | Practice | | Content |
| | 33.3.3P0 | <i>Specific Objectives</i> | 33.3.4T1 | Terms used in Electromagnetic waves |
| | | By the end of the sub-module unit, the trainee should be able to: | i) | Plane waves |
| | | a) Verify the Maxwell's equation | ii) | Transverse electromagnetic (TEM) wave |
| | | b) Apply the Maxwell's equation to determine the instantaneous vector field theorems | iii) | Skin depth |
| | | | 33.3.4T2 | Properties of an electromagnetic wave |
| | | | i) | Velocity of propagation, |
| | 33.3.3P1 | Content | ii) | Intrinsic wave impedance |
| | | Verification of Maxwell's equation | iii) | Frequency |
| | | i) Gauss's laws for electric and magnetic fields | iv) | Wavelength, |
| | | ii) Amperes law | v) | Attenuation, |
| | | iii) Faraday's law | 33.3.4T3 | Wave Characteristics in various media |
| | 33.3.3P2 | Determination of instantaneous vector field theorems | i) | Lossy Media |
| | | i) Maxwell's equation | ii) | Lossless Media |
| | | ii) Poyting's vector theorem | iii) | Free Space |
| | | | iv) | Good Conductors |

| | | | |
|---------------|--|---------|--|
| 33.3.4T4 | Principles of electromagnetic shielding | 33.3.5C | Competence The trainee should have the ability to: |
| 33.3.4T5 | Skin Effect | i) | Measure magnetic circuit parameters |
| 33.3.4T6 | Poynting's theorem and the Poynting's vector | ii) | Plot the B-H curve and determine characteristic of magnetic materials by studying the hysteresis loop. |
| 33.3.5 | ENERGY AND MOMENTUM IN THE ELECTROMAGNETIC FIELD | iii) | Use detectors to determine various wavelengths |
| | Theory | iv) | Apply vector field theorems to analyse wave propagation |
| 33.3.5T0 | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: | | <i>Suggested teaching/Learning Activities</i> |
| | a) describe the Energy Conservation Theorem | - | Discussion |
| | b) describe momentum flux | - | Illustration |
| | c) determine the electromagnetic energy flow | - | Demonstration |
| | | - | Note taking |
| | | - | Practical exercise |
| | | - | Calculations |
| | <i>Content</i> | | <i>Suggested teaching/Learning Resources</i> |
| 33.3.5T1 | The Energy Conservation Theorem - Poyntings' Theorem i) Ohmic Heating ii) Electric field Energy Density iii) Magnetostatic Field Energy Density | | - Spectrum analysers - Cathode Ray Oscilloscope - Detectors |
| 33.3.5T2 | Magnetostatic Momentum Flux | | |
| 33.3.5T3 | Electromagnetic Energy Flow i) Energy Flow into a Resistive Wire ii) Energy Flow out of Battery iii) Propagation of Energy along a Wire | | <i>Suggested Evaluation Methods</i> |
| | | - | Oral tests |
| | | - | Timed written tests |
| | | - | Assignments |
| | | - | Timed practical tests |

34.3.0 MACHINES AND UTILIZATION**34.3.01 Introduction**

The module unit is designed to equip the trainee with knowledge, skills and attitudes necessary to understand machine design, construction, installation, maintenance and their applications.

34.3.02 General Objectives

At the end of this Module Unit, the trainee should be able to:

- a) Understand the principles of operation of various electric machine
- b) Maintain and repair electrical machines and machine controls
- c) Install electrical machines
- d) Observe safety standards when installing electric machines
- e) Analyse electrical machine systems
- f) Select and use/recommend ac and dc Machines for various purposes
- g) Understand the concepts of refrigeration and air conditioning
- h) Outline the operational principles of electric traction

34.3.03 Module Unit Summary and Time Allocation**Machines and Utilization**

| Code | Sub-Module Unit | Content | Time |
|--------|-------------------------|---|------|
| 34.3.1 | Induction Machines | <ul style="list-style-type: none">• Construction of induction motors• Equivalent circuit for induction motors• Operation• Circle diagram• Speed control• Application | 14 |
| 34.3.2 | Synchronous Machines | <ul style="list-style-type: none">• Construction• Equivalent circuit• Operation• Circle diagram• Applications | 14 |
| 34.3.3 | Direct Current Machines | <ul style="list-style-type: none">• Construction• Operation• Speed control• Application | 10 |

| | | | |
|-------------------|------------------------------------|---|-----------|
| 34.3.4 | Special Machines | <ul style="list-style-type: none"> • Types • Construction • Operation | 12 |
| 34.3.5 | Electric Drives | <ul style="list-style-type: none"> • Choice of motor • Heating and cooling curves • Power rating • Application | 12 |
| 34.3.6 | Refrigeration And Air-conditioning | <ul style="list-style-type: none"> • Operation • Construction • Layout of plant | 14 |
| 34.3.7 | Electric Traction | <ul style="list-style-type: none"> • Introduction • Mechanics of train movement • Starting and speed control • Braking • Construction control and distribution systems | 12 |
| Total Time | | | 88 |

| | | | |
|-----------------|---|-----------------|--|
| 34.3.1 | INDUCTION MACHINES | 34.3.1T3 | Description of the operation of the induction machines <ul style="list-style-type: none"> i) Phasor diagrams at: ii) No load iii) On-load iv) Primary and secondary v) Derive expressions for machine parameters vi) Torque vii) Current viii) Output power ix) Slip x) Power factor |
| 34.3.1T0 | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: | 34.3.1T4 | Explanation of the application of the circle diagram <ul style="list-style-type: none"> i) Locus diagrams ii) Open-circuit current iii) Iron and copper losses iv) Air gap power v) Mechanical power output vi) Electrical torque vii) Rotor current viii) Characteristics ix) Torque/slips characteristics x) Acceleration, deceleration and stopping times |
| 34.3.1T1 | <i>Content</i> Description of the construction of induction machines <ul style="list-style-type: none"> i) Stator ii) Rotor | 34.3.1T5 | Description of the speed control methods of the induction machines <ul style="list-style-type: none"> i) Frequency variation ii) Pole changing iii) Voltage variation iv) Cascade connection |
| 34.3.1T2 | Analysis of an equivalent circuit diagram <ul style="list-style-type: none"> i) Ideal equivalent circuit ii) Equivalent circuit at no-load iii) Equivalent circuit at load | 34.3.1T6 | Application of induction machines |
| | | | Practice |
| | | 34.3.1T0 | <i>Specific Objectives</i> |

- By the end of the sub-module unit, the trainee should be able to:
- connect and measure torque of an induction machine
 - measure speed of an induction machine
 - perform tests to plot circle diagrams
 - connect and measure the efficiency of induction machines
 - apply various methods to control the speed of an induction machine

- Interpret measurement to determine induction machine equivalent circuit
- Determine efficiency of induction machines

Teaching / Learning Resources

- Induction machines
- Measuring instruments
- Connecting cables

Suggested teaching/Learning Activities

- Discussion
- Illustration
- Demonstration
- Note taking
- Practical exercise
- Calculations

