

**REPUBLIC OF KENYA**

**COMPETENCY-BASED MODULAR CURRICULUM**

**FOR**

**BIOMEDICAL ENGINEERING TECHNOLOGY**

**KNQF LEVEL 6**

**PROGRAMME** **ISCED CODE: 0914554A**

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**Council Secretary/CEO/Chief Principal**

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# FOREWORD

The provision of quality education and training is fundamental to the Government’s overall strategy for social and economic development. Quality education and training contribute to the achievement of Kenya’s development blueprint and sustainable development goals.

Reforms in the education sector are necessary to achieve Kenya Vision 2030 and meet the provisions of the Constitution of Kenya 2010. The education sector had to be aligned to the Constitution, and this resulted in the formulation of the Policy Framework for Reforming Education and Training in Kenya (Sessional Paper No. 14 of 2012). A key feature of this policy is the radical change in the design and delivery of TVET training. This policy document requires that training in TVET be competency-based, curriculum development be industry-led, certification be based on demonstration of competence, and the mode of delivery allow for multiple entry and exit in TVET programmes.

These reforms demand that Industry takes a leading role in curriculum development to ensure the curriculum addresses its competence needs. It is against this background that this curriculum has been developed. For trainees to build their skills on foundational hands-on activities of the occupation, units of learning are grouped in modules. This has eliminated duplication of content and streamlined exemptions based on skills acquired as a trainee progresses in the up-skilling process, while at the same time allowing trainees to be employable in the shortest time possible through the acquisition of part qualifications.

It is my conviction that this curriculum will play a great role in developing competent human resources for the Biomedical Engineering Sector’s growth and development.

**PRINCIPAL SECRETARY**

**STATE DEPARTMENT FOR TVET**

**MINISTRY OF EDUCATION**

# PREFACE

Kenya Vision 2030 aims to transform Kenya into a newly industrializing middle-income country, providing high-quality life to all its citizens by the year 2030. Kenya intends to create globally competitive and adaptive human resource base to meet the requirements of a rapidly industrializing economy through lifelong education and training. TVET has a responsibility to facilitate the process of inculcating knowledge, skills, and worker behaviour necessary for catapulting the nation to a globally competitive country, hence the paradigm shift to embrace Competency-Based Education and Training (CBET).

TVET Act 210A and Sessional Paper No. 1 of 2019 on Reforming Education and Training in Kenya for Sustainable Development emphasized the need to reform curriculum development, assessment, and certification. This called for a shift to CBET to address the mismatch between skills acquired through training and skills needed by industry, as well as increase the global competitiveness of the Kenyan labour force.

This curriculum has been developed in adherence to the Kenya National Qualifications Framework and CBETA standards and guidelines. The curriculum is designed and organized into Units of Learning with Learning Outcomes, suggested delivery methods, learning resources, and methods of assessing the trainee’s achievement. In addition, the units of learning have been grouped in modules to concretize the skills acquisition process and streamline upskilling.

I am grateful to all expert trainers and everyone who played a role in translating the Occupational Standards into this competency-based modular curriculum.

**Council Secretary/CEO/Chief Principal**

# ACKNOWLEDGEMENT

This curriculum has been designed for competency-based training and has independent units of learning that allow the trainee flexibility in entry and exit. In developing the curriculum, significant involvement and support were received from expert trainers, institutions and organizations.

I recognize with appreciation the role of the Biomedical Engineering National Sector Skills Committee (NSSC) in ensuring that competencies required by the industry are addressed in the curriculum. I also thank all stakeholders in the Biomedical engineering sector for their valuable input and everyone who participated in developing this curriculum.

I am convinced that this curriculum will go a long way in ensuring that individuals aspiring to work in the Biomedical Engineering Sector acquire competencies to perform their work more efficiently and effectively.

**Council Secretary/CEO/Chief Principal**

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# ABBREVIATIONS AND ACRONYMS

**CBET** Competency Based Education and Training

**ENT** Ear Nose and Throat

**CSSD** Central Sterile Supply Department

**ICU** Intensive Care Unit

**RO** Reverse Osmosis

**UV** Ultraviolet

# KEY TO ISCED UNIT CODE



# COURSE OVERVIEW

This biomedical engineering technology level 6 curriculum consists of competencies that an individual must have to perform biomedical equipment maintenance. It involves, performing maintenance of diagnostic and laboratory equipment I, diagnostic and laboratory equipment II, operation theatre equipment, dental equipment, maternity equipment, radiology and imaging equipment, ICU and renal equipment, ophthalmic and ENT equipment, physiotherapy and orthopaedic equipment, refrigeration and air conditioning equipment and hospital plant and building services I, hospital plant and building services maintenance II.

**SUMMARY OF UNITS OF LEARNING**

|  |  |  |  |
| --- | --- | --- | --- |
| **UNIT CODE** | **Units Title** | **Unit Duration (Hours))** | **Credit Factor** |
| **MODULE I** | | | |
| 0417541 03B | Work ethics and practices | 40 | 4 |
| 0541441 05A | Engineering technician mathematics I | 60 | 6 |
| 0713441 07A | Workshop practice | 70 | 7 |
| 0914441 08A | Human anatomy and physiology principles | 80 | 8 |
| 0715541 09A | Mechanical science principles | 80 | 8 |
| 0914551 21A | Refrigeration and air conditioning equipment | 120 | 12 |
| **MODULE II** | | | |
| 0611541 01B | Digital literacy | 40 | 4 |
| 0031541 02B | Communication skills | 40 | 4 |
| 0541441 06A | Engineering technician mathematics | 60 | 6 |
| 0713441 12A | Electrical principles I | 80 | 8 |
| 0914551 19A | Dental equipment | 90 | 9 |
| 0914551 22A | Hospital plant and building services I | 120 | 12 |
| **MODULE III** | | | |
| 0714441 10A | Analogue electronics I | 80 | 8 |
| 0713441 13A | Electrical principles II | 80 | 8 |
| 0732441 15A | Technical drawings I | 60 | 6 |
| 0914551 20A | Maternity equipment | 120 | 12 |
| 0914551 23A | Hospital plant and building services II | 120 | 12 |
| **MODULE IV** | | | |
| 0413541 04B | Entrepreneurial skills | 40 | 4 |
| 0714441 11A | Analogue electronics II | 70 | 7 |
| 0713441 14A | Electrical principles III | 80 | 8 |
| 0713441 16A | Technical drawing II | 70 | 7 |
| 0914451 17A | Diagnostic and laboratory equipment I | 80 | 8 |
| 0914451 18A | Operation theatre | 120 | 12 |
| **MODULE V** | | | |
| 0541541 07A | Engineering technician mathematics III | 80 | 8 |
| 0713541 18A | Electrical principles IV | 60 | 6 |
| 0914541 21A | Measurement and control | 120 | 12 |
| 0914541 33A | Ophthalmic and ENT equipment | 120 | 12 |
| 0914541 27A | Diagnostic and laboratory equipment II | 80 | 8 |
| **MODULE VI** | | | |
| 0713541 14A | Digital electronics | 130 | 13 |
| 0541541 08A | Engineering technician mathematics IV | 60 | 6 |
| 0715541 22A | Microcontrollers and microprocessors I | 80 | 8 |
| 0914541 32A | ICU and renal equipment | 120 | 12 |
| 0914541 31A | Radiology and imaging equipment | 120 | 12 |
| **MODULE VII** | | | |
| 0715541 23A | Microcontrollers and microprocessors II | 80 | 8 |
| 0914541 25A | Hospital organization and maintenance principles | 50 | 5 |
| 0111541 24A | Research methods | 60 | 6 |
| 0914541 34A | Physiotherapy and orthopaedic equipment | 120 | 12 |
| **Sub Total** | | **3080** | **308** |
| **Industry Training** | | **480** | **48** |
| **GRAND TOTAL** | | **3560** | **356** |

**Entry Requirements**

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

1. Kenya Certificate of Secondary Education (KCSE) mean grade C-, KCE Div. 3

**Or**

1. Equivalent qualifications as determined by TVETA

**Trainer Qualification**

A trainer for any of the units of competency in this course must:

1. Possess at least KNQF Level 6 or its equivalent in related trade area;
2. Licensed by TVETA.

**Industry Training**

An individual enrolled in this course will be required to undergo Industry training for a minimum period of 480 hours in Health-related sector. The industrial training may be taken after completion of all units for those pursuing the full qualification or be distributed equally in each unit for those pursuing part qualification. In the case of dual training model, industrial training shall be as guided by the dual training policy.

**Assessment**

The course shall be assessed formatively and summatively:

1. During formative assessment all performance criteria shall be assessed based on performance criteria weighting.
2. Number of formative assessments shall minimally be equal to the number of elements in a unit of competency.
3. During summative assessment basic and common units may be integrated in the core units or assessed as discrete units.
4. Theoretical and practical weight for each unit of learning shall be shall be as follows;
5. 30:70 for units in modules I to IV.
6. 40:60 for units in module V to VII
7. Formative and summative assessments shall be weighted at 60% and 40% respectively in the overall unit of learning score

For a candidate to be declared competent in a unit of competency, the candidate must meet the following conditions:

1. Obtained at least 40% in theory assessment in formative and summative assessments.
2. Obtained at least 60% in practical assessment in formative and summative assessment where applicable.
3. Obtained at least 50% in the weighted results between formative assessment and summative assessment where the former constitutes 60% and the latter 40% of the overall score.
4. Assessment performance rating for each unit of competency shall be as follows:

|  |  |
| --- | --- |
| **MARKS** | **COMPETENCE RATING** |
| 80 -100 | Attained Mastery |
| 65 - 79 | Proficient |
| 50 - 64 | Competent |
| 49 and below | Not Yet Competent |
| Y | Assessment Malpractice/irregularities |

1. Assessment for Recognition of Prior Learning (RPL) may lead to award of part and/or full qualification.

**Certification**

A candidate will be issued with a Certificate of Competency upon demonstration of competence in a core Unit of Competency. To be issued with Kenya National TVET Certificate in Biomedical Engineering Technology Level 6, the candidate must demonstrate competence in all the Units of Competency as given in the qualification pack. Statement of Attainment certificate may be awarded upon demonstration of competence in certifiable element within a unit.

These certificates will be issued by ……… (QAI)

# MODULE I

## WORK ETHICS AND PRACTICES

**UNIT CODE:** 0417541 03B

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply work ethics and practices.

**Duration of Unit**: 40 hours

**Unit Description**

This unit covers competencies required to demonstrate work ethics and practices. It involves the ability to: conduct self-management, promote ethical work practices and values, promote teamwork, manage workplace conflicts, maintain professional and personal development, apply problem-solving, and promote customer care.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration in hours.** |
|  | To Apply Self-Management Skills | **10** |
|  | To Promote Ethical Practices and Values | **4** |
|  | To Promote Teamwork | **10** |
|  | To Maintain Professional and Personal Development | **10** |
|  | To Apply Problem-Solving Skills | **4** |
|  | To Promote Customer Care. | **2** |
|  | **TOTAL** | **40** |

**Learning Outcomes, Content, and Suggested Assessment Methods**

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Apply Self-Management Skills | 1. Self-awareness 2. Formulating personal vision, mission, and goals 3. Healthy lifestyle practices 4. Strategies for overcoming work challenges 5. Emotional intelligence 6. Coping with Work Stress. 7. Assertiveness versus aggressiveness and passiveness 8. Developing and maintaining high self-esteem 9. Developing and maintaining positive self-image 10. Time management 11. Setting performance targets 12. Monitoring and evaluating performance targets | * Observation * Written assessment * Oral assessment * Third party reports * Portfolio of evidence * Project * Practical |
| 1. Promote Ethical Work Practices And Values | 1. Integrity 2. Core Values, ethics and beliefs 3. Patriotism 4. Professionalism 5. Organizational codes of conduct 6. Industry policies and procedures | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Promote Teamwork | 1. Types of teams 2. Team building 3. Individual responsibilities in a team 4. Determination of team roles and objectives 5. Team parameters and relationships 6. Benefits of teamwork 7. Qualities of a team player 8. Leading a team 9. Team performance and evaluation 10. Conflicts and conflict resolution 11. Gender and diversity mainstreaming 12. Developing Healthy workplace relationships 13. Adaptability and flexibility 14. Coaching and mentoring skills | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Maintain Professional and Personal Development | 1. Personal vs professional development and growth 2. Avenues for professional growth 3. Recognizing career advancement 4. Training and career opportunities 5. Assessing training needs 6. Mobilizing training resources 7. Licenses and certifications for professional growth and development 8. Pursuing personal and organizational goals 9. Managing work priorities and commitments 10. Dynamism and on-the-job learning | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Apply Problem-Solving Skills | 1. Causes of problems 2. Methods of solving problems 3. Problem-solving process 4. Decision making 5. Creative thinking and critical thinking process in development of innovative and practical solutions | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Promote Customer Care | 1. Identifying customer needs 2. Qualities of good customer service 3. Customer feedback methods 4. Resolving customer concerns 5. Customer outreach programs 6. Customer retention | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |

**Suggested Methods of Instruction**

* Instructor lead facilitation of theory using active learning strategies.
* Demonstrations
* Simulation Role play
* Group Discussion
* Presentations
* Projects
* Case studies
* Assignments

**Recommended Resources for 25 Trainees**

* Computers
* Stationery
* Charts
* Video clips
* Audio tapes
* Radio sets
* TV sets
* LCD projectors

## ENGINEERING TECHNICIAN MATHEMATICS I

**UNIT CODE:** 0541 441 05A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply engineering technician mathematics I.