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

34.3.2 SYNCHRONOUS MACHINES

Theory

34.3.2T0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- describe the construction of synchronous machine
- analyse the equivalent circuit of the synchronous machine
- explain the operation of synchronous machine connected to an infinite busbar

| <i>Content</i> | |
|----------------|---|
| 34.3.1P1 | Connection and measurement of torque |
| 34.3.1P2 | Measurement of speed of an induction machine |
| 34.3.1P3 | Testing of induction machine to plot the circle diagram |
| 34.3.1P4 | connection and measure of the efficiency of the induction machine |
| 34.3.1P5 | Application of various methods to control the speed of induction machine <ul style="list-style-type: none"> i) Frequency variation ii) Voltage variation iii) Cascade connection |

| 34.3.1C | Competence |
|----------------|---|
| | The trainee should have the ability to: |
| | i) Control induction motor speeds ii) Apply circle diagram parameters to obtain induction machine output characteristics |

- d) describe the application of circle diagram to determine machine parameters
 - e) state the application of the synchronous machine
- 34.3.2T5 x) Machine characteristics
Starting the application of the synchronous machine
- i) Constant speed drivers
 - ii) Power factor correction

Content

- 34.3.2T1 Description of the construction of the synchronous machine
- i) Field windings
 - ii) Armature windings
 - iii) Salient and cylindrical motors
- 34.3.2T2 Analysis of the equivalent circuit of synchronous machine
- i) Ideal equivalent circuit
 - ii) Equivalent circuit at no-load
 - iii) Equivalent circuit at load
- 34.3.2T3 Describe the operation of the synchronous machine connected to
- i) Infinite bus-bars
 - ii) Connection to bus-bars
 - iii) Synchronizing
 - iv) Switching
- 34.3.2T4 Application of circle diagram to derive operation parameters
- i) Locus diagrams
 - ii) Open circuit current
 - iii) Iron and copper losses
 - iv) Air gap power
 - v) Air gap power
 - vi) Mechanical power output
 - vii) Electric torque
 - viii) Rotor torque
 - ix) Rotor current

Practice

- 34.3.2P0 *Specific Objectives*
By the end of the sub-module unit, the trainee should be able to:
- a) connect synchronous machines using various starting methods
 - b) synchronise the machine for parallel operation
 - c) connect the machine for power factor correction and determination of V-curves
 - d) locate faults in machines

Content

- 34.3.2P1 Connection of synchronous machines using various starting machines
- i) Induction motor
- 34.3.2P2 Synchronization of machine for parallel operation
- ii) Lamps dark method
 - iii) Lamps bright method
 - iv) Synchroscope
- 34.3.2P3 Connection of the machine for power factor correction and determination of the V-curves

| | | |
|-----------------|--|--|
| | i) Synchronous phase modifier ii) Plot of V-curves | 34.3.3 DIRECT CURRENT MACHINES |
| 34.3.2P4 | Location of faults in synchronous machines i) Open circuit ii) Short circuit iii) Earth fault iv) Phase failure | Theory |
| 34.3.2C | Competence The trainee should have the ability to ability to: i) Synchronise machines to infinite bus-bars ii) Operate synchronous machines in parallel iii) Locate faults and perform repair iv) Run synchronous machines | 34.3.3T0 Specific Objectives By the end of the sub-module unit, the trainee should be able to: a) describe the construction of the synchronous machine b) explain the operation of the synchronous machine c) describe the speed control methods used in DC machines d) state the application of dc machines |
| | <i>Suggested Teaching / Learning resources</i> | <i>Content</i> |
| | - Lamps - Synchronous machines - Teaching aids - Measuring instruments | 34.3.3T1 Description of the construction of the synchronous machine i) Armature ii) Field iii) Commutator iv) Shaft and bearings v) Orientation of the field with respect to brushes |
| | <i>Suggested teaching/Learning Activities</i> | 34.3.3T2 Explanation of the operation of synchronous machine i) Derivation of the machine parameters ii) E.m.f. equation iii) Power equation iv) Torque equation v) Analysis of circuits vi) Field circuit vii) Armature current viii) Characteristics ix) E.m.f / speed x) Torque/speed |
| | <i>Suggested Evaluation Methods</i> | |
| | - Oral tests - Timed written tests - Assignments - Timed practical tests | |

| | | |
|----------|--|---|
| | xii) Magnetization curves | e) correct dc machines for speed control |
| 34.3. T3 | Explanation of speed control | |
| | i) General speed equation | 34.3.3P1 Drawing and connecting of dc machines for starting |
| | ii) Base speed control | i) Manual starting methods |
| | iii) SCR speed control | ii) Automatic starting methods |
| | iv) Dynamic behaviours during speed adjustment | 34.3.3P2 Connection of different types of dc machines |
| | v) Armature control | i) Series |
| | vi) Shunt field control | ii) Shunt |
| | vii) Precautions when increasing speed through field weakening | iii) Compound |
| | viii) Speed changes should be made slowly to avoid damage to commutators and brushes | 34.3.3P3 Measuring of the parameters of dc machines |
| 34.3.3T4 | Application of dc machines | i) Effect of Armature inductance on commutation |
| | | ii) Mechanical power and developed torque |
| | | iii) Losses and efficiency |
| | | iv) Torque / speed characteristics |
| | | v) Field current and armature current |
| 34.3.3P0 | Practice | 34.3.3P4 Connection of dc machines for braking |
| | <i>Specific Objectives</i> | Regenerative braking |
| | By the end of the sub-module unit, the trainee should be able to: | vi) Equipment for braking |
| | a) draw circuit diagrams for starting dc machines and demonstrate the connection of starters | 34.3.3P5 Connection of dc machines for speed control |
| | b) connect different types of dc machines | i) Rheostatic control |
| | c) measure the parameters of dc machines to plot machine characteristics | ii) Thyristor control |
| | d) connect dc machines for braking | iii) Ward Leonard speed control |

34.3.3C Competence
The trainee should have the ability to:

- i) Connect and operate dc machines

- ii) Measure and interpret dc machine parameters for particular application
 - iii) Test dc machines to ascertain operational status
 - iv) Determine losses and calculate efficiency for given dc machines
 - v) Perform braking
 - vi) operations for dc machines
- b) describe the construction of the special machines
- c) explain the principles of operation of special machines

Teaching / learning Resources

- i) Dc machines (series, shunt and compound)
- ii) Measuring instruments
- iii) Starters
- iv) Rheostats
- v) Ward Leonard dc/ac motors
- vi) motors

Suggested teaching/Learning Activities

- Discussion
- Illustration
- Demonstration
- Note taking
- Practical exercise
- Calculations

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

34.3.4 SPECIAL MACHINES

Theory

- 34.3.4T0 Specific Objectives**
 By the end of the sub-module unit, the trainee should be able to:
- a) identify the types of special machines

- 34.3.4T1 Content**
 Identification of the types of special machines
- i) Reluctance motors
 - ii) Hysteresis motors
 - iii) Stepper motors
 - iv) Stepper motors
 - v) Variable-reluctance stepper motor
 - vi) Linear induction motor
 - vii) Universal motor
 - viii) Universal motor
- 34.3.4T2 Content**
 Description of the construction of special machines
- i) Rotor limitations
 - ii) Permanent magnet alloy material
 - iii) Non-magnetic supports
 - iv) Toothed stator
 - v) Toothed rotor
 - vi) Stator
- 34.3.4T3 Content**
 Principles of operation of special machines
- i) Reluctance motors
 - ii) Hysteresis motors
 - iii) Stepper motors
 - iv) Variable – reluctance stepper motor
 - v) Linear induction motor
 - vi) Universal motor

| | | |
|----------|---|---|
| | Practice | Special machines i) Routine maintenance ii) Locate faults diagnose and repair iii) Test motor for operation |
| 34.3.4P0 | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: a) operate the types of special machines b) draw the construction details of special machines c) perform experiments to verify the characteristics of the special machines d) maintain special machines | 34.3.4C Competence The trainee should be ability to apply special machines in production systems |
| 34.3.4P1 | <i>Content</i> Operation of the types special machines i) Reluctance motors ii) Hysteresis motors iii) Stepper motors iv) Variable – reactance stepper motors v) Linear induction motor vi) Universal | <i>Suggested Teaching / Learning Resources</i> - Different types of laboratory simulators - Measuring instruments |
| 34.3.4P2 | Drawing the constructional details of special machines i) Reluctance motors ii) Hysteresis motors iii) Stepper motors iv) Variable – reactance stepper motors v) Linear induction motors vi) Universal motor | <i>Suggested teaching/Learning Activities</i> - Discussion - Illustration - Demonstration - Note taking - Practical exercise |
| 34.3.4P3 | Experiments to verify the characteristic of special machines | <i>Suggested Evaluation Methods</i> - Oral tests - Timed written tests - Assignments - Timed practical tests |
| 34.3.4P4 | Maintenance of | 34.3.5 ELECTRIC DRIVES Theory |
| 34.3.5T0 | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: a) explain the factors that affect the choice of motor for a particular drive | |

| | | |
|----------|---|--|
| | b) explain the application of various drives c) derive the expressions for the heating and cooling curves d) explain the motor power rating | types of electric drives b) connect motor enclosures |
| | | <i>Content</i> |
| 34.3.5T1 | Explanation of the factors that affect the choice of motor for a particular drive i) Supply available iii) Load characteristics iv) Cost v) Efficiency vi) Enclosure vii) Braking | 34.3.5P1 Dismantling and assembling different types of electric drives i) Linear ii) Rotary |
| 34.3.5T2 | Explanation of the application of various motor drives i) Individual drives ii) Group drives | 34.3.5P2 Connection of motor enclosures i) Open type ii) Totally enclosed iii) Air cooled iv) Water cooled |
| 34.3.5T3 | Derivation of the expressions for the heating and cooling curves i) Heating curves ii) Cooling curves | <i>Suggested teaching/Learning Activities</i> - Discussion - Illustration - Demonstration - Note taking - Practical exercise |
| 34.3.5T4 | Explanation of power rating i) Continuous rating ii) Intermediate rating | <i>Suggested Evaluation Methods</i> - Oral tests - Timed written tests - Assignments - Timed practical tests |
| | Practice | 34.3.6 REFRIGERATION AND AIR CONDITIONING |
| 34.3.5P0 | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: a) dismantle and assemble different | Theory 34.3.6T0 Specific Objectives By the end of the sub-module unit, the trainee should be able to: a) explain the principle of operation of the refrigeration and air conditioning |

| | | |
|----------|--|--|
| | b) describe the construction of the refrigeration and air conditioning units c) state common refrigerants d) describe the layout of typical refrigeration and air conditioning plant | should be able install, test, trouble shoot and repair refrigeration and air conditioning plants |
| | | <i>Content</i> 34.3.6P1 Installation, testing, trouble shooting and repair refrigeration and air conditioning plants |
| 34.3.6T1 | <i>Content</i> Principles of operation of: i) Air conditioning and refrigeration ii) Refrigeration cycle iii) insulating materials iv) Refrigeration load v) Refrigeration capacity control vi) Air – circulation vii) Control of temperature and humidity viii) Humidification ix) Temperature and humidity transducers x) Psychrometry mixtures | <i>Suggested teaching/Learning Activities</i> <ul style="list-style-type: none">- Discussion- Illustration- Demonstration- Note taking- Practical exercise |
| 34.3.6T2 | Description of the of refrigeration and air conditioning units i) Compressors ii) Condensers iii) Evaporators iv) Valves v) Transducers | <i>Suggested Evaluation Methods</i> <ul style="list-style-type: none">- Oral tests- Timed written tests- Assignments- Timed practical tests |
| 34.3.6T4 | Refrigeration and air conditioning plants layout i) Use of block diagrams ii) Use of layout drawings | 34.3.7 ELECTRIC TRACTION Theory 34.3.7T0 Specific Objectives By the end of the sub-module unit, the trainee should be able to: <ul style="list-style-type: none">a) explain the fundamental concepts of the electric tractionb) analyse the mechanics of train movementc) outline the starting and speed control systems of traction motors |
| | Practice | |
| 34.3.6P0 | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee | |

- d) explain the principles of braking of electric traction
- e) describe the construction, control and distribution of traction systems
- Content*
- 34.3.7T1 Fundamental concepts of the electric traction
- i) Systems of operation for Tram cars, Trolley buses comparison of tramways, trolley buses, steam and diesel railway system
 - ii) Methods of supplying power to railway train's
 - Overhead systems
 - Conductor rail systems
 - Dc systems
 - Ac single phase and ac three-phase systems
- 34.3.7T2 Analysis of the mechanics of train movement
- i) Speed-time curves for urban, suburban and main line service trains
 - ii) Energy required for propulsion
 - iii) Tractive forces for acceleration, gravitational effect and resistance to motion
 - iv) Total tractive effort for propulsion of train
- 34.3.7T3 Outlining the starting and speed control systems of electric traction
- i) Series – parallel
 - ii) Double – series – parallel
 - iii) Control of series motors
 - iv) Accomplishing control by shunt transition and bridge transition
- 34.3.7T4 Explanation of the principles of braking of electric traction
- i) Regenerative braking with three-phase motors, and single phase motors
 - ii) Equipment for braking
- 34.3.7T5 Construction, control and distribution of traction systems
- i) Control and auxiliary equipment
 - ii) Contractors, relays, circuit breakers
 - iii) Starting resistors, compressors, exhausters
 - iv) Train heating overhead and conductor rail collection systems
 - v) Overhead construction
 - vi) Trolley wires
 - vii) Support for trolley wires
 - viii) Construction at curves
 - ix) Special fittings and poles
 - x) Feeding and distribution systems
 - xi) Traction distribution systems
 - xii) Length of trolley wire between feeding points, feeders
 - xiii) Negative feeding and distributing systems

Practice

34.3.7P0 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- a) simulate train movements
- b) perform experiments to indicate starting and speed control systems of electric traction

Content

34.3.7P1 Simulation of train movements

- i) Propulsion
- ii) Braking
- iii) Acceleration

34.3.7P2 Performing experiments to indicate starting and speed control systems

- i) Series – parallel
- ii) Double-series-parallel
- iii) Control of series motors
- iv) Control by shunt transition
- v) Control by bridge transition

34.3.7C Competence

The trainee should have the ability to:

- i) Simulate train movements
- ii) Start and control speed of traction drives

Suggested Teaching / Learning Resources

- Simulators for electric traction
- Measuring instruments

Suggested teaching/Learning Activities

- Discussion
- Illustration
- Demonstration
- Note taking
- Practical exercise

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

35.3.0

ELECTRICAL POWER TRANSMISSION SYSTEMS

35.3.01

Introduction

The module unit is designed to equip the trainee with knowledge, skills and attitudes to install and maintain power transmission lines. The unit covers in-depth analyses of transmission lines, conductor faults and line protection.