**Duration of Unit**: 60 hours.

**Unit Description:**

This unit describes the competencies required by a technician in order to apply engineering technician mathematics I. It enables the learner to; apply algebra, carry out mensuration, and apply number systems, trigonometry and hyperbolic functions.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration in hours.** |
|  | To Apply algebra | 12 |
|  | To Carry out mensuration | 12 |
|  | To Apply number systems | 12 |
|  | To Apply trigonometry | 12 |
|  | To Apply hyperbolic functions | 12 |
|  | **TOTAL** | **60** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply algebra | * 1. Importance of algebra in engineering   2. Indices and logarithms      1. Indices         1. Define Base and index         2. Laws of indices         3. Indicial equations      2. Logarithms         1. Laws of logarithm         2. Logarithmic equations         3. Conversion of bases      3. Use of calculator   3. Linear Equations      1. Definition and standard form.      2. Methods of solving: Graphical, substitution, and elimination methods.      3. Applications in engineering problems.   4. Quadratic Equations      1. Definition and standard form.      2. Methods of solving: Factoring, completing the square, and quadratic formula.      3. Real-world engineering applications.   5. Algebraic functions and graph      1. Types of functions         1. Linear, quadratic, polynomial, rational, and exponential functions         2. Characteristics and properties of each function type.      2. Graphing Functions         1. Cartesian coordinate system.         2. Plotting and interpreting graphs of algebraic functions.   6. Using graphs to solve engineering problems. | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Carry out mensuration | * 1. Basic Concepts of mensuration      1. Importance of mensuration in engineering and real-world applications      2. Units of measurement         1. SI units         2. Imperial units         3. Conversion between different units.   2. Plane Geometry      1. Area and Perimeter of Basic Shapes         1. Squares, rectangles, parallelograms, triangles, and trapezoids.         2. Formulas for area and perimeter.      2. Circles and Ellipses         1. Circumference and area of circles.         2. Properties and formulas for ellipses.      3. Composite Figures         1. Methods to find the area and perimeter of composite shapes.         2. Decomposition into simpler shapes.   3. Solid Geometry      1. Surface Area and Volume of Prisms and Cylinders         1. Rectangular prisms, cubes, and general prisms.         2. Right circular cylinders.      2. Surface Area and Volume of Pyramids and Cones         1. Square pyramids, triangular pyramids (tetrahedrons), and general pyramids.         2. Right circular cones.      3. Surface Area and Volume of Spheres and Spheroids         1. Spheres and oblate/prolate spheroids.      4. Composite Solids         1. Methods to find the surface area and volume of composite solids.         2. Decomposition into simpler solids.         3. Engineering applications and problem-solving.   4. Frustums of Cones and Pyramids.      1. Surface area and volume.   5. Sector and Segment of a Circle  1. Area of a sector and length of an arc. 2. Area of a segment 3. Engineering applications | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Apply number systems | 1. Types of numbers 2. Round off numbers to the nearest tens, 3. hundreds, thousands, millions and 4. billions 5. Whole numbers 6. Odd numbers 7. Even numbers 8. Prime number 9. Ratio and proportions 10. Percentages 11. Word problems involving natural 12. Numbers 13. Factors 14. Factors of composite numbers 15. Prime factors 16. Factors in power form 17. Divisibility Test 18. GCD 19. Application of GCD/HCF to real life situations 20. LCM 21. Multiples of a number 22. LCM of a set of numbers 23. Application of LCM in real life situations 24. Integers 25. The number line 26. Operation on integers 27. Order of operations 28. Application to real life situation 29. Fractions 30. Proper, improper fractions and mixed numbers 31. Conversion of improper fractions to mixed numbers and vice versa 32. Comparing fractions 33. Operations on fractions 34. Order of operations on fractions 35. Word problems involving fractions in real life situations 36. Decimals 37. Fractions and decimals 38. Recurring decimals 39. Recurring decimals and fractions 40. Decimal places 41. Standard form 42. Operations on decimals 43. Order of operations 44. Real life problems involving decimals 45. Arithmetic operation 46. Addition 47. Subtraction 48. Multiplication 49. Division 50. Squares and square roots 51. Squares by multiplication 52. Squares from Calculators 53. Square roots by factorization 54. Square roots from Calculators | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Apply trigonometry functions | * 1. Importance of trigonometry in engineering.   2. Trigonometric Ratios and Functions  1. Definitions of sine, cosine, tangent, cosecant, secant, and cotangent. 2. Unit circle and angle measurement Degrees and radians 3. Graphs of trigonometric functions.    1. Trigonometric Identities 4. Fundamental identities 5. Pythagorean 6. Reciprocal 7. Quotient identities 8. Co-function identities and even-odd properties. 9. Sum and difference formulas, double-angle, and half-angle formulas.    1. Solving Trigonometric Equations 10. Basic Trigonometric Equations 11. Solving equations involving basic trigonometric functions. 12. Using identities to simplify and solve equations. 13. Inverse Trigonometric Functions 14. Definition and properties. 15. Solving equations using inverse trigonometric functions. 16. Applications of Trigonometric Equations 17. Engineering problems involving periodic functions and waveforms. 18. Harmonic motion and oscillations in mechanical systems.     1. Trigonometry in Triangles 19. Right-Angle Triangles 20. Solving for sides and angles using trigonometric ratios. 21. Applications in engineering problems such as inclined planes and forces. 22. Non-Right-Angle Triangles 23. Law of Sines and Law of Cosines. 24. Solving oblique triangles.     1. Applications in engineering fields of structural analysis and navigation. | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Apply hyperbolic functions | * 1. Introduction to Hyperbolic Functions  1. Definitions of hyperbolic sine, cosine, tangent, and their reciprocals. 2. Graphs and properties of hyperbolic functions.    1. Hyperbolic Identities 3. Fundamental identities 4. Pythagorean-like identities 5. Sum and difference formulas, double-angle, and half-angle formulas.    1. Solving Hyperbolic Equations 6. Basic Hyperbolic Equations 7. Solving equations involving basic hyperbolic functions. 8. Using identities to simplify and solve equations. 9. Inverse Hyperbolic Functions 10. Definition and properties. 11. Solving equations using inverse hyperbolic functions.     1. Applications of Hyperbolic Functions in Engineering | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |

**Suggested Delivery Methods**

* Demonstration
* Discussions
* Practical
* Project work
* Direct instruction

**List of Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/**  **Specifications** | **Quantity** | **Recommended**  **Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Textbooks | Engineering Mathematics by K.A. Stroud  Advanced Engineering Mathematics by Erwin Kreyszig | 5 pcs  5 pcs | 1:5  1:5 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture/theory room | 60m2 | 1 | 1:25 |
|  | Computer | Operating System: 64-bit Windows 11 or 10 version 1809 or above  Processor: 2.5 GHz (3+ GHz recommended),  Memory: 8 GB (32GB recommended)  Disk space: 10 GB  Display: 1920 x 1080 resolution  Display Card: 2 GB GPU (8 GB recommended) and DirectX 11 compliant (DirectX 12 recommended) | 25 pcs | 1:1 |
|  | Projector |  | 1 | 1:25 |
|  | Interactive screen | Specifications: 77-inch interactive whiteboard with touch and pen functionality. | 1 | 1:25 |
| **C** | **Software** | | | |
|  | MATLAB | License: Educational licenses available.  Features: Matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, interfacing with programs in other languages. | Installed in 25 computers | 1:1 |
|  | GeoGebra | License: Free educational software.  Interactive geometry, algebra, statistics, and calculus applications | Installed in 25 computers | 1:1 |
| **D** | **Consumables** |  |  |  |
|  | Pens, pencils, rulers and paper | Whiteboard markers, 2H pencils, plastic rulers, A2 white papers | Enough |  |

## WORKSHOP PRACTICE

**UNIT CODE:** 0713441 09A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Perform workshop processes

**Duration of Unit:** 70 HOURS

**Unit Description**

This unit covers competences required to perform workshop processes. It involves applying workshop safety practice, controlling OSH hazards, implementing OSH programs, controlling environmental pollution, demonstrating sustainable resource use, implementing specific environmental programs, monitoring activities on environmental protection programs, preparing workshop tools, equipment and materials, using workshop machines and tools and storing electrical tools and material.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration in hours.** |
|  | To Apply workshop safety practice | 8 |
|  | To Control OSH hazards | 4 |
|  | To Implement OSH programs | 6 |
|  | To Control environmental Pollution | 4 |
|  | To Demonstrate sustainable resource use | 4 |
|  | To Implement specific environmental programs | 4 |
|  | To Monitor activities on Environmental protection/Programs | 6 |
|  | To Prepare workshop tools, equipment and materials | 10 |
|  | To Use of workshop machines and tools | 20 |
|  | To Store Electrical tools and material | 4 |
|  | **TOTAL** | **70** |

**Learning Outcomes, Content and Suggested Assessment Methods:**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply workshop safety practice | 1. Workshop rules 2. Safety regulations 3. Importance of safety in workshop 4. Meaning of PPE 5. Types of PPEs 6. Mask 7. Gloves 8. Goggles 9. Safety hat 10. Overall 11. Ear protector 12. Standard operating procedure in PPE 13. Hazards in workshop 14. Electrical hazards 15. Fire 16. Fire 17. Classes of fire 18. Causes of fire 19. Various methods of fire extinguishing 20. First Aid | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Control OSH hazards | 1. Meaning of Hazards 2. Risks hazards 3. Physical hazards – impact, illumination, pressure, noise, 4. vibration, extreme temperature, radiation 5. Biological hazards- bacteria, viruses, plants, parasites, mites, molds, fungi, insects 6. Chemical hazards – dusts, fibers, mists, fumes, smoke, gasses, vapors 7. Ergonomics 8. Psychological factors – over exertion excessive force, awkward static positions, fatigue, direct pressure, 9. varying metabolic cycles 10. Physiological factors – monotony, personal relationship, work out cycle 11. Safety hazards (unsafe workplace condition) –confined space, excavations, falling objects, gas leaks, electrical, poor storage of materials and waste, spillage, waste and debris) 12. Unsafe workers’ act (Smoking in off-limited areas, Substance and alcohol abuse at work) 13. Hazard indicators 14. Increased of incidents of accidents, injuries 15. Increased occurrence of sickness or health complaints symptoms 16. Common complaints of workers related to OSH 17. High absenteeism for work-related reasons 18. OSH concerns 19. Workers ‘experience observance on presence of work hazards 20. Unsafe unhealthy administrative arrangements (prolonged work hours, no break time, constant overtime, scheduling of tasks) 21. Reasons for compliance non-compliance to use of PPEs or other OSH procedures policies guidelines 22. Hazard prevention and control measures 23. Appropriate risk controls in order of impact are as follows: 24. Eliminate the hazard altogether (i.e., get rid of the dangerous machine) 25. Isolate the hazard from anyone who could be harmed (i.e., keep the machine in a closed room and operate it remotely; barricade an unsafe area off) 26. Substitute the hazard with a safer alternative (i.e., replace the machine with a safer one) 27. Use administrative controls to reduce the risk (i.e., train workers how to use equipment safely; train workers about the risks of harassment; issue signage) 28. Use engineering controls to reduce the risk (i.e., attach guards to the machine to protect users) 29. Use personal protective equipment (i.e., wear gloves and goggles when using the machine) 30. Contingency measures 31. Evacuation 32. Isolation 33. Decontamination 34. (Calling designed) emergency personnel 35. Emergency 36. Chemical spills 37. Equipment vehicle accidents 38. Explosion 39. Fire 40. Gas leak 41. Injury to personnel 42. Structural collapse 43. Toxic and or flammable vapors emission 44. Emergency procedure 45. Fire drill 46. Earthquake drill 47. Basic life support CPR 48. First aid 49. Spillage control 50. Decontamination of chemical and toxics 51. Disaster preparedness 52. Use of fire extinguishes | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Implement OSH programs | 1. Company OSH programs 2. OSH standards and procedures 3. OSH-related records 4. Medical Health records 5. Incident accident reports 6. Sickness notifications sick leave application 7. OSH-related trainings obtained | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Control environmental Pollution | 1. Meaning of Environmental pollution 2. Types of Environmental pollution 3. Environmental pollution control measures 4. Methods for minimizing or stopping spread and ingestion of airborne particles 5. Methods for minimizing or stopping spread and ingestion of gases and fumes 6. Methods for minimizing or stopping spread and ingestion of liquid wastes 7. Procedures for solid waste management are observed 8. Methods for minimizing noise pollution | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Demonstrate sustainable resource use | 1. Organizational waste management 2. Methods for minimizing wastage 3. Reduce 4. Reuse 5. Recycle 6. Waste management procedures 7. Sorting 8. Storing of items 9. Recycling of items 10. Disposal of items 11. Methods for economizing and reducing resource consumption 12. Resources 13. Electricity 14. Water 15. Fuel 16. Telecommunications 17. Supplies 18. Materials 19. Resource conservation plan development | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Implement specific environmental programs | 1. Define specific environmental programs 2. Individual responsibilities in implementing specific environmental programs 3. Problems encountered in implementing specific environmental programs 4. Resolving problems encountered in implementing specific environmental programs 5. Organizations’ policies and guidelines 6. supply chain, procurement and purchasing 7. quality assurance 8. making recommendations and seeking approvals 9. Stakeholders consulted in implementing specific environmental programs | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Monitor activities on Environmental protection Programs | 1. Activities periodically monitored on Environmental protection Programs 2. Activities evaluated based objectives of the environmental program. 3. Recommendations submission 4. Management support systems establishment 5. Environmental incidents reports | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Prepare workshop tools, equipment and materials | 1. Classification of workshop tools and equipment 2. Mechanical tools 3. Electrical tools 4. Uses of workshop tools, materials and equipment 5. Care and Maintenance of workshop tools and Instruments 6. Tools and instruments for an Electrical practical 7. Preparation of a list of tools and instruments for an Electrical practical. 8. Issuing and confirmation of tools and instruments before and after practical 9. Safety measures on workshop tools, equipment and materials | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Use workshop machines and tools | 1. Health and safety procedures 2. Workshop machines 3. Safety precautions 4. Operation of machines e.g. Lathe, Grinder, etc 5. Common sheet metals 6. Forming in sheet metal 7. Workshop tools 8. Use of tools 9. Marking out 10. Filing etc 11. Mechanical joining of metal 12. Welding 13. Riveting etc 14. Machine operation | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Store Electrical tools and material | 1. Classification of workshop tools and materials 2. Tools machines and equipment cleaning 3. Checking of tools and equipment 4. Maintenance of tools, equipment and machines 5. Storage of workshop tools and equipment 6. Waste management | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group discussions
* Interactive lectures
* Industrial attachment
* Viewing of related videos
* Field trips