35.3.02

General Objectives

At the end of the module unit, the trainee should be able to:

- a) Design electrical overhead transmission schemes
- b) Understand the operating principles of transmission and distribution units
- c) Observe safety and standards when operating transmission lines
- d) Design power systems regulation schemes
- e) Interpret control systems charts in power generating and transmission systems

35.3.03

Module Unit Summary and Time Allocation

Power Systems II

| Code | Sub Module Unit | Content | Time Hrs |
|-------------|----------------------------|---|-----------------|
| 35.3.1 | Protection | <ul style="list-style-type: none">• Protection schemes• Relaying systems• Unit protection• Non unit protection | 16 |
| 35.3.2 | Overhead Line Construction | <ul style="list-style-type: none">• Conductor vibrations• Conductor tension and sag• Corona• Synchronous phase modifier | 18 |
| 35.3.3 | Overhead Line Transmission | <ul style="list-style-type: none">• Classification of lines• Surge• Surge power and energy• Protection against surges | 16 |
| 35.3.4 | Overhead Lines Faults | <ul style="list-style-type: none">• Symmetrical and asymmetrical faults• Equivalent circuits and phase sequence impendence matrix• Equivalent circuit for | 18 |

| | | | |
|--------|------------------------|---|-----------|
| | | asymmetrical faults | |
| 35.3.5 | Power System Stability | <ul style="list-style-type: none"> • Stability of asynchronous machine feeding infinite bus bars • Steady state stability • Surge angle • Methods of improving power system stability | 20 |
| | Total Time | | 88 |

35.3.1 PROTECTION

| | | Theory | Practice |
|----------|--|---------------|--|
| 35.3.1T0 | <i>Specific Objectives</i> By the end of the sub module unit, the trainee should be able to: a) describe the systems of protective schemes b) explain the types of relaying systems c) explain the type of unit protection d) describe the types of non unit protection | 35.3.1P0 | <i>Specific Objectives</i> By the end of the sub module unit, the trainee should be able to: a) Perform tests to show the tripping characteristics of different protective devices b) Demonstrate the working of different types of protection relays |
| | <i>Content</i> | | <i>Content</i> |
| 35.3.1T1 | Protective schemes i) Core balance protective schemes ii) Merze price protective schemes iii) Pilot iv) Pilotless | 35.3.1P1 | Performance tests for the tripping characteristics of protective devices i) High Rupturing Capacity fuse (HRC) ii) Miniature Circuit Breakers (MCB) |
| 35.3.1T2 | Types of relaying systems i) Permanent magnet moving coil ii) Balanced beam iii) Induction type over current relay iv) Distance relays v) Directional relays vi) Non directional relays vii) Solid state relays | 35.3.1P2 | Demonstration of the working of different types of relays i) Distance ii) Directional iii) Non directional |
| 35.3.1T3 | Types of unit protection i) Generator protection ii) Transformer protection iii) Bus bars protection iv) Feeder protection | 35.3.1C | Competence The trainee should have the ability to control power lines in transmission systems to maintain |
| 35.3.1T4 | Non unit protection i) Directional over current protection ii) Distance protection iii) Grade time protection | | <i>Suggested teaching/Learning Activities</i> - Discussion - Illustration - Demonstration - Note taking |

- Practical exercise continuity of supply

Suggested teaching /learning resources

- i) Assorted relays
- ii) Cabling and accessories
- iii) Test board
- iv) Measuring instruments

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

35.3.2 OVER HEAD LINE CONSTRUCTION

Theory

35.3.2T Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) explain the types of conductor vibrations
- b) differentiate between types of conductors sag and tension
- c) describe the corona phenomena in overhead transmission lines
- d) explain the principles of the operation of the synchronous phase modifiers

Content

35.3.2T1 Types of conductor vibrations

- i) Swinging
- ii) Dancing

- iii) Galloping of conductors
- iv) High frequency vibrations

35.3.2T2 Differentiation of conductor sag and Tension

- i) Catenary methods
- ii) Unequal and equal ground level
- iii) Effects of wind and ice loading

35.3.2T3 Description of the corona phenomena

- i) Disruptive
- ii) Visible
- iii) Critical

35.3.2T74 Explaining the principles of operator of the synchronous phase modifier

- i) lagging and leading VARs
- ii) Voltage drop compensation

Practice

35.3.2P0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) install different types of model transmission lines using different materials
- b) perform experiments to demonstrate conductor sag

Content

35.3.2P4 Experiments to demonstrate conductor sag

| | |
|--|--|
| 35.3.2C Competence The trainee should have the ability to install, test and maintain overhead line poles and conductors | <i>Content</i> |
| <i>Suggested teaching/Learning Activities</i> | 35.3.3T1 Classification of transmission lines <ul style="list-style-type: none"> i) Short lines ii) Medium lines iii) Long line |
| <i>Suggested Teaching/Learning Resources</i> | 35.3.3T2 Types of surges in transmission lines <ul style="list-style-type: none"> i) Direct and indirect lightning strokes ii) Switching surges due to iii) Open circuited lines iv) Short circuited lines v) Load interruption vi) Arching ground lines |
| <i>Suggested Evaluation Methods</i> | 35.3.3T3 Explanation of the phenomena of surges in transmission line systems <ul style="list-style-type: none"> i) Surge velocity ii) Surge impendence iii) Open circuited lines iv) Short circuited lines |
| 35.3.3 OVERHEAD LINE TRANSMISSION | 35.3.3T4 Protection of transmission lines against surges effect and over currents <ul style="list-style-type: none"> i) Overhead earth wire ii) Horn gaps iii) Silicon and zinc oxide surge diverter iv) Peterson coil |
| Theory | Practice |
| 35.3.3T0 Specific Objectives By the end of the sub module unit, the trainee should be able to: | 35.3.3P0 Specific Objectives By the end of the sub module unit, the trainee should be able to protect overhead lines against the phenomenon of surge |
| <ul style="list-style-type: none"> a) classify transmission lines b) explain the causes for surges in transmission lines c) explain the phenomena of surges in transmission lines systems d) describe the protection of surges against over voltages | <ul style="list-style-type: none"> <i>Content</i> 35.3.3P1 Protection of overhead lines against surges <ul style="list-style-type: none"> i) Overhead earth wire |

- ii) Horn gaps
- iii) Silicon and Zinc oxide surge diverter
- iv) Peterson coil
- c) outline the equivalent circuit for the asymmetrical faults
- d) explain the operation of the equivalent circuit and phase sequence impedance matrix

35.3.3C Competence

The trainee should have the ability to install surge diverters to prevent the surge effects

Suggested Teaching/ Learning resources

- Protective devices
- Insulators
- Visits to industries

Suggested teaching/Learning Activities

- Discussion
- Illustration
- Demonstration
- Note taking
- Practical exercise

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

35.3.4 OVERHEAD LINE FAULTS

Theory

35.3.4T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) explain types of power line faults
- b) describe the symmetrical and asymmetrical faults

Content

35.3.4T1 Types of power line faults

- i) Single phase earth faults
- ii) Three phase balanced fault
- iii) Line to line ground fault
- iv) Line to line fault
- v) Arching ground fault

35.3.4T2 Description of symmetrical and asymmetrical faults

- i) Balanced faults
- ii) Unbalanced faults
- iii) Positive, negative and zero sequence vectors
- iv) Impedance connection matrix for faults

35.3.4T3 The equivalent circuit for the asymmetrical faults

35.3.4T4 Operation of the equivalent circuit and phase sequence impedance matrix

Practice

35.3.4P0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) draw equivalent circuits for the phase sequence matrix
- b) simulate equivalent circuit and determine the sequence impedance matrix

- c) verify through experiment the difference between
- d) symmetrical and asymmetrical faults

Content

- 35.3.4P1 Equivalent circuit for phase sequence matrix
- 35.3.4P2 Circuit simulation
- 35.3.4P3 Symmetrical and asymmetrical faults verification

35.3.4C Competence

The trainee should have the ability to:

- Determine line faults for symmetrical and asymmetrical conductors
- Simulate faults and apply them to determine protective devices ratings

Teaching /Learning resources

- Experimental models for fault levels
- Measuring instruments

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

35.3.5 POWER SYSTEM STABILITY

Theory

35.3.5T0 Specific Objectives

By the end of the sub module unit, the trainee should be able to:

- a) describe the stability of the synchronous generator feeding infinite bus bars
- b) derive the equal area criteria for transient stability
- c) derive the swing equation
- d) describe the method for improving power system stability

Content

- 35.3.5T1 Description of synchronous generators stability
 - Power transfer regulation
- 35.3.5T2 Derivation of equal area criteria
 - i) Change in load
 - ii) Change in transfer reactance due to switching
 - iii) Change in transfer reactance due to fault
- 35.3.5T3 Derivation of the swing equation
 - Load angle/time curve
- 35.3.5T4 Description of methods of improving system stability
 - Turbine governor
 - Automatic voltage regulations

Practice

- 35.3.5P0 *Specific Objectives*
 - By the end of the sub module unit, the trainee should be able to:

- a) connect the synchronous machine to adjust to infinite bus bars
- b) set the synchronous machine to adjust excitation

Content

- 35.3.5P1 Connection of synchronous machine to infinite bus bars
 - i) Syncro -scope
 - ii) Lamps dark method
 - iii) Lamps bright method
- 35.3.5P2 Setting of the synchronous machine to adjust excitation system:
 - i) Leading power factor
 - ii) Lagging power factor

35.3.5C Competence

The trainee should have the ability to connect test and run synchronous machine to infinite bus bars

Suggested Teaching/Learning Resources

- Synchro - scope
- Generating machine
- Lamps
- Accessories

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests

36.3.0 POWER ELECTRONICS

36.3.01 Introduction

This module unit is designed to equip the trainee with appropriate knowledge, skills and attitudes necessary for the design, fabrication and maintenance of the power electronic systems and equipment.

36.3.02 General Objectives

At the end of the module unit, the trainee should be able to;

- a) Understand the operation and performance characteristics of power electronic devices.
- b) Explain the applications of power electronic devices
- c) Describe the operation of converters
- d) Understand the operation of Inverters
- e) Analyze the ac voltage controllers
- f) Apply the principles of power controls in electrical machines and equipment

36.3.03 Module Unit Summary and Time Allocation

Power Electronics

| Code | Sub Module Unit | Content | Time Hours |
|-------------|------------------------------|---|-------------------|
| 36.3.1 | Power semi-conductor devices | <ul style="list-style-type: none">• Construction and Operation, of special semi conductor devices• Analyses of semiconductor devices• Application of special semi conductor devices | 10 |
| 36.3.2 | Rectifier circuits | <ul style="list-style-type: none">• Rectifier circuits• Calculations related to rectifiers circuit• Controlled rectification techniques• Phase shift circuits• Calculations related to phase shift circuits for power control• Converter operation• Dc line commutation• Applications of controlled rectifier system | 10 |
| 36.3.3 | Cyclo-converters | <ul style="list-style-type: none">• Operation | 12 |

| | | | |
|-------------------|--|---|-----------|
| | | Principles of Cyclo-converters <ul style="list-style-type: none"> • Operation of Single phase to single phase circuit • Operation of Three phase half-wave Cyclo-converter • Operation of Load Commutated Cyclo converters • Envelope Cyclo-converter Operation • Applications of Cyclo-converters | |
| 36.3.4 | Inverters | <ul style="list-style-type: none"> • Single phase inverters • Forced commutated thyristor inverters • Three phase bridge inverters • Pulse-width Modulated Inverters • Current source inverters • Series Inverters • Parallel inverters • Steady state inverter output voltage • Applications of inverters | 12 |
| 36.3.5 | Electric drives | <ul style="list-style-type: none"> • Dc motor drives. • Dc motor control circuits • Dc motor speed controller • Ac machine drives • Ac motor controls • Motor control systems | 12 |
| 36.3.6 | High frequency power sources and heating | <ul style="list-style-type: none"> • High frequency power source • Induction heating process • Di electric heating process • Operation of resistance heating process • Eddy current heating process • Solar heating systems | 10 |
| Total time | | | 66 |

- 36.3.1 POWER SEMI-CONDUCTOR DEVICES**
- Theory**
- 36.3.1T0 Specific Objectives**
By the end of this module unit the trainee should be able to;
- explain the construction, operation and characteristics of various types of special semi conductor devices
 - analyze power electronic circuits
 - describe the applications of power semiconductor devices.