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S No.** | **Category Item** | **Description Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Textbooks | J.K. Gupta & R.S. Khurmi Workshop technology | 5 pcs for each | 1:5 |
|  | Installation manuals | Electrical machine manuals | 5 pcs | 1:5 |
|  | Charts | Machine Charts | 1 pcs for each | 1:25 |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
| **C** | **Tools and Equipment** | | | |
|  | Pliers |  | 25 pcs | 1:1 |
|  | Tape measure |  | 25 pcs | 1:1 |
|  | Try Square |  | 25 pcs | 1:1 |
|  | Spirit level |  | 25 pcs | 1:1 |
|  | Assorted Screw driver |  | 25 pcs | 1:1 |
|  | Assorted hammers |  | 25 pcs | 1:1 |
|  | Crimping tools |  | 5 pcs | 1:5 |
|  | PPEs |  | 25 pcs | 1:1 |
|  | Multimeters |  | 5 pcs | 1:5 |
|  | Clamp meters |  | 5 pcs | 1:5 |
|  | Earth resistance meter |  | 5 pcs | 1:5 |
|  | Stocks & Dies |  | 5 pcs | 1:5 |
|  | Vices |  | 5 pcs | 1:5 |
|  | Pipe bending Machine |  | 5 pcs | 1:5 |
|  | Bending machine |  | 5 pcs | 1:5 |
|  | Installation boards |  | 13 pcs | 1:2 |
|  | PCB prototyping machine |  | 2 | 1:13 |
|  | Solder guns |  | 25 pcs | 1:1 |
|  | Hot air gun |  | 5 pcs | 1:5 |
|  | Drilling machines |  | 5 pcs | 1:5 |
|  | Work stations |  | 25 | 1:1 |
|  | Welding Machine |  | 5 pcs | 1:5 |
|  | Lathe Machine |  | 5 pcs | 1:5 |
|  | Metal sheets |  | 5 pcs | 1:5 |
|  | Grinding machine |  | 5 pcs | 1:5 |
|  | Punch tool |  | 5 pcs | 1:5 |

## HUMAN ANATOMY AND PHYSIOLOGY PRINCIPLES

**UNIT CODE:** 0914441 10A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply human anatomy and physiology principles

**Duration of Unit:** 80Hours

**Unit Description**

This unit specifies the competencies required to apply human anatomy and physiology principles. It involves applying knowledge of basics of human anatomy and physiology, musculoskeletal system knowledge, cardiovascular system knowledge, respiratory system knowledge, digestive system knowledge, urinary system knowledge, nervous system knowledge, reproductive system knowledge, dental anatomy knowledge, special sensory organs and basic patient care and medical ethics.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration in hours.** |
|  | To Apply Basics of Human Anatomy and Physiology | 8 |
|  | To Apply Musculoskeletal System knowledge | 7 |
|  | To Apply Cardiovascular System knowledge | 7 |
|  | To Apply Respiratory System knowledge | 7 |
|  | To Apply Digestive System knowledge | 7 |
|  | To Apply Urinary System knowledge | 7 |
|  | To Apply Nervous System knowledge | 8 |
|  | To Apply Reproductive System knowledge | 7 |
|  | To Apply dental anatomy knowledge | 7 |
|  | To Apply Special Sensory Organ knowledge | 8 |
|  | To Apply basic patient care and medical ethics knowledge | 7 |
|  | **TOTAL** | **80** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply Basics of Human Anatomy and Physiology | 1. Medical terminologies 2. Directional terms 3. Regional terms 4. Body and plane sections 5. Terms of motion 6. Body cavities 7. Human body compartments 8. Human body cells, tissues and organ | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Apply Musculoskeletal System knowledge | 1. Bone Anatomy and Physiology 2. Functions of bones 3. Types of bones 4. Bone structure 5. Microscopic structure of bone 6. Development of bone tissue 7. Healing of bone 8. Types of skeletons 9. Types of joints 10. Muscle Anatomy and Physiology 11. Organization of skeletal muscle 12. The neuromuscular junction 13. Action of skeletal muscle 14. Principal skeletal muscles 15. Musculoskeletal disorders | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Apply Cardiovascular System knowledge | * 1. Heart Anatomy and Physiology  1. Position 2. Structure 3. Flow of blood through the heart 4. Blood supply to the heart (the coronary circulation) 5. Conducting system of the heart 6. The cardiac cycle 7. Cardiac output    1. Blood circulation       1. Blood pressure       2. Types of blood circulations       3. Fetal circulation    2. Cardiovascular disorders | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Apply Respiratory System knowledge | * 1. Respiratory System Anatomy and Physiology   2. Nose and nasal cavity   3. Pharynx   4. Larynx   5. Trachea   6. Lungs   7. Bronchi and bronchioles   8. Respiratory bronchioles and alveoli   9. Respiration process   10. Respiratory disorders | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Apply Digestive System knowledge | * 1. Digestive System Anatomy and Physiology  1. The digestive tract 2. Pancreas 3. Liver 4. Biliary tract 5. Bile ducts Gall bladder    1. Digestive process.    2. Digestive disorders | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Apply Urinary System knowledge | * 1. Kidney Anatomy and Physiology  1. Gross structure of the kidney 2. Microscopic structure of the kidney 3. Functions of the kidney 4. Ureters 5. Urinary bladder 6. Urethra    1. Urinary process    2. Urinary disorders | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Apply Nervous System knowledge | * 1. Cells and tissues of nervous system.   2. Nervous System Anatomy and Physiology  1. The meninges and cerebrospinal 2. fluid (CSF) 3. The meninges 4. Central nervous system 5. Brain 6. Spinal cord 7. Peripheral nervous system 8. Autonomic nervous system    1. Nervous disorders | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Apply Reproductive System knowledge | * 1. Female Reproductive Anatomy and Physiology  1. External genitalia (vulva) 2. Internal genitalia 3. Breasts 4. Puberty in the female 5. The reproductive cycle    1. Male Reproductive Anatomy and Physiology 6. Scrotum 7. Testes 8. Seminal vesicles 9. Ejaculatory ducts 10. Prostate gland 11. Urethra and penis     1. Human development process     2. Reproductive disorders | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Apply dental anatomy knowledge | 1. The tooth and buccal cavity 2. Common dental disease and disorders 3. Dental diagnostic and therapeutic measures | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Apply Special Sensory Organ knowledge | * 1. Eye Anatomy and Physiology  1. Structure 2. Physiology of sight    1. Ear Anatomy and Physiology 3. Structure 4. Physiology of hearing    1. Nose Anatomy and Physiology    2. Sensory Organs disorders | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Apply basic patient care and medical ethics knowledge | 1. Basic patient care 2. Medical ethics 3. Code of practice | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group Discussions
* Role Play
* Interactive lectures
* Individual Assignments
* Industial Attachments
* Viewing of Related Videos
* Clinical and Hospital Trips

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S No.** | **Category Item** | **Description Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Reference books | Principles of Anatomy and Physiology" by Gerard J. Tortora and Bryan Derrickson  Human Anatomy & Physiology" by Elaine N. Marieb and Katja Hoehn | 5 pcs for each | 1:5 |
|  | Charts | Assorted Human Anatomy diagrams | 1 | 1:25 |
|  | Audio visual presentations | Projector, Atlas of Human Anatomy" by Frank H. Netter, 3D Anatomy Apps | 1 | 1:25 |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture theory room | 60m2 | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Assorted model materials | Skeletons, Organs | 25 pcs for each | 1:1 |
| **D** | **Tools & Equipment** | | | |
|  | Assorted Anatomical models | 3D models of the human body | 5 pcs | 1:5 |

## MECHANICAL SCIENCE PRINCIPLES

**UNIT CODE:** 0715541 11A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply mechanical science principles

**Duration of Unit:** 80Hours

**Unit Description**

This unit specifies the competencies required to apply mechanical science principles. It involves applying forces in a system, knowledge of moments, friction principles and motions laws, describing work, energy and power, demonstrating gas principles, applying heat knowledge, density knowledge, pressure principles, pneumatics and hydraulics principles, optical principles and wave principles.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration in hours.** |
|  | To Apply Forces In A System | 10 |
|  | To Apply Knowledge Of Moments | 10 |
|  | To Apply Friction Principles | 5 |
|  | To Apply Motions Laws | 10 |
|  | To Describe Work, Energy And Power | 10 |
|  | To Demonstrate Gas Principles | 5 |
|  | To Apply Heat Knowledge | 5 |
|  | To Apply Density Knowledge | 5 |
|  | To Apply Pressure Principles | 5 |
|  | To Apply Pneumatics And Hydraulics Principles | 5 |
|  | To Apply Optical Principles | 5 |
|  | To Apply Wave Principles | 5 |
|  | **TOTAL** | **80** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply forces in a system | 1. Definition of terms 2. Resolution of forces 3. Statement and application of forces theorems 4. Newton's First law 5. Newton's Second Law 6. Newton's Third Law 7. Bow’s Notation 8. Resultant of forces (Graphical methods and analysis) 9. Mechanical calculations 10. Mechanical advantage 11. Efficiency 12. Torque 13. Power/Energy 14. Work done | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Apply knowledge of moments | 1. Definition of moments 2. Principles of Moments 3. Stability and C.o.G 4. Couples 5. Engineering examples on application of moments 6. Calculation of moments and reaction on beams 7. Single load on beam 8. Multiple loads on beam | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Apply friction principles | 1. Nature of friction 2. Laws of friction 3. Coefficient of friction 4. Angle of repose 5. Friction on a horizontal plane 6. Friction on an inclined plane 7. Advantages and disadvantages of friction 8. Applications of friction 9. Methods of increasing and reducing friction | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Apply motions laws | 1. Definition of terms 2. Laws of motion 3. Graphs of motion 4. Equations of motion 5. Relationship between linear and angular motion 6. Calculations of linear and angular motion | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Describe work, energy and power | 1. Definition of energy, work and power 2. Sources of energy 3. Types and forms of energy 4. Kinetic and potential energy 5. Energy work equation 6. Calculation of energy 7. Calculation of work 8. Calculation of power 9. Problems on simple machine parameters    1. Machine advantage    2. Velocity ratio    3. Efficiency | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Demonstrate gas principles | 1. Gas laws    1. Boyles law    2. Charles law    3. Gas equation 2. Solution of engineering problems involving gas laws 3. Uses of gases in engineering systems | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Apply heat knowledge | * 1. Heat concepts   2. Working principle of heat   3. Heat capacity   4. Heat problems | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Apply density knowledge | * 1. Density terminology   2. Density measurements   3. Density problems | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Apply pressure principles | * 1. Pressure concepts   2. Working principles of pressure   3. Pressure problems   4. Pressure applications  1. Braking systems 2. Vacuum pump 3. Hydraulic pump 4. Hydrometers | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Apply pneumatics and hydraulics principles | * 1. Pneumatics and hydraulic working principles   2. Types of pneumatic and hydraulics systems   3. Uses of pneumatic and hydraulics systems | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Apply optical principles | 1. Optics 2. Nature of Light concepts 3. Types of optics 4. Geometrical optics 5. Fibre optics 6. Geometric Optic Concepts    1. Light Propagation,    2. Reflection    3. Refraction    4. Image Formation    5. Mirrors    6. Lenses 7. Snell’s laws 8. Optical devices 9. Mirrors 10. Lenses 11. Ray tracing | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Apply wave principles | 1. Wave properties 2. Amplitude 3. Wavelength 4. Speed 5. Frequency 6. Types of waves 7. Mechanical waves 8. Electromagnetic waves 9. Matter waves 10. Superposition principle 11. Characteristics of waves 12. Reflection 13. Diffraction 14. Refraction 15. Standing waves | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group Discussions
* Role Play
* Interactive lectures
* Individual Assignments
* Industial Attachments
* Viewing of Related Videos
* Clinical and Hospital Trips

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S No.** | **Category Item** | **Description Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Reference books | Engineering Mechanics: Statics and Dynamics by R.C. Hibbeler:  Mechanics of Materials by R.C. Hibbeler:  Fluid Mechanics by Frank M. White: | 5 pcs for each | 1:5 |
|  | Training kits | Fibre optical training kit, laser training kit | 5 pcs for each | 1:5 |
|  | Installation manuals | Assorted Systems component Manufacturer’s manuals and data sheets  Instrumentation Handbooks | 5 pcs for each | 1:5 |
|  | Charts | Assorted mechanical systems diagrams  Relevant charts | 1 pc for each | 1:25 |
|  | Audio visual presentations | Projector | 1 | 1:25 |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |

## REFRIGERATION AND AIR CONDITIONING EQUIPMENT

**UNIT CODE:** 0914551 35A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Perform refrigeration and air conditioning equipment maintenance.