- classify the power electronic and special semiconductor devices
- design a voltage regulator
- analyze the characteristics of the power electronic devices
- apply power electronic devices in electrical and electronic circuits

- Content**
- 36.3.1T1** Construction, operation, characteristic and applications
- SCR
 - Diac
 - Triac
 - power transistors
 - power MOSFET
 - insulated gate bipolar transistor
 - MOS controlled thyristors
 - SCR
 - GTO
 - other thyristor devices

Practice

- 36.3.1P0 Specific Objectives**
By the end of the sub-module unit the trainee should be able to:

- Content**
- 36.3.1P1** Power Electronic devices
- UJT
 - SCR
 - DIAC
 - Power Transistors
- 36.3.1P2** The voltage regulator
- 36.3.1P3** Characteristics of power electronic devices
- 36.3.1P4** Applications of power electronic devices

- 36.3.1C Competence**
The trainee should have the ability to:
- classify the electronic semiconductor devices
 - design and fabricate a Voltage regulator

Suggested teaching/Learning Activities

- Discussion
- Illustration
- Demonstration
- Note taking
- Practical exercise
- Calculations
- Project work

Suggested Teaching and Learning Resources

- Relevant text books

| | | |
|--|----------|--------------------------------------|
| - Assortment of power electronic devices | 36.3.2T1 | <i>Content</i> |
| - Connecting leads | | Rectifier circuits |
| - Strip boards | | i) Single phase half wave rectifiers |
| - CRO | | - Uncontrolled |
| - Signal Analyzer | | - Fully controlled |

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests
- Project

36.3.2 RECTIFIER CIRCUITS

Theory

36.3.2 T0 Specific Objectives

By the end of the sub-module, the trainee should be able to;

- a) describe operation of rectifier circuits.
- b) solve problems related to rectifier circuits.
- c) explain controlled rectification techniques.
- d) describe phase shift circuits for power control
- e) solve problems on phase shift circuits for power controls.
- f) explain converter operation.
- g) solve problems on converter operation.
- h) explain dc line commutation.
- i) illustrate the applications of controlled rectifier system.

| | |
|----------|--|
| 36.3.2T1 | <i>Content</i> |
| | Rectifier circuits |
| | i) Single phase half wave rectifiers |
| | - Uncontrolled |
| | - Fully controlled |
| | - Half controlled |
| | - Bi-phase half wave rectifier |
| | - Single phase bridge rectifier |
| | ii) Three phase half wave rectifier |
| | iii) Twelve pulse circuits |
| | iv) Choice of transformer in rectification |
| | v) Single phase two pulse converters with discontinuous load current |
| | vi) full converter |
| | vii) semi-converter |
| | viii) Dual converters |
| | ix) Converters' Power Factor |
| | x) Regulation of Converters |
| | xi) Inversion |
| | xii) P-pulse equation |
| 36.3.2T2 | Calculations related to rectifiers circuit |
| 36.3.2T3 | Controlled rectification |
| 36.3.2T4 | Phase shift circuits |
| 36.3.2T5 | Calculations related to phase shift circuits for power control |
| 36.3.2T6 | Converter operation |
| 36.3.2T7 | Dc line commutation |
| 36.3.2T8 | Applications of controlled rectifier system |

Practice

36.3.2P0 Specific Objectives

By the end of the module unit the trainee should be able to:

- a) test the outputs from converters
- b) design a converter system
- c) fabricate a converter system

Content

36.3.2P2 Single phase half wave rectifiers

- i) Uncontrolled
- ii) Fully controlled
- iii) Half controlled

36.3.2P3 Bi-phase half wave rectifier

36.3.2P4 Single phase bridge rectifier

36.3.2P5 Three phase half wave rectifier

36.3.2C Competence

The trainee should have the ability to:

- test the converter circuits
- fabricate converter circuits

Suggested teaching/Learning

Activities

- Discussion
- Illustration
- Demonstration
- Note taking
- Practical exercise
- Project work

Suggested Teaching and Learning Resources

- Relevant text Books
- Assorted rectifier devices
- Strip boards
- Assorted Fabrication Accessories
- CRO
- Signal Analyzers

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests
- Project

36.3.3 CYCLO-CONVERTERS

Theory

36.3.3T0 Specific Objectives

By the end of the sub-module, the trainee should be able to:

- a) describe the operation of the Cyclo-converter.
- b) solve problems on single phase to single phase rectifier circuits.
- c) Explain the operation of three phase -half wave cyclo converters
- d) Explain the operation of load commutated cyclo converters
- e) Explain the operation of envelop cyclo converter operation
- f) Identify applications of cyclo converters

Content

36.3.3T1 Operation

| | | |
|----------|--|--|
| | principles of Cyclo-converters | a) analyze the outputs of cyclo-converter signals |
| | i) Block to group operation | b) design and fabricate a cyclo-converter system |
| | ii) Circulating current mode | c) install a cyclo-converter system |
| | iii) Cyclo-converters in Control | |
| 36.3.3T2 | Operation of Single phase to single phase circuit | <i>Content</i> |
| | i) Step down Cyclo-converter operation | 36.3.3P7 Single phase to single phase – step up |
| | ii) Midpoint Cyclo-converter | i) Midpoint Cyclo-converter |
| | iii) Bridge type Cyclo-converter | ii) Bridge type Cyclo-converter |
| | iv) Output voltage equations | iii) Output voltage equations |
| 36.3.3T3 | Operation of Three phase half-wave Cyclo-converter | 36.3.3T8 Three phase half-wave Cyclo-converter |
| | i) Three-phase to Single-phase Cyclo-converters | i) Three-phase to Single-phase Cyclo-converters |
| | ii) Three-phase to Three-phase Cyclo-converters | ii) Three-phase to Three-phase Cyclo-converters |
| | iii) Output Voltage equation | iii) Output Voltage equation |
| 36.3.3T4 | Operation of Load Commutated Cyclo-converters | |
| 36.3.3T5 | Envelope Cyclo-converter Operation | <i>Suggested teaching/Learning Activities</i> |
| 36.3.3T6 | The Applications of Cyclo-converters | <ul style="list-style-type: none"> - Discussion - Illustration - Demonstration - Note taking - Practical exercise - Project work |
| | Practice | |
| 36.3.3P0 | <i>Specific Objectives</i> | <i>Suggested Teaching/Learning Resources</i> |
| | By the end of the module unit the trainee should be able to: | <ul style="list-style-type: none"> - Relevant Text Books - Assorted Power Electronic Devises - Signal analyzer - Strip boards - Assorted materials ,tools and equipment |

36.3.3C Competence

| | | |
|----------|---|--|
| | The trainee should have the ability to: | <i>Content</i> |
| 36.3.4T1 | i) Analyze Cyclo-converter outputs ii) Design and construct a Cyclo-converter system | Operation principles of Single-phase Inverters <ul style="list-style-type: none"> i) Single-phase Bridge Inverters ii) Steady-state analysis of single-Phase Inverters iii) Fourier Analysis of Single-phase Inverters iv) Voltage control in single phase inverters |
| 36.3.4T2 | | Operation of Forced – commutated Thyristor Inverters <ul style="list-style-type: none"> i) Half-Bridge Inverters ii) Full-Bridge inverters |
| 36.3.4T3 | | Operation of three phase Bridge inverters <ul style="list-style-type: none"> i) Three phase 180 degree mode ii) Three phase 120degree mode |
| 36.3.4T4 | | Operation of pulse width modulated inverters <ul style="list-style-type: none"> i) Single-pulse modulation ii) Multiple-pulse modulation iii) Sinusoidal-pulse modulation |
| 36.3.4T5 | | Operation of current Source inverters <ul style="list-style-type: none"> i) Single phase CSI with ideal switches ii) Single phase-capacitor commutated CSI with R load iii) Single phase Auto-sequential commutated inverters |
| 36.3.4T6 | | Operation of Series inverters <ul style="list-style-type: none"> i) Basic Series inverters |