**Duration of Unit:** 120Hours

**Unit Description**

This unit specifies the competencies required to perform refrigeration and air conditioning equipment installation and maintenance. It involves maintaining refrigerator, cold room equipment, freezer and air conditioner.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration in hours.** |
|  | To Maintain Refrigerator | 50 |
|  | To Maintain Cold Room Equipment | 20 |
|  | To Maintain Freezer | 20 |
|  | To Maintain Air Conditioner | 30 |
|  | **TOTAL** | **120** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Perform Refrigerator Maintenance | 1. Application of physics to basic refrigeration systems;    1. Gas laws       1. Boyle’s law       2. Charles’ laws       3. Daltons law of partial pressure 2. Heat transfer mechanisms    1. Conversion of relevant units    2. Sensible and latent heat    3. Temperature enthalpy relationship    4. Thermal insulation 3. Refrigeration cycles    1. Vapour compression, absorption    2. Evaporative cooling    3. Pettier effect 4. Refrigerants    1. Fluoro-carbons (CFC)    2. Replacement of fluoro-carbons with hydro-carbons 5. Safe handling    1. Toxicity    2. Cold burns    3. Environmental protection (ozone) 6. Recycling fluoro-carbons 7. Applications of refrigeration in hospitals    1. Vaccines    2. Blood bank    3. Laboratory    4. Pathology    5. Kitchen and food storage 8. Parts of refrigerator 9. Evaporator 10. Condenser 11. Compressor 12. Expansion valve 13. Reservoir 14. Funs 15. Ducts 16. Filters 17. Refrigeration systems installation 18. Pipe work processes     1. Cutting     2. Debarring     3. Bending     4. Joining     5. Soldering brazing     6. Flared joints     7. Swaged joint 19. Maintenance procedures | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Cold Room Equipment Maintenance | 1. Commercial systems 2. hermetic and semi-hermetic units 3. Open type compressors    * 1. Reciprocating      2. Vane      3. Screw 4. Compressor capacity 5. Condensers    1. Natural draught    2. Forced draught 6. Refrigerant controls    1. Capillary tube sizes and capacity    2. Expansion devices 7. Evaporators    1. Natural convection    2. Forced draught 8. Auxiliary components    1. Receivers    2. filter driers    3. solenoid valves 9. Automatic control    1. control devices    2. wiring circuits 10. Equipment sizing and matching 11. Applications of refrigeration in hospitals     1. Vaccines     2. Blood bank     3. Laboratory     4. Kitchen and food storage     5. Mortuary 12. Parts of Cold Room Equipment 13. Evaporator 14. Condenser 15. Compressor 16. Expansion valve 17. Reservoir 18. Funs 19. Ducts 20. Filters 21. Cold room equipment installation and maintenance procedures | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Freezer Maintenance | 1. Types of freezers 2. Parts of Freezers 3. Evaporator 4. Condenser 5. Freezer Installation and Maintenance | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Air Conditioner Maintenance | 1. Functions of basic air conditioning systems. 2. Parts of Air Conditioner 3. Evaporator 4. Condenser 5. Compressor 6. Expansion valve 7. Reservoir 8. Funs 9. Ducts 10. Filters 11. Mechanical ventilation air conditioning system 12. Air Conditioner installation and maintenance procedures 13. Maintenance procedures | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group Discussions
* Role Play
* Interactive lectures
* Individual Assignments
* Industial Attachments
* Viewing of Related Videos
* Clinical and Hospital Trips

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S No.** | **Category Item** | **Description Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | | |
|  | Reference books | Modern Refrigeration and Air Conditioning by Althouse, Turnquist, and Bracciano:  Fundamentals of Refrigeration and Air Conditioning by Donald P. Moran: | 5 pcs for each | 1:5 |
|  | Maintenance manuals | Assorted Systems component Maintenance reports, manufacture’s manuals and data sheets  Instrumentation Handbooks | 5 pcs for each | 1:5 |
|  | Charts | Assorted maternity equipment diagrams  Equipment block diagram charts | 1 pc for each | 1:25 |
|  | Software | Assorted installation software for the equipment | 25 pcs for each | 1:1 |
|  | Audio visual presentations | Projector | 1 | 1:25 |
| **B** | **Learning Facilities & Infrastructure** | | | | |
|  | Lecture theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Simulation Lab | 100m2 | 1 | 1:25 |
| **C** | **Consumable Materials** | | | | |
|  | Installation materials | Insulation tape, cables, Refrigerant leak detector  Recovery unit  Refrigeration thermometer  Refrigeration weighing scale  Refrigeration copper tube type L  Copper fittings (elbows, tee)  Brazing torch with horse pipe  Filter drier  R134a-Refrigerant (13.6kg)  Wrench Socket Spanner Set  Refrigeration Manifold gauge (with horses)  Charging valves  Refrigerator Air conditioner water dispenser  Compressor oil  Syringe  Flaring tool kit  Vacuum pump  MAPP gas  Copper brazing rod  Brazing White flux (500g)  Multi-meter  Gloves (heavy duty) | 25 pcs for each | 1:1 |
|  | Maintenance materials | Wipes, spare batteries, sanitizer, service kits | 25 pcs for each | 1:1 |
|  | Assorted electrical components | Contactors, transformer, overload relays, timers | 25 pcs for each | 1:1 |
|  | Assorted instrumentation components | Sensors, transducers, actuators | 25 pcs for each | 1:5 |
| **D** | **Tools & Equipment** | | | | |
|  | Assorted tools and equipment | Side cutters, Allen keys set, Side cutters, Pliers, Screw driver, Multi-meter, | 25 pcs for each | 1:1 |
|  | PPEs | Safety boots, overall, masks, gloves, antistatic shoes | 25 pcs for each | 1:1 |
|  | Hot air gun |  | 5 pcs | 1:5 |
|  | Blower |  | 5 pcs | 1:5 |
|  | Drilling machines |  | 5 pcs | 1:5 |
|  | Refrigerator |  | 5 pcs | 1:5 |
|  | Cold Room Equipment |  | 5 pcs | 1:5 |
|  | Freezer |  | 3 pcs | 1:8 |
|  | Air Conditioner |  | 5 pcs | 1:5 |

# MODULE II

## DIGITAL LITERACY

**UNIT CODE:** 0611441 01B

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply digital literacy

**Duration of Unit:** 40 Hours

**Unit Description**

This unit covers the competencies required to demonstrate digital literacy. It involves operating computer devices, solving tasks using the office suite, managing data and information, performing online communication and collaboration, applying cyber-security skills, and performing jobs online.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration in hours.** |
|  | To Operate Computer Devices | 6 |
|  | To Solve Tasks Using Office Suite | 14 |
|  | To Manage Data And Information | 6 |
|  | To Perform Online Communication And Collaboration | 4 |
|  | To Apply Cyber-security Skills | 4 |
|  | To Perform Online Jobs | 4 |
|  | To Apply Job Entry Techniques | 2 |
|  | **TOTAL** | **40** |

**Learning Outcomes, Content, and Suggested Assessment Methods**

| **Learning Outcome** | **Content** | **Suggested**  **Assessment Methods** |
| --- | --- | --- |
| 1. Operate computer devices | 1. Meaning and importance of digital literacy 2. Functions and Uses of Computers 3. Classification of computers 4. Components of a computer system 5. Computer Hardware    1. The System Unit E.g. Motherboard, CPU, casing    2. Input Devices e.g. pointing, keying, scanning, voice speech recognition, direct data capture devices.    3. Output Devices e.g. hardcopy output and softcopy output    4. Storage Devices e.g. main memory e.g. RAM, secondary storage (Solid state devices, Hard Drives, CDs & DVDs, Memory cards, Flash drives    5. Computer Ports e.g. HDMI, DVI, VGA, USB type C etc. 6. Classification of computer software 7. Operating system functions 8. Procedure for turning off a computer 9. Mouse use techniques 10. Keyboard Parts and Use Techniques 11. Desktop Customization 12. File and Files Management using an operating system 13. Computer Internet Connection Options     1. Mobile Networks Data Plans     2. Wireless Hotspots     3. Cabled (Ethernet Fiber)     4. Dial-Up     5. Satellite 14. Computer external devices management     1. Device connections     2. Device controls (volume controls and display properties) | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Solve tasks using Office suite | 1. Meaning and Importance of Word Processing 2. Examples of Word Processors 3. Working with word documents    1. Open and close word processor    2. Create a new document    3. Save a document    4. Switch between open documents 4. Enhancing productivity    1. Set basic options preferences    2. Help resources    3. Use magnification zoom tools    4. Display, hide built-in tool bar    5. Using navigation tools 5. Typing Text 6. Document editing (copy, cut, paste commands, spelling and Grammar check) 7. Document formatting    1. Formatting text    2. Formatting paragraph    3. Formatting styles    4. Alignment    5. Creating tables    6. Formatting tables 8. Graphical objects    1. Insert object (picture, drawn object)    2. Select an object    3. Edit an object    4. Format an object 9. Document Print setup    1. Page layout,    2. Margins set up    3. Orientation. 10. Word Document Printing 11. Meaning & Importance of electronic spreadsheets 12. Components of Spreadsheets 13. Application areas of spreadsheets 14. Using spreadsheet application     1. Parts of Excel screen: ribbon, formula bar, active cell, name box, column letter,row number, Quick Access Toolbar.     2. Cell Data Types     3. Block operations     4. Arithmetic operators (formula bar (-, +, \*, ).     5. Cell Referencing 15. Data Manipulation     1. Using Functions (Sum, Average, SumIF, Count, Max, Max, IF, Rank, Product, mode etc)     2. Using Formulae     3. Sorting data     4. Filtering data     5. Visual representation using charts 16. Worksheet printing 17. Electronic Presentations 18. Meaning and Importance of electronic presentations 19. Examples of Presentation Software 20. Using the electronic presentation application     1. Parts of the PowerPoint screen (slide navigation pane, slide pane, notes, the ribbon, quick access toolbar, and scroll bars).     2. Open and close presentations     3. Creating Slides (Insert new slides, duplicate, or reuse slides.)     4. Text Management (insert, delete, copy, cut and paste, drag and drop, format, and use spell check).     5. Use magnification zoom tools     6. Apply or change a theme.     7. Save a presentations     8. Switch between open presentations 21. Developing a presentation     1. Presentation views     2. Slides     3. Master slide 22. Text     1. Editing text     2. Formatting     3. Tables 23. Charts     1. Using charts     2. Organization charts 24. Graphical objects     1. Insert, manipulate     2. Drawings 25. Prepare outputs     1. Applying slide effects and transitions     2. Check and deliver        1. Spell check a presentation        2. Slide orientation        3. Slide shows, navigation 26. Print presentations (slides and handouts) | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Manage Data and Information | 1. Meaning of Data and information 2. Importance and Uses of data and information 3. Types of internet services    1. Communication Services    2. Information Retrieval Services    3. File Transfer    4. World Wide Web Services    5. Web Services    6. Automatic Network Address Configuration    7. NewsGroup    8. Ecommerce 4. Types of Internet Access Applications 5. Web browsing concepts    1. Key concepts    2. Security and safety 6. Web browsing    1. Using the web browser    2. Tools and settings    3. Clearing Cache and cookies    4. URIs    5. Bookmarks    6. Web outputs 7. Web based information    1. Search    2. Critical evaluation of information    3. Copyright, data protection 8. Downloads Management 9. Performing Digital Data Backup (Online and Offline) 10. Emerging issues in internet | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Perform online communication and collaboration | 1. Netiquette principles 2. Communication concepts    1. Online communities    2. Communication tools    3. Email concepts 3. Using email    1. Sending email    2. Receiving email    3. Tools and settings    4. Organizing email 4. Digital content copyright and licenses 5. Online collaboration tools    1. Online Storage (Google Drive)    2. Online productivity applications (Google Docs & Forms)    3. Online meetings (Google Meet Zoom)    4. Online learning environments    5. Online calendars (Google Calendars)    6. Social networks (Facebook Twitter - Settings & Privacy) 6. Preparation for online collaboration    1. Common setup features    2. Setup 7. Mobile collaboration    1. Key concepts    2. Using mobile devices    3. Applications    4. Synchronization | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Apply cybersecurity skills | 1. Data protection and privacy 2. Confidentiality of data information 3. Integrity of data information 4. Availability of data information 5. Internet security threats    1. Malware attacks    2. Social engineering attacks    3. Distributed denial of service (DDoS)    4. Man-in-the-middle attack (MitM)    5. Password attacks    6. IoT Attacks    7. [Phishing Attacks](https://onlinedegrees.sandiego.edu/top-cyber-security-threats/#phishing-attacks)    8. [Ransomware](https://onlinedegrees.sandiego.edu/top-cyber-security-threats/#ransomware) 6. Computer threats and crimes 7. Cybersecurity control measures    1. Physical Controls    2. Technical Logical Controls (Passwords,PINs, Biometrics)    3. Operational Controls 8. Laws governing protection of ICT in Kenya    1. The Computer Misuse and Cybercrimes Act No. 5 of 2018    2. The Data Protection Act No. 24 Of 2019 | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Online Jobs | 1. Introduction to online working 2. Types of online Jobs 3. Online job platforms    1. Remotask    2. Data annotation tech    3. Cloud worker    4. Upwork    5. Oneforma    6. Appen 4. Online account and profile management 5. Identifying online jobs job bidding 6. Online digital identity 7. Executing online tasks 8. Management of online payment accounts. | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Apply job entry techniques | 1. Types of job opportunities 2. Self-employment 3. Service provision 4. product development 5. salaried employment 6. Sources of job opportunities 7. Resume curriculum vitae 8. What is a CV 9. How long should a CV be 10. What to include in a AC 11. Format of CV 12. How to write a good CV 13. Don’ts of writing a CV 14. Job application letter 15. What to include 16. Addressing a cover letter 17. Signing off a cover letter 18. Portfolio of Evidence 19. Academic credentials 20. Letters of commendations 21. Certification of participations 22. Awards and decorations 23. Interview skills 24. Listening skills 25. Grooming 26. Language command 27. Articulation of issues 28. Body language 29. Time management 30. Honesty 31. Generally knowledgeable in current affairs and technical area | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |

**Suggested Methods Instruction**

* + Instructor-led facilitation using active learning strategies
  + Demonstration by trainer
  + Practical work by trainees
  + Viewing of related videos
  + Group discussions
  + Project
  + Role play
  + Case study

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/**  **Specifications** | **Quantity** | **Recommended**  **Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Textbooks | Digital Literacy: Concepts and Applications by Ben Brow | 10 pcs | 1:3 |
|  | Printed training materials | Sample CVs  Sample job applications | 5 pcs  5 pcs | 1:5  1:5 |
|  | Online Resources | Khan Academy, Coursera, and YouTube for supplementary video content. | Accessible in 25 computers | 1:1 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture/theory room | 60m2 | 1 | 1:25 |
|  | Computer workshop | 160 m2 | 1 | 1:25 |
|  | Computers | Operating System: 64-bit Windows 11 or 10 version 1809 or above  Processor: 2.5 GHz (3+ GHz recommended),  Memory: 8 GB (32GB recommended)  Disk space: 10 GB  Display: 1920 x 1080 resolution  Display Card: 2 GB GPU (8 GB recommended) and DirectX 11 compliant (DirectX 12 recommended) | 25 pcs | 1:1 |
|  | Projector | high-resolution projectors with HDMI input | 1 | 1:25 |
|  | Smartboard/Smart TV | Specifications: 77-inch interactive whiteboard with touch and pen functionality. | 1 | 1:25 |
|  | Whiteboard | Traditional whiteboard | 1 | 1:25 |
|  | External storage media | USB flash drives (32GB), External HDD/SSD | 25 pcs | 1:1 |
|  | Webcams | HD (1080p) | 25 pcs | 1:1 |
|  | Printers | With Print, Copy, Scan and Fax | 2 | 1:13 |
|  | Over-ear headphones | Large diaphragm | 25 pcs | 1:1 |
| **C** | **Software** |  |  |  |
|  | Operating systems | Windows/Linux/Macintosh Operating System | For 25 computers | 1:1 |
|  | Office | Microsoft Office Software | For 25 computers | 1:1 |
|  | Workspace | Google Workspace Account | For 25 computers | 1:1 |
|  | Antivirus Software |  | For 25 computers | 1:1 |
|  | Photo editing software | Adobe Photoshop, Canva, GIMP | For 25 computers | 1:1 |
|  | Video editing software | Adobe Premiere Pro, iMovie, DaVinci Resolve | For 25 computers | 1:1 |
|  | Web Browsers | Chrome, Firefox, Edge, Safari | For 25 computers | 1:1 |
| **D** | **Consumables** |  |  |  |
|  | Pens, pencils, rulers and paper | Whiteboard markers, 2H pencils, plastic rulers, A2 white papers | Enough |  |
|  | Printing papers | A4 and A3 | Enough |  |

## COMMUNICATION SKILLS

**UNIT CODE:** 0031441 02B

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply communication skills

**Duration of Unit:** 40 hours

**Unit Description**

This unit covers the competencies required to apply communication skills. It involves applying communication channels, written, non-verbal, oral, and group communication skills.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
|  | **Learning Outcome** | **Duration in hours.** |
|  | To Apply Communication Channels. | 10 |
|  | To Apply Written Communication Skills. | 12 |
|  | To Apply Non-Verbal Skills. | 4 |
|  | To Apply Oral Communication Skills. | 4 |
|  | To Apply Group Communication Skills. | 10 |
|  | **TOTAL** | **40** |

**Learning Outcomes, Content, and Suggested Assessment Methods**

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Apply communication channels | 1. Communication process 2. Principles of effective communication 3. Channels medium modes of communication 4. Factors to consider when selecting a channel of communication 5. Barriers to effective communication 6. Flow patterns of communication 7. Sources of information 8. Organizational policies | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Apply written communication skills | 1. Types of written communication 2. Elements of communication 3. Organization requirements for written communication | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Apply non-verbal communication skills | 1. Utilize body language and 2. gestures 3. Apply body posture 4. Apply workplace dressing code | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Apply oral communication skills | 1. Types of oral communication pathways 2. Effective questioning techniques 3. Workplace etiquette 4. Active listening | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Apply group discussion skills | 1. Establishing rapport 2. Facilitating resolution of issues 3. Developing action plans 4. Group organization techniques 5. Turn-taking techniques 6. Conflict resolution techniques 7. Team-work | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |

**Suggested Methods of Instruction**

* Discussion
* Roleplaying
* Simulation
* Direct instruction
* Demonstration
* Field trips

**Recommended Resources for 25 trainees**

|  |  |  |
| --- | --- | --- |
| **General Resources** | **Tools and Equipment** | **Materials and Supplies** |
| * 25 Desktop computers laptops | Mobile phones | Flashcards |
| * Internet connection |  | Flip charts |
| * 1 Projector * 1 Printer |  | 2 packets of assorted colors of whiteboard marker pens |
| * 1 Whiteboard |  | Printing papers |
| * Report writing templates |  |  |

## ENGINEERING TECHNICIAN MATHEMATICS II

**UNIT CODE:** 0541441 06A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply engineering technician mathematics II.

**Duration of Unit**: 60 hours.

**Unit Description:**

This unit describes the competencies required by a technician in order to apply engineering technician mathematics. It enables the learner to; apply statistics and probability, matrices, and vector theorem, and carry out binomial expansion.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration in hours.** |
|  | To Apply statistics and probability | 15 |
|  | To Apply matrices | 15 |
|  | To Apply vector theorem | 15 |
|  | To Carry out binomial expansion | 15 |
|  | **TOTAL** | **60** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| * + - 1. Apply statistics and probability | 1. Measures of central tendency mean, mode and median 2. Measures of dispersion 3. Variance and standard deviation 4. Definition of probability 5. Laws of probability 6. Expectation variance and SD 7. Calculations involving discrete and continuous random variables. 8. Types of distributions 9. Binomial 10. Poisson 11. Normal 12. Mean, variance and SD of probability distributions 13. Application of probability distributions | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment   Oral Questioning |
| * + - 1. Apply matrices | * 1. Introduction to matrices      1. Definition of a matrix.      2. Different types of matrices: row, column, square, rectangular, diagonal, identity, zero.      3. Notation and elements of a matrix.      4. Basic operations: addition, subtraction, scalar multiplication.      5. Special Matrices         1. Identity matrix, diagonal matrix, symmetric matrix, skew-symmetric matrix.   2. Matrix Multiplication      1. Rules and properties of matrix multiplication.      2. Properties of Matrix Multiplication         1. Associative, distributive, and commutative properties.         2. Transpose of a matrix and properties.   3. Determinants and Inverses      1. Calculating determinants for 2x2 and 3x3 matrices.      2. Methods to find the inverse (adjoint method, Gauss-Jordan elimination).      3. Conditions for the existence of an inverse.   4. Solving Systems of Linear Equations      1. Representation of linear systems using matrices.      2. Application of Cramer's rule for solving systems of linear equations.      3. Using the inverse matrix inverse method to solve linear systems.   5. Using the inverse determinant method to solve linear systems. | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| * + - 1. Apply vector theorem | * 1. Vectors and scalar in two and three dimensions   2. Operations on vectors: Addition and subtraction   3. Position vectors   4. Resolution of vectors   5. Scalar and vector product | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| * + - 1. Carry out binomial expansion | * 1. Basic concepts of binomial theorem      1. Binomial expressions and notation.      2. Factorials and their use in binomial coefficients.      3. Binomial Coefficients         1. Definition and calculation using combinations (nCr).         2. Pascal’s Triangle as a tool for finding binomial coefficients.   2. Binomial Expansion      1. General form of the binomial expansion expression      2. Binomial Expansion of where      3. Special cases         1. When         2. Negative and fractional binomial expansions using the binomial series   3. Applications of Binomial Expansion      1. Simplifying algebraic expressions using binomial expansion.      2. Solving polynomial equations.   4. Engineering Applications   5. Estimating values in engineering calculations. | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |

**Suggested Delivery Methods**

* Demonstration
* Discussions
* Practical
* Project work
* Direct instruction

**List of Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/**  **Specifications** | **Quantity** | **Recommended**  **Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Textbooks | Engineering Mathematics by K.A. Stroud  Advanced Engineering Mathematics by Erwin Kreyszig | 5 pcs  5 pcs | 1:5  1:5 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture/theory room | 60m2 | 1 | 1:25 |
|  | Computer | Operating System: 64-bit Windows 11 or 10 version 1809 or above  Processor: 2.5 GHz (3+ GHz recommended),  Memory: 8 GB (32GB recommended)  Disk space: 10 GB  Display: 1920 x 1080 resolution  Display Card: 2 GB GPU (8 GB recommended) and DirectX 11 compliant (DirectX 12 recommended) | 25 pcs | 1:1 |
|  | Projector |  | 1 | 1:25 |
|  | Interactive screen | Specifications: 77-inch interactive whiteboard with touch and pen functionality. | 1 | 1:25 |
| **C** | **Software** | | | |
|  | MATLAB | License: Educational licenses available.  Features: Matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, interfacing with programs in other languages. | Installed in 25 computers | 1:1 |
|  | GeoGebra | License: Free educational software.  Interactive geometry, algebra, statistics, and calculus applications | Installed in 25 computers | 1:1 |
| **D** | **Consumables** |  |  |  |
|  | Pens, pencils, rulers and paper | Whiteboard markers, 2H pencils, plastic rulers, A2 white papers | Enough |  |

## ELECTRICAL PRINCIPLES I

**UNIT CODE:** 0713441 12A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply electrical principles I.

**Duration of Unit:** 80 HOURS

**UNIT DESCRIPTION**

This unit describes competences required to apply electrical principles I. It involves applying electrical quantities, use cells and batteries and apply concepts of dc circuit.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
|  | **Learning Outcome** | **Duration in hours.** |
|  | Applying Electrical quantities | 20 |
|  | Use cells and batteries | 30 |
|  | Apply DC circuit | 30 |
|  | **TOTAL** | **80** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply Electrical quantities | 1. The meaning of SI unit 2. SI unit of various types of Electrical parameters 3. Ohm’s law 4. Calculations involving various Electrical parameters e.g. Power, Current, Voltage, Resistance 5. Instruments used in measuring various types of Electrical parameters | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Use cells and batteries | 1. Sources of electricity 2. electrolysis and its applications 3. Simple cells 4. Primary and secondary cells 5. Types of cells and batteries 6. Dry cells 7. Leclanché 8. Mercury 9. Lead-acid 10. Alkaline 11. Lithium 12. E.m.f and internal resistance of cells 13. Maintenance of batteries 14. Applications of batteries | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Apply DC circuit | 1. Resistance and resistivity 2. Parallel and series circuits 3. Basic electrical laws 4. Ohms law 5. DC theorems 6. Kirchhoff’s theorem 7. Superposition theorem 8. Thevenin’s theorem 9. Norton theorem 10. Maxwell theorem | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group Discussions
* Field trips
* On-job-training