| | | |
|----------|--|---|
| | <ul style="list-style-type: none"> ii) Analysis of Series Inverters | <ul style="list-style-type: none"> i) Single-pulse modulation |
| 36.3.4T7 | <ul style="list-style-type: none"> Operation of Parallel inverters - Analysis of Parallel Inverters | <ul style="list-style-type: none"> ii) Multiple-pulse modulation |
| 36.3.4T8 | <ul style="list-style-type: none"> steady state inverter output voltage - Reduction of Harmonics in the Inverters Voltage Output | <ul style="list-style-type: none"> iii) Sinusoidal-pulse modulation |
| 36.3.4T9 | Applications of inverters | <p>36.3.4P13 Current Source Inverters</p> <ul style="list-style-type: none"> i) Single phase CSI with ideal switches ii) Single phase-capacitor commutated CSI with R load iii) Project work |

Practice

| | |
|----------------|---|
| 36.3.4P0 | <i>Specific Objectives</i> By the end of the sub-module unit, the trainee should be able to: <ul style="list-style-type: none"> a) analyze the inverter output voltage b) design and construct an inverter system c) service and maintain an inverter system |
| <i>Content</i> | |

| | |
|-----------|--|
| 36.3.4P1 | Single-phase Bridge Inverters |
| | <ul style="list-style-type: none"> i) Steady-state analysis of single-Phase Inverters ii) Fourier Analysis of Single-phase Inverters iii) Voltage control in single phase inverters |
| 36.3.4P10 | Forced -commutated Thyristor Inverters |
| | <ul style="list-style-type: none"> i) Half-Bridge Inverters ii) Full-Bridge inverters |
| 36.3.4P11 | Three phase Bridge inverters mode |
| 36.3.4P12 | Pulse-width modulated inverters |

Suggested teaching/Learning Activities

- Discussion
- Illustration
- Demonstration
- Note taking
- Practical exercise
- Visits to industries

Suggested Teaching and Learning Resources

- Relevant Text books
- Assorted Power Electronic Devices
- Assorted tools and accessories
- Signal Analyzers

36.3.4C Competence

The trainee should have the ability to:

- i) Design and construct an inverter
- ii) Service and maintain an Inverter system

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments

- Timed practical tests
- Project
- viii) three-phase dual-converter drives

36.3.5 ELECTRIC DRIVES

Theory

36.3.5 Specific Objectives

By the end of the sub-module unit, the trainee should be able to:

- explain the operation of dc motor drives
- describe dc motor control systems
- analyze dc motor speed control circuits
- describe the operation of ac machine drives
- analyze the ac motor controls
- explain the applications of ac motor control systems

Content

- 36.3.5T1 Dc motor drive
- Operation and performance equations
 - single-phase half-wave converter drives
 - single-phase semi-converter drives
 - single-phase full-wave converter drives
 - three-phase half-wave converter drives
 - three-phase semi-converter drives
 - three-phase full-wave converter drives

- 36.3.5T2 A.c electric drive
- Operation and performance
 - Synchronous Machines
 - Cage Induction Motors
 - Slip-ring Induction Motors
- 36.3.5T3 DC motor speed controls
- traction drives
 - control feedbacks\
 - chopper drive controls
- 36.3.5T4 Ac machines speed controls
- Motor speed control by voltage regulation
 - Transformer tap changers
 - Cyclo-converter control
 - Reluctance and stepper motor drives
 - Constant voltage inverters control
 - Constant current controls
 - Transistorized inverter controls

Practice

- 36.3.5P0 Specific Objectives
- By the end of the sub-module unit, the trainee should be able to:
- operate motor controls
 - service motor control system
 - install motor control system

| | | |
|----------|--|---|
| | d) design a motor control system | By the end of the sub-module unit, the trainee should be able to: |
| | <i>Content</i> | |
| 36.3.5P5 | Dc Electric Drives | a) explain the operation of high frequency power source. |
| 36.3.5P6 | Ac Electric Drives | b) describe induction heating process. |
| 36.3.5P7 | Dc Motor Speed Controls | c) analyze dielectric heating process. |
| 36.3.5P8 | Ac motor Speed Controls | d) explain the operation of resistance heating process |
| 36.3.5C | Competence The trainee should have the ability to: i) Operate a motor control system ii) Design a motor control system iii) Install and maintain motor control system | e) describe eddy current heating process. f) explain the solar heating system |
| | <i>Content</i> | |
| 36.3.6T1 | Operation of high frequency power sources | |
| | | i) Thyratron ii) Magnetron iii) Klystron |
| 36.3.6T2 | Operation and design of Uninterruptable power sources | |
| | | i) UPS ii) PWM power supply iii) Transformer isolated switching mode power supply |
| 36.3.6T3 | Operation of high frequency heating systems | |
| | | i) Induction heating ii) Resistance heating iii) Eddy current heating iv) Dielectric heating |
| 36.3.6T4 | Solar Heating | |
| | Practice | |
| 36.3.6P0 | <i>Specific Objectives</i> | |
| | By the end of the sub-module unit, the trainee should be able to: | |
| 36.3.6 | <i>Specific Objectives</i> | |

- a) Maintain a High frequency heating device
- b) Design solar heater system
- c) Install and maintain solar heater system
- ii) Maintain high frequency heating system
- iii) Design and install UPS

Content

36.3.6P7 High Frequency power sources

36.3.6P8 Uninterruptable Power Sources

36.3.6P9 High Frequency heating

36.3.6P10 Solar Heating

36.3.6C Competence

The trainee should have the ability to:

- i) Install and maintain a Solar Heating system

Suggested Teaching and Learning Resources

- Relevant text books
- Solar Concentrators and accessories
- Assorted Power electronic components and devices

Suggested Evaluation Methods

- Oral tests
- Timed written tests
- Assignments
- Timed practical tests
- Project

TOOLS AND EQUIPMENT FOR THE COURSE

FOR 20 TRAINEES

| A | Measuring Instruments | QTY |
|----------|---|------------|
| 1. | Ac Ammeters Multirange | 15 |
| 2. | Ac Voltmeter | 15 |
| 3. | Cathode Ray Oscilloscope | 5 |
| 4. | Clip On Meters | 5 |
| 5. | Dc Ammeters | 15 |
| 6. | Dc Millimetres | 15 |
| 7. | Dc Voltmeters | 10 |
| 8. | Electrodynamics Wattmeter- Three Phase | 5 |
| 9. | Electrodynamics Wattmeter- Single Phase | 15 |
| 10. | Frequency meter | 5 |
| 11. | Galvanometers (Central Zero) | 10 |
| 12. | High Temperatures Thermometers | 5 |
| 13. | Insulation Resistance Tester | 5 |
| 14. | Line Earth Loop Impedance Tester | 5 |
| 15. | Multi Meters (Multirange) | 5 |
| 16. | Tachometers | 5 |
| 17. | Transformer Tester | 5 |