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Textbooks | J. Bird Electrical and Electronic Principles  V.K. Mehta & R. Mehta Basic Electrical Engineering | 5 pcs | 1:5 |
|  | Installation manuals | Electronic components datasheets | 5 pcs | 1:5 |
|  | Charts | Circuit diagrams  Colour codes | 1 pcs for each | 1:25 |
|  | Scientific Calculators |  | 25 | 1:1 |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
| 1. 1. | Lecture/theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
| **C** | **Consumable materials** |  |  |  |
| 1. 1. | Connector wires | Jumper wires, | 5 pkts | 1:5 |
| 1. 2. | Insulation tapes |  | 25 pcs | 1:1 |
|  | Circuit boards | Bread board, copper strip boards | 25 pcs | 1:1 |
|  | Assorted electronic components | Resistors, diodes, capacitors, transistors, ICs, Transformers, Inductors, Batteries | 25 pcs | 1:1 |
|  | Soldering wires |  | 5 rolls | 1:5 |
| **D** | **Tools and Equipment** | | | |
| 1. 1. | Striping knives |  | 25 pcs | 1:1 |
| 1. 2. | Side cutters |  | 25 pcs | 1:1 |
| 1. 3. | Pliers |  | 25 pcs | 1:1 |
|  | Assorted Screw driver |  | 25 pcs | 1:1 |
|  | Crimping tools |  | 5 pcs | 1:5 |
|  | PPEs |  | 25 pcs | 1:1 |
|  | Multimeters |  | 5 pcs | 1:5 |
|  | Oscilloscope |  | 5 pcs | 1:5 |
|  | Function generator |  | 5 pcs | 1:5 |
|  | Spectrum analyser |  | 5 pcs | 1:5 |
|  | Variable power supply |  | 5 pcs | 1:5 |
|  | Solder guns |  | 25 pcs | 1:1 |
|  | Hot air gun |  | 5 pcs | 1:5 |
|  | Work stations |  | 25 | 1:1 |

## DENTAL EQUIPMENT

**UNIT CODE:** 0914551 19A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Perform dental equipment maintenance.

**Duration of Unit:** 90 Hours

**Unit Description**

This unit specifies the competencies required to perform dental equipment maintenance. It involves dental unit, amalgamator, light cure machine, dental laser, dental x-ray, dental laboratory equipment, and dental scaler.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration in hours.** |
|  | To Maintain Dental Unit Maintenance | 20 |
|  | To Maintain Amalgamator Maintenance | 10 |
|  | To Maintain Light Cure Machine Maintenance | 10 |
|  | To Maintain Dental Scaler Maintenance | 10 |
|  | To Maintain Dental X-Ray Machine Maintenance | 10 |
|  | To Maintain Dental Laboratory Equipment Maintenance | 20 |
|  | To Maintain Dental Laser Equipment | 10 |
|  | **TOTAL** | **90** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Maintain Dental Unit | 1. Functions of dental unit 2. Parts of dental units 3. Compressor 4. Handpieces 5. Inter-oral camera 6. Dental Chair 7. Examination Lamp 8. Spittoon bowl / cuspidor 9. Utility box 10. Classification of dental chairs     1. Hydraulic-mechanical     2. Electro-hydraulic     3. Electro-mechanical 11. Components of various dental chairs     1. Hydraulic pump     2. Hydraulic valves     3. Pump motor     4. Limit switches     5. Solenoid valves     6. Oil reservoirs 12. Maintenance procedures of dental chairs. 13. Functions of a dental unit     1. Cutting     2. Descaling     3. Suction     4. Drilling 14. Description of the layout of the supplies to the dental unit and drainage 15. Hand pieces     1. Micrometer drill     2. Turbine     3. Spray unit     4. Suction device     5. Descaler     6. Light cure     7. Sensitivity tester 16. Operating principles of different hand pieces of a dental unit 17. Dental unit supplies     1. Electricity     2. Water     3. Compressed air     4. Vacuum 18. Supply diagram of the hand pieces for a dental unit 19. Maintenance procedures of a dental unit. 20. Safety tests     1. Safety valves     2. Water spillage 21. Earth leakage | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Maintain Amalgamator | 1. Functions of Amalgamator 2. Parts of Amalgamator 3. Time setting 4. LCD display 5. Rubber tray 6. Clip 7. Start/stop buttons 8. Maintenance procedures 9. Safety procedures | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Maintain Light Cure Machine | 1. Overview of light curing 2. Principles of Light-Curing 3. Polymerization of Composites: 4. Photo-initiators: 5. Light Wavelengths and Energy Output 6. Types of Light-Curing Units (LCUs) 7. Halogen Curing Lights 8. LED (Light-Emitting Diode) Curing Light 9. Plasma Arc Curing (PAC) Lights 10. Laser Curing Units 11. Curing Techniques 12. Safety Measures 13. Fault diagnosis 14. Maintenance procedures | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Maintain Dental Scaler | 1. Definition and purpose of dental scaling 2. Types and Components of scalers (manual and ultrasonic) 3. Curettes 4. Sickle scalers 5. Ultrasonic scalers 6. Safety Measures 7. Fault diagnosis 8. Maintenance procedures | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Maintain Dental X-Ray Machine | 1. Brief Physics of Dental X-rays and production. 2. Parts of Dental X-Ray Machine 3. X-ray tube 4. Collimator 5. Arms 6. Control panel 7. Position indicating device 8. Main parts of an X-ray tube    1. Cathode    2. Focusing cup    3. Filament    4. Anode    5. Vacuum glass envelope    6. High tension cables    7. Control cables 9. Block diagram of X-ray machine 10. Electric circuits and controls 11. Operation of control 12. Fault diagnosis 13. Maintenance procedures 14. Safety procedures 15. Calibration of the dental X-ray machines | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Maintain Dental Laboratory Equipment | 1. Functions of dental laboratory equipment 2. Parts of dental laboratory equipment 3. Dental Microscope 4. Dental Scanner 5. Porcelain Machine 6. Model trimmer 7. Suspension motor 8. Maintenance procedures of dental laboratory equipment 9. Safety procedures | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Maintain Dental laser Equipment | 1. Basic Principles of Laser Technology 2. Types of Lasers Used in Dentistry 3. Parts of Dental laser Equipment 4. Laser Unit 5. Handpiece 6. Fiber Optic Cable 7. Safety Interlocks 8. Beam Delivery System 9. Calibration Tools 10. Laser Safety and Maintenance 11. Fault diagnosis 12. Maintenance procedures | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group Discussions
* Role Play
* Interactive lectures
* Individual Assignments
* Industial Attachments
* Viewing of Related Videos
* Clinical and Hospital Trips

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category Item** | **Description Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | | |
|  | Reference books | Dental Instruments: A Pocket Guide by Linda R. Bartolomucci-Boyd:  Modern Dental Assisting by Doni L. Bird and Debbie Robinson: | 5 pcs for each | 1:5 |
|  | Maintenance manuals | Assorted Systems component Maintenance reports, manufacture’s manuals and data sheets  Instrumentation Handbooks | 5 pcs for each | 1:5 |
|  | Charts | Assorted ICU and Theatre equipment diagrams  Equipment block diagram charts | 1 pc for each | 1:25 |
|  | Software | Assorted installation software for the equipment | 25 | 1:1 |
|  | Audio visual presentations | Projector | 1 | 1:25 |
| **B** | **Learning Facilities & Infrastructure** | | | | |
|  | Lecture theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Simulation Lab | 100m2 | 1 | 1:25 |
|  | Clinical Rotations | Operating room, ICU | 1 | 1:25 |
| **C** | **Consumable Materials** | | | | |
|  | Installation materials | Insulation tape, cables, | 25 pcs for each | 1:1 |
|  | Maintenance materials | Wipes, spare batteries, sanitizer, service kits | 25 pcs for each | 1:1 |
|  | Assorted electrical components | Contactors, transformer, overload relays, timers | 25 pcs for each | 1:1 |
|  | Assorted instrumentation components | Sensors, transducers, actuators, cuvettes | 25 pcs for each | 1:5 |
| **D** | **Tools & Equipment** | | | | |
|  | Assorted tools and equipment | Side cutters, Allen keys set, Side cutters, Pliers, Screw driver, Crimping tools, Multi-meter, Oscilloscope, Solder guns | 25 pcs for each | 1:1 |
|  | PPEs | Safety boots, overall, masks, gloves, antistatic shoes | 25 pcs for each | 1:1 |
|  | Hot air gun |  | 5 pcs | 1:5 |
|  | Blower |  | 5 pcs | 1:5 |
|  | Drilling machines |  | 5 pcs | 1:5 |
|  | Air Compressor with tubings |  | 2 pcs | 1:12 |
|  | Dental unit |  | 2 pcs | 1:12 |
|  | Amalgamator |  | 2 pcs | 1:12 |
|  | Light Cure |  | 3 pcs | 1:8 |
|  | Dental Scaler |  | 2 pcs | 1:12 |
|  | Dental X-Ray |  | 1 pc | 1:25 |
|  | Dental Laboratory Equipment | Assorted | 2 pcs | 1:12 |
|  | Dental laser |  | 2 pcs | 1:12 |

## HOSPITAL PLANT AND BUILDING SERVICES I

**UNIT CODE:** 0914551 36A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Perform hospital plant and building services I.

**Duration of Unit:** 120Hours

**Unit Description**

This unit specifies the competencies required to perform hospital plant and building services I maintenance. It involves performing hospital hygiene and sanitation equipment maintenance, performing water systems maintenance and performing steam systems maintenance.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration in hours.** |
|  | To perform hospital hygiene and sanitation equipment maintenance | 30 |
|  | To perform water systems maintenance | 50 |
|  | To perform steam systems maintenance | 40 |
|  | **TOTAL** | **120** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Install and Maintain hospital hygiene and sanitation equipment | 1. Micro Organisms    1. Pathogenic    2. Non-pathogenic. 2. Disinfection    1. methods of disinfections    2. types of disinfectants 3. Sterilization    1. Methods of sterilisation 4. Importance of sanitation and environmental management 5. Waste Management 6. Drainage systems 7. Natural treatment of sewage 8. Classes of hospital waste 9. Segregation 10. Handling and disposal methods 11. Radioactive waste. 12. Environmental aspects     1. Recycling of harmless waste     2. Gas waste toxic gas     3. Reclamation     4. Chemical reduction     5. Filtration 13. Incinerator working principle parts and maintenance 14. Microwave shredder working principle parts and maintenance | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Install and Maintain water systems | 1. Use of water in health facilities 2. Water sources 3. Water lifting methods    1. Traditional methods    2. Pumps       1. Centrifugal pumps       2. Reciprocating pumps       3. Hydraulic rams 4. Water distribution systems    1. Pressure    2. Flow rate    3. Pipe sizing    4. Valves    5. Airlocks    6. Taps    7. Gridiron    8. Branch (dead-ends)    9. Ring. 5. Water storage    1. types of tanks    2. tank sizes    3. material and costs    4. durability of tanks 6. Raw water treatment    1. Mechanical    2. Chemical    3. De-ionizing 7. Methods of water heating    1. Boiler    2. instant hot water heater    3. solar    4. central system    5. decentralized system 8. Functional principles    1. Gas boiler    2. Electric boiler    3. Fuel boiler 9. Instantaneous heaters 10. gas 11. electric 12. Water systems installation and Maintenance | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Install and Maintain steam systems | 1. Basic principles    1. Steam formation    2. Energy content    3. Steam tables 2. Steam generation    1. Boiler components    2. Boiler operations    3. Boiler maintenance 3. Steam distribution    1. Steam cycles    2. Steam controls    3. Steam regulators 4. Steam systems accessories 5. Pressure control 6. Water level control 7. Blow down 8. Start-up procedure 9. Feed water treatment 10. Steam traps 11. Strainers 12. Steam separators 13. Shut-off valves 14. Pressure reducing valves 15. Application of steam in hospitals     1. Sterilization     2. Heating     3. Kitchen     4. Laundry 16. Steam systems Maintenance 17. Legal and safety aspects of steam | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group discussions
* Role playing
* Interactive lectures
* Individual assignments
* Industrial attachment
* Viewing of related videos