B Tools

| | | |
|----|---|---------------------|
| 1. | Allan Screw Set | 5 |
| 2. | Assorted Sizes And Types Of Pliers | 5 of each type/size |
| 3. | Assorted Types And Sizes Of Screw Drivers | 5 of each type/size |
| 4. | Bradawl | 10 |
| 5. | Brass Wood Mallet | 5 |
| 6. | Centre Punch | 5 |
| 7. | Chisels | 5 |
| 8. | Claw And Ball Type Hammers | 5 |

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| 9. Drill Gauge | 5 |
| 10. Electric Soldering Iron (various sizes) | 5 of each size |
| 11. Electrician Knife | 5 |
| 12. Electrician Tool Kit | 5 |
| 13. Fish Tape | 5 |
| 14. Framing Square | 5 |
| 15. Griping Tool | 5 |
| 16. Hacksaw Frames and Blades | 10 |
| 17. Hand Reamers | 10 |
| 18. Knock Out Punches | 10 |
| 19. Micrometer | 5 |
| 20. MIMS Cable Terminating Tools | 5 |
| 21. Nuts Driver Sets | 5 |
| 22. Phase Tester | 10 |
| 23. Pipe Bending Springs | 10 |
| 24. Pipe Cutter | 5 |
| 25. Pipe Pliers | 5 |
| 26. Pipe Stocks And Die | 10 sets |
| 27. Pipe Wrench | 10 |
| 28. Plumb Bobs | 5 |
| 29. Precision Screw Drivers (set) | 5 |
| 30. Prick Punches | 5 |
| 31. Scribes | 10 |
| 32. Side Cutting Tool | 10 |
| 33. Spirit Level | 10 |
| 34. Standard Wire Gauge | 5 |
| 35. Steel Measuring Tape -3m | 10 |
| 36. Tin Snips | 10 |
| 37. Try Square | 10 |
| 38. Various Type And Sizes Of Files | 10 each |
| 39. Vervier Callipers | 5 |

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| 40. Vice Grip Pliers | 5 |
| 41. Wire Strippers | 10 |

C Equipment

| | |
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| 1. Air conditioning units | 5 |
| 2. Audio Function generators | 5 |
| 3. Battery Charger | 1 set |
| 4. Bells 240 volts | 15 |
| 5. Bells 12 volts | 15 |
| 6. Bench Vices | 6 |
| 7. Blow Out Lamp | 5 |
| 8. Bread Boards | 21 |
| 9. Charge Controllers For Solar Systems | 5 |
| 10. Circuit breakers (various sizes) | 5 each |
| 11. Computers and computer peripherals(workstation) | 21 |
| 12. Conduit Benders | 5 |
| 13. Dc Power Supply Units | 6 |
| 14. Digital Counter | 5 |
| 15. Digital Function Generators | 5 |
| 16. Digital Trainer Kit | 6 |
| 17. Dish Reflectors - for Solar Harvesting | 1 |
| 18. Drawing Equipment | 21 |
| 19. Drill Press | 4 |
| 20. Electrical Consumer Control Unit | 5 |
| 21. Electrical Distribution Boards | 5 |
| 22. Electro traction simulators | 5 |
| 23. Electronic /Electrical Bell Indicator Boards | 5 each |
| 24. Electronic Tool Kit | 5 |
| 25. Fire Extinguishers | 5 |
| 26. First Aid Kit | 2 |
| 27. Flat Plate Collector | 1 |

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| 28. Fluorescent Fitting (various sizes) | 10 Of each |
| 29. Folding Vices(Both Portable And Bench Vices) | 10 |
| 30. Function/Arbitrary waveform generators | 5 |
| 31. Grinder | 2 |
| 32. Hand Drill | 5 |
| 33. HRC fuses (various sizes) | 10 of each |
| 34. KVA meter | 5 |
| 35. Lead acid cells | 5 |
| 36. Line insulators | 5 |
| 37. Microcontrollers trainer kit | 10 |
| 38. Microprocessor units | 10 |
| 39. Model Power Station | 2 |
| 40. Motor simulators | 10 |
| 41. Oxy acetylene gas equipment | 1 |
| 42. Panel mounted digital multimeter and calibrator | 5 |
| 43. Parabolic reflectors for solar harvesting | 2 |
| 44. PID process control trainer | 10 |
| 45. Pipe Vices | 5 |
| 46. PLC control interface panel for measurement of level | 5 |
| 47. Power Cut Out | 5 |
| 48. Power Transformers(Variacs) | 5 |
| 49. Programmable DC Electronic Loads | 5 |
| 50. Programmable DC Power Supplies | 5 |
| 51. Refrigerators | 2 |
| 52. Relays (various rating) | 20 each |
| 53. Shearing machines | 2 |
| 54. Solar batteries | 5 |
| 55. Solar concentrators | 5 |
| 56. Solar energy inverter | 5 |
| 57. Solar module | 5 |
| 58. Solar systems service kit | 5 |

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| 59. Solder sucker | 10 |
| 60. Surge diverters | 5 |
| 61. Syncroscope | 5 |
| 62. Used Electrical Appliances (enough) | |
| 63. Ward Leonard dc/ac motors | 5 |
| 64. X-Y Plotter | 5 |

D-1 Electrical Machines – Transformers

| | |
|---------------------------------|----|
| 1. Auto Transformers | 5 |
| 2. Bell Transformers (12v/240v) | 10 |
| 3. Current Transformers | 5 |
| 4. Power Transformers | 5 |
| 5. Variable Transformers | 5 |

D-2 Electrical Machines – Motors

| | |
|----------------------------------|---|
| 1. Capacitor Start – Run Motor | 5 |
| 2. Dc Compound Motor | 5 |
| 3. Dc Shunt Motor | 5 |
| 4. Repulsion Induction Motor | 5 |
| 5. Shaded Pole Motor | 5 |
| 6. Split Phase Motor | 5 |
| 7. Three Phase Induction Motor | 5 |
| 8. Three Phase Synchronous Motor | 5 |
| 9. Three Phase Wound Rotor Motor | 5 |
| 10. Universal Motor | 5 |

D-3 Electrical Machines – Generators

| | |
|------------------------------|---|
| 1. Ac Single Phase Generator | 5 |
| 2. Ac Three Phase Generator | 5 |
| 3. Dc Compound Generator | 5 |
| 4. Dc Series Generator | 5 |
| 5. Dc Shunt Generator | 5 |

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| 6. Diesel Generator | 2 |
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D-4 Motor Control Devices

| | |
|-----------------------------------|---------|
| 1. Auxiliary Hold On Devices | Enough |
| 2. Direct On Line Starter | 5 |
| 3. Face Plate Starter | 5 |
| 4. Magnetic Relays (240/415V) | 15 Each |
| 5. SCR Speed Controller | 5 |
| 6. Star Delta Starter | 5 |
| 7. Start -Stop Push Buttons | 5 |
| 8. Magnetic Contactors (240/415V) | 15 Each |