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S No.** | **Category Item** | **Description Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Reference books | Safety and Health Management in Engineering – by Paul A. Erickson  Building Services Engineering – by David V. Chadderton  Guidelines for Design and Construction of Hospitals and Outpatient Facilities" – by The Facility Guidelines Institute (FGI)  Modern Refrigeration and Air Conditioning by Althouse, Turnquist, and Bracciano:  Medical Gas and Vacuum Systems Handbook:  NFPA 99: Health Care Facilities Code: | 5 pcs for each | 1:5 |
|  | Maintenance manuals | Assorted Systems component Maintenance reports, manufacture’s manuals and data sheets  Instrumentation Handbooks | 5 pcs for each | 1:5 |
|  | Charts | Assorted Hospital Plant and Building Services equipment diagrams  Equipment block diagram charts  Assorted Medical Gases and Vacuum equipment diagrams  Equipment lock diagram charts | 1 pcs for each | 1:25 |
|  | Software | Assorted installation software for the equipment | 25 for each | 1:1 |
|  | Audio visual presentations | Projector | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Simulation Lab | 100m2 | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Installation materials | PPR welding machine  Fittings PPR elbow ¾ and ½  Fittings PPR union ¾ and ½  Fittings PPR Tee ¾ and ½  Fittings PPR reducer ¾ and ½  Fittings GI elbow ¾ and ½  Fittings GI union ¾ and ½  Fittings GI Tee ¾ and ½  Fittings GI reducer ¾ and ½  Tape measure  Thread tape  Pipe wrench  10 Litres tank  PPR pipe ¾ and ½  PPR pipe cutter  100L tanks  Sink assembly  GI pipe¾ and ½  PPR cutter  Insulation tape, cables, leak detector  Refrigeration thermometer  Refrigeration copper tube type L  Copper fittings (elbows, tee)  Brazing torch with horse pipe  Wrench Socket Spanner Set  Manifold gauge (with horses)  Charging valves  Flaring tool kit  Vacuum pump  MAPP gas  Copper brazing rod  Brazing White flux (500g)  Gloves ( heavy duty) | 25 pcs for each | 1:1 |
|  | Maintenance materials | Wipes, spare batteries ,sanitizer, service kits | 25 pcs for each | 1:1 |
|  | Assorted electrical components | Contactors, transformer, overload relays, timers | 25 pcs for each | 1:1 |
|  | Assorted instrumentation components | Sensors, transducers, actuators | 25 for each | 1:5 |
| **D** | **Tools and Equipment** | | | |
|  | Assorted tools and equipment | Side cutters, Side cutters, Pliers, Screw driver, Multi-meter, Allen keys set | 25 pcs for each | 1:1 |
|  | PPEs | Safety boots, overall, masks, gloves, antistatic shoes | 25 pcs for each | 1:1 |
|  | Hot air gun |  | 5 pcs | 1:5 |
|  | Water pumps |  | 5 pcs | 1:5 |
|  | Drilling machines |  | 5 pcs | 1:5 |
|  | laundry equipment |  | 2 pcs | 1:12 |
|  | Boiler assembly |  | 2 | 1:12 |
|  | Blower |  | 5 pcs | 1:5 |
|  | Drilling machines |  | 5 pcs | 1:5 |
|  | Oxygen Concentrator |  | 3 pcs | 1:8 |
|  | Suction Machine |  | 3 pcs | 1:8 |
|  | gas manifold |  | 5 pcs | 1:5 |

# MODULE III

## ANALOGUE ELECTRONICS I

**UNIT CODE:** 0714441 12A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply analogue electronics I.

**Duration of Unit:** 80 Hours

**UNIT DESCRIPTION**

This unit describes the competencies required to apply analogue electronics I. It involves applying semiconductor theory, semiconductor diodes, understanding of transistors, special semiconductor devices and performing rectification

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
|  | **Learning Outcome** | **Duration in hours.** |
|  | To understand semiconductor theory | 20 |
|  | To apply semiconductor diodes | 20 |
|  | To apply transistors | 20 |
|  | To apply special semiconductor devices | 10 |
|  | To perform rectification | 10 |
|  | **TOTAL** | **80** |

**Learning Outcomes, Content and Suggested Assessment Methods**

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Understand semiconductor theory | 1. Atomic structure 2. Structure of the Atom 3. Electron Configuration 4. Ions and Charge Carriers 5. Types of materials 6. Insulators 7. Conductors 8. Semiconductors 9. Semiconductor materials 10. Types of semiconductors materials 11. Intrinsic semiconductors 12. Extrinsic semiconductors     1. n-type extrinsic semiconductor     2. p-type extrinsic semiconductor 13. The pn junction 14. Properties of pn junction 15. Current flow in a forward biased pn junction 16. Current flow in a reverse biased pn junction 17. V-I characteristics of a pn junction | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Apply semiconductor diodes. | 1. Introduction to the crystal diode 2. Characteristics of the crystal diode 3. Resistance of a crystal diode 4. Equivalent circuit of the crystal diode 5. Biasing of the crystal diode 6. Foreward biasing 7. Reverse biasing 8. Limitations in the operating conditions of a crystal diode 9. forward current rating 10. PIV 11. power rating 12. Special purpose diodes 13. LED 14. Photodiode 15. Optoisolator 16. Tunnel diode 17. Varactor diode 18. Schockley diode 19. Application of semiconductor diodes | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Apply transistors. | 1. Bipolar junction transistors (BJTs) 2. Types and construction of BJT transistors 3. Operation of NPN and PNP transistors 4. Charactristics of BJTs, i.e., V-I, and gain 5. BJT configurations 6. Common emitter 7. Common base 8. Common collector 9. Characteristics of BJT connections 10. BJT transistor load line analysis 11. DC load line 12. AC load line 13. BJT transistor biasing methods 14. Key terms in transistor biasing (faithful amplification, variation of transistor parameters, stabilisation) 15. Base resistor, emitter bias, collector feedback, voltage divider biasing techniques 16. Field Effect Transistors (FETs) – JFET & MOSFET 17. P and N channels of FETs 18. Operation of FETs 19. Characteristics of FETs 20. Biasing techniques of FETs 21. Application of FETs | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Apply special semiconductor devices. | 1. Special semiconductor devices 2. SCR 3. LASCR 4. TRIAC 5. DIAC 6. SCS 7. UJT 8. Operation principle of special semiconductor devices 9. Schematic symbols of special semiconductor devices 10. Application of special semiconductor devices | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform rectification. | 1. Types of rectifiers 2. Half wave rectifiers 3. Full wave rectifiers (center-tap and bridge) 4. Classes of rectifiers 5. Uncontrolled Rectifier 6. Controlled Rectifier 7. Half-Controlled Rectifier 8. Fully-Controlled Rectifier 9. Application of rectifiers 10. Types of converters 11. AC to DC converter (rectifier) 12. DC to AC Converter (Inverter) 13. DC to DC Converter 14. AC to AC Converter 15. Application of converters | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group discussions
* Interactive lectures
* Industrial attachment
* Viewing of related videos

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S No.** | **Category Item** | **Description Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Reference books | Mehta, V. K., & Mehta, R. (2020). Principles of electronics (12 edition). S. Chand and Company Limited, Theraja, B. L., & Theraja, A. K. (2005).  A textbook of electrical technology (1st multicolour ed., Multicolour illustrative ed., 23rd rev. multicoloured ed). S. Chand & Co.  Bird, J. O. (2022). Bird’s electrical and electronic principles and technology (Seventh edition). Routledge, Taylor & Francis Group. | 10 pcs for each book | 1:2.5 |
|  | Software | Assorted simulation software  e.g., Circuit wizard. | 25 | 1:1 |
|  | Audio visual presentations | Projector | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Computer laboratory | 100m2 | 1 | 1:25 |
| **C** | **Consumable materials** |  |  |  |
|  | Electronic components | Breadboards, Stripboards, Jumper wires, Assorted resistors, Assorted capacitors, Assorted MOSFETs, Assorted JFETs, 555 timers, Solder wire, LEDs, Assorted BJT transistors, LDRs, OPAMPs, thermistors, 12V DC motors | 25 pcs | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | Assorted tools and equipment | Side cutters, Side cutters, Pliers, Screw driver, Crimping tools, Mult-meter, Solder guns | 25 pcs | 1:1 |
|  | Assorted electrical gadgets | Solder gun, Heat sink, Hot air guns, function generator | 25 pcs | 1:1 |
|  | Assorted measuring instruments | Digital Oscilloscope, | 5 for each category | 1:5 |
|  | Digital Multimeter, |  |  |  |
|  | Digital functional generator |  | 3 pcs | 1:8 |
|  | Laser jet printer |  | 2 pcs | 1:13 |
|  | Power supply | Variable power supply, 5V Power adapters, 9V Power adapters, 12V Power adapters. | 10 pcs | 1:3 |
|  | Trainers kit | Analogue training kits, PWM kit | 5 pcs | 1:5 |
|  | PCB prototyping material | Copper board, ferrite chloride solution, see-through printing paper, HASL finishing PCB | 25 for each category | 1:1 |
|  | Drilling gun |  | 3 pcs | 1:8 |
|  | Work stations |  | 25 | 1:1 |

## ELECTRICAL PRINCIPLES II

**UNIT CODE:** 0713441 16A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply electrical principles II.

**Duration of Unit:** 80 HOURS

**UNIT DESCRIPTION**

This unit describes competences required to apply electrical principles II. It involves applying magnetism and electromagnetism, applying electrostatics principles, applying AC circuits and conducting system earthing and protection.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration in hours.** |
|  | To Apply magnetism and electromagnetism | 10 |
|  | To Apply Electrostatics principles | 20 |
|  | To Apply AC circuits | 20 |
|  | To Conduct Electrical installation, system earthing and protection | 30 |
|  | **TOTAL** | **80** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply magnetism and electromagnetism | 1. Magnetic and non-magnetic materials 2. Concepts of magnetic fields and field distribution 3. Existence of magnetic field 4. Concepts of electromagnetism 5. Laws of electromagnetic induction 6. Screw rule 7. Grip 8. Flemings 9. Faradays 10. Concepts of self and mutual induction | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Apply Electrostatics principles | 1. Electrostatics quantities 2. Types of capacitors 3. Concept of charge and electrostatic field 4. Capacitors in series and parallel 5. Measurement of capacitance 6. Application of Capacitors 7. Testing of capacitor | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Apply A.C circuits concepts | 1. AC generators concepts 2. AC waveforms concepts 3. Derivation of generator e.m.f equation 4. Sine wave equations 5. Passive elements in AC circuits 6. Power triangle Active, Apparent and reactive power 7. Power factor correction 8. Methods of power factor correction | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Conduct Electrical installation, system earthing and protection | 1. Electrical installation 2. Preparation of cable ways and wiring systems 3. Call and alarm circuits installation 4. Domestic wiring circuits installation 5. Testing electrical installation 6. Application of System and equipment protection principles 7. Protection zones 8. Protection systems 9. Perform Protection system design 10. Protection system Drawings 11. Protection system Device sizing 12. Protection system Location 13. Design Earthing systems 14. TT 15. TNC 16. TNCS 17. IT 18. TNS 19. Perform Test on an earthing system 20. Earth resistance test 21. Earth loop impedance test 22. Identification of various types of lightning strikes based on Benjamin Franklin 23. Perform Lightning system design 24. Lightning arrestors 25. Lightning design drawing 26. Size of lightning system | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group Discussions
* Field trips
* On-job-training

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Textbooks | J. Bird Electrical and Electronic Principles  V.K. Mehta & R. Mehta Basic Electrical Engineering | 5 pcs | 1:5 |
|  | Installation manuals | Electronic components datasheets | 5 pcs | 1:5 |
|  | Charts | Circuit diagrams  Colour codes | 1 pcs for each | 1:25 |
|  | Scientific Calculators |  | 25 | 1:1 |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
| 1. 1. | Lecture/theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
| **C** | **Consumable materials** |  |  |  |
| 1. 1. | Connector wires | Jumper wires, | 5 pkts | 1:5 |
| 1. 2. | Insulation tapes |  | 25 pcs | 1:1 |
|  | Circuit boards | Bread board, copper strip boards | 25 pcs | 1:1 |
|  | Assorted electronic components | Resistors, diodes, capacitors, transistors, ICs, Transformers, Inductors, Batteries | 25 pcs | 1:1 |
|  | Soldering wires |  | 5 rolls | 1:5 |
| **D** | **Tools and Equipment** | | | |
|  | Striping knives |  | 25 pcs | 1:1 |
|  | Side cutters |  | 25 pcs | 1:1 |
|  | Pliers |  | 25 pcs | 1:1 |
|  | Assorted Screw driver |  | 25 pcs | 1:1 |
|  | Crimping tools |  | 5 pcs | 1:5 |
|  | PPEs |  | 25 pcs | 1:1 |
|  | Multimeters |  | 5 pcs | 1:5 |
|  | Oscilloscope |  | 5 pcs | 1:5 |
|  | Function generator |  | 5 pcs | 1:5 |
|  | Spectrum analyser |  | 5 pcs | 1:5 |
|  | Variable power supply |  | 5 pcs | 1:5 |
|  | Solder guns |  | 25 pcs | 1:1 |
|  | Hot air gun |  | 5 pcs | 1:5 |
|  | Work stations |  | 25 | 1:1 |

## TECHNICAL DRAWINGS 1

**UNIT CODE:** 0732441 19A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Prepare technical drawings I.

**Duration of Unit:** 60 HOURS

**UNIT DESCRIPTION**

This unit covers competences required to prepare engineering drawings I. It involves preparing drawing equipment and materials, producing plane geometry drawings, managing basic operations in AutoCAD and developing 2D Drawings in AutoCAD.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration in hours.** |
|  | To prepare drawing equipment and materials | 10 |
|  | To produce plane geometry drawings | 10 |
|  | To manage basic operations in AutoCAD | 15 |
|  | To develop 2D Drawings in AutoCAD | 15 |
|  | **TOTAL** | **60** |

**Learning Outcomes, Content and Suggested Assessment Methods:**

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Prepare drawing equipment and materials | 1. Identification and care of drawing equipment 2. Drawing boards 3. T and set squares 4. Drawing set etc 5. Identification and care of drawing materials 6. Drawing papers 7. Pencils 8. Erasers 9. Masking tapes 10. 2.5 Paper clips etc 11. Reference to manufacturer’s instructions and work place procedures on use and maintenance of drawing equipment and materials 12. Reference to relevant environmental legislations 13. Waste materials are disposed | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Produce plane geometry drawings | 1. Types of lines in drawings 2. Freehand printing of letters 3. Borderlines and title blocks 4. Construction of different angles 5. Measurement of different angles 6. Bisection of different angles and lines 7. Construction of geometric forms e.g.  Circles, Triangles, Rectangles, Parallelogram, Polygons, loci etc 8. Patterns development e.g cones, pyramids, prisms, cylinders 9. Different types of Tangents 10. Exterior tangents to a circle 11. Interior tangents to a circle 12.          Standard drawing conventions | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Manage basic operations in AutoCAD | 1. Identification of Key features of CAD software 2. 2D drafting and drawing 3. 3D drafting and drawing 4. AutoCAD visual reference commands 5. Visual styles 6. Materials and textures 7. Writing 8. Rendering 9. View port 10. AutoCAD ***ribbon*** tools 11. Draw panel 12. Modify panel 13. Layer 14. Annotation 15. AutoCAD ***status bar***tools 16. Snap 17. Grid 18. Ortho 19. Object snap 20. Polar tracking 21. Isometric drafting 22. AutoCAD navigation commands 23. AutoCAD drawing work 24.          Saving of AutoCAD drawing files in proper format | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Develop 2D Drawings in AutoCAD | 1. Setting  up of Drawing interface. 2. Creating drawing Layouts 3. Creation of 2D drawings 4. Editing/modification of 2D drawings 5. Saving AutoCAD drawings 6. AutoCAD 2D drawing work | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |

**Suggested Methods of Delivery**

* Practical
* Projects
* Demonstrations
* Group discussions
* Interactive lectures
* Industrial attachment
* Viewing of related videos

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
| 1. | Textbooks | K.Morling Geometric and Engineering drawing | 5 pcs | 1:5 |
| 2. | Drawing instruments | T-squares, set squares, drawing sets, Masking tapes | 25 | 1:1 |
| 3. | Power point presentations | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
| 4. | Lecture/theory room | 50m2 | 1 | 1:25 |
| 5. | Computer Workshop | 200m2  Computers installed with relevant CAD packages | 1 | 1:25 |
| 6. | Drawing tables |  | 25 | 1:1 |

## MATERNITY EQUIPMENT

**UNIT CODE:** 0914451 30A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Perform maternity equipment maintenance.

**Duration of Unit:** 120Hours

**Unit Description**

This unit specifies the competencies required to perform maternity equipment maintenance. It involves maintaining infant incubator, continuous positive airway pressure (CPAP) machine, phototherapy machine, resuscitatiare, delivery bed, weighing balance, cardiotocography (CTG) machine and room warmers.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration in hours.** |
|  | To Maintain Infant Incubator | 25 |
|  | To Maintain Continuous Positive Airway Pressure (CPAP) Machine | 20 |
|  | To Maintain Phototherapy Machine | 10 |
|  | To Maintain Resuscitaire | 10 |
|  | To Maintain Delivery Bed | 15 |
|  | To Maintain Weighing Balance | 15 |
|  | To Maintain Cardiotocography (CTG) Machine | 10 |
|  | To Maintain Room Warmers | 15 |
|  | **TOTAL** | **120** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Maintain Infant Incubator | 1. Maternity layout. 2. Need of infant incubators 3. Parts of infant incubator 4. Hood/Canopy 5. Control valve 6. Heating element 7. Control panel 8. Distilled water reservoir 9. Air filter 10. Temperature probe 11. Fans 12. Principles of operation of different types of infant incubators 13. Heat source (types –bulbs, elements) 14. Temperature range 15. Temperature control 16. Ventilation 17. Fan fail and alarm 18. Oxygen supply and control 19. Humidity source and control 20. Safety alarms 21. Typical faults 22. Maintenance procedures of infant incubators 23. Calibration and safety tests on infant incubators | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Maintain continuous positive airway pressure (CPAP) Machine | 1. Definition and purpose indications of CPAP 2. Types and components of CPAP 3. Principle of operations 4. Fault diagnosis 5. Service kit components 6. Air filters 7. O-rings 8. Mask replacement 9. Maintenance procedures | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Maintain Phototherapy Machine | 1. Applications of phototherapy 2. Principle of Phototherapy 3. Wavelength of light used 4. Mechanism of action 5. Types and components of phototherapy machine. 6. Installation and Operation 7. Fault diagnosis 8. Maintenance procedures 9. Safety procedures | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Maintain Resuscitaire | 1. Importance of resuscitation in newborns 2. Components of the Resuscitaire Machine 3. Radiant Warmer 4. **Suction Unit** 5. Oxygen Delivery System 6. Bag-and-Mask Ventilation 7. Heart Rate and Oxygen Saturation Monitors 8. Principle of operation 9. Fault diagnosis 10. Maintenance procedures 11. Safety procedures | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Maintain Delivery Bed | 1. Functions of a delivery bed 2. Classification of delivery beds 3. Hydraulic-mechanical 4. Electro-hydraulic 5. Electro-mechanical 6. Working principles of various types of delivery bed 7. Maintenance procedures of a delivery bed | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Maintain Weighing balance | 1. Use of baby weighing scale/balance 2. Parts of baby weighing scale/balance 3. Base 4. Platter 5. Strain Gauge 6. Load cell 7. Principle of operation 8. Beam type − Spring type − Transducer principles (resistive, inductive and capacitive) 9. Fault diagnosis 10. Maintenance procedures 11. Calibration procedures on baby weighing scales | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Maintain Cardiotocography (CTG) Machine | 1. Use of CTG machine 2. Parts of CTG Machine 3. Transducer probes 4. Monitor 5. Doppler 6. Principle of operation Foetal Monitoring Techniques 7. Fault diagnosis 8. Maintenance procedures 9. Calibration procedures | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Maintain Room Warmers | 1. Use of Room Warmers 2. Parts of Room Warmers 3. Heating elements 4. Temperature regulator 5. Fan 6. Principle of operation 7. Fault diagnosis 8. Maintenance procedures | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group Discussions
* Role Play
* Interactive lectures
* Individual Assignments
* Industial Attachments
* Viewing of Related Videos
* Clinical and Hospital Trips

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S No.** | **Category Item** | **Description Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | | |
|  | Reference books | Sound Design for the maternity by David Grenfell:  Principles of Instrumental Analysis by Douglas A. Skoog, F. James Holler, and Stanley R. Crouch  Electrical Measurements and Instrumentation 2nd edition | 5 pcs for each | 1:5 |
|  | Maintenance manuals | Assorted Systems component Maintenance reports, manufacture’s manuals and data sheets  Instrumentation Handbooks | 5 pcs for each | 1:5 |
|  | Charts | Assorted maternity equipment diagrams  Equipment block diagram charts | 1 pc for each | 1:25 |
|  | Software | Assorted installation software for the equipment | 25 pcs for each | 1:1 |
|  | Audio visual presentations | Projector | 1 | 1:25 |
| **B** | **Learning Facilities & Infrastructure** | | | | |
|  | Lecture theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Simulation Lab | 100m2 | 1 | 1:25 |
|  | Clinical Rotations | Maternity departments | 1 | 1:25 |
| **C** | **Consumable Materials** | | | | |
|  | Installation materials | Insulation tape, cables. | 25 pcs for each | 1:1 |
|  | Maintenance materials | Wipes, spare batteries, sanitizer, service kits. | 25 pcs for each | 1:1 |
|  | Assorted electrical components | Contactors, transformer, overload relays, timers. | 25 pcs for each | 1:1 |
|  | Assorted instrumentation components | Sensors, transducers, actuators. | 25 pcs for each | 1:5 |
| **D** | **Tools & Equipment** | | | | |
|  | Assorted tools and equipment | Side cutters, Allen keys set, Side cutters, Pliers, Screw driver, Crimping tools, Multi-meter, Oscilloscope, Solder guns. | 25 pcs for each | 1:1 |
|  | PPEs | Safety boots, overall, masks, gloves, antistatic shoes. | 25 pcs for each | 1:1 |
|  | Hot air gun |  | 5 pcs | 1:5 |
|  | Blower |  | 5 pcs | 1:5 |
|  | Drilling machines |  | 5 pcs | 1:5 |
|  | Infant Incubator |  | 2 pcs | 1:12 |
|  | CPAP) Machine |  | 2 pcs | 1:12 |
|  | Phototherapy Machine |  | 3 pcs | 1:8 |
|  | Resuscitaire |  | 2 pcs | 1:12 |
|  | Delivery Bed |  | 1 pc | 1:25 |
|  | Weighing balance | Assorted | 2 pcs | 1:12 |
|  | Cardiotocography |  | 2 pcs | 1:12 |
|  | Room Warmers |  | 5 pcs | 1:5 |

## HOSPITAL PLANT AND BUILDING SERVICES II

**UNIT CODE:** 0914441 37A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Perform hospital plant and building services maintenance II.

**Duration of Unit:** 80Hours

**Unit Description**

This unit specifies the competencies required to perform hospital plant and building services maintenance II. It involves performing laundry equipment maintenance and medical gases maintenance and vacuum systems equipment maintenance.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration in hours.** |
|  | Perform laundry equipment maintenance | 40 |
|  | Perform Medical Gases maintenance | 20 |
|  | Perform vacuum systems Equipment maintenance | 20 |
|  | **TOTAL** | **80** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Perform laundry equipment maintenance | 1. Importance of laundry in hospital 2. Laundry equipment parts and working principle    1. Washing machine    2. Driers    3. Pressing boxes    4. Hydro-extractors 3. Maintenance procedures 4. Energy and other supplies 5. Electricity 6. Gas 7. Water 8. Steam | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Medical Gases maintenance | 1. Basics of Oxygen Production 2. Pressure Swing Adsorption (PSA) 3. Cryogenic Air Separation 4. Vacuum Swing Adsorption (VSA) 5. Electrolysis of Water 6. Chemical Methods 7. Types of oxygen plants 8. Components/parts of an Oxygen Plant 9. Distribution System 10. Oxygen Plant Maintenance 11. Working Mechanism of Oxygen Concentrators 12. Components/parts of an Oxygen Concentrator 13. Types of Oxygen Concentrators 14. Oxygen Concentrator Maintenance 15. Piping system components/parts 16. Pipe work processes 17. Choice of correct pipe. 18. Medical air applications in hospitals and healthcare facilities 19. Air Generation and its controlling mechanism 20. Components of Medical Air Systems 21. Uses and types of Gas Manifolds 22. Gas Properties 23. Manifold Components and Functionality 24. Design Considerations 25. Installation Procedures 26. Maintenance procedures 27. Safety procedures | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform vacuum systems Equipment maintenance | 1. Applications of vacuum in medical field 2. Components of a Vacuum Plant 3. Operation of Vacuum Plants 4. Maintenance procedures 5. Parts of Suction Machine. 6. Operation and Fault diagnosis 7. Maintenance proceduresS | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group discussions
* Role playing
* Interactive lectures
* Individual assignments
* Industrial attachment
* Viewing of related videos

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S No.** | **Category Item** | **Description Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Reference books | Safety and Health Management in Engineering – by Paul A. Erickson  Building Services Engineering – by David V. Chadderton  Guidelines for Design and Construction of Hospitals and Outpatient Facilities" – by The Facility Guidelines Institute (FGI)  Modern Refrigeration and Air Conditioning by Althouse, Turnquist, and Bracciano:  Medical Gas and Vacuum Systems Handbook:  NFPA 99: Health Care Facilities Code: | 5 pcs for each | 1:5 |
|  | Maintenance manuals | Assorted Systems component Maintenance reports, manufacture’s manuals and data sheets  Instrumentation Handbooks | 5 pcs for each | 1:5 |
|  | Charts | Assorted Hospital Plant and Building Services equipment diagrams  Equipment block diagram charts  Assorted Medical Gases and Vacuum equipment diagrams  Equipment lock diagram charts | 1 pcs for each | 1:25 |
|  | Software | Assorted installation software for the equipment | 25 for each | 1:1 |
|  | Audio visual presentations | Projector | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Simulation Lab | 100m2 | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Installation materials | PPR welding machine  Fittings PPR elbow ¾ and ½  Fittings PPR union ¾ and ½  Fittings PPR Tee ¾ and ½  Fittings PPR reducer ¾ and ½  Fittings GI elbow ¾ and ½  Fittings GI union ¾ and ½  Fittings GI Tee ¾ and ½  Fittings GI reducer ¾ and ½  Tape measure  Thread tape  Pipe wrench  10 Litres tank  PPR pipe ¾ and ½  PPR pipe cutter  100L tanks  Sink assembly  GI pipe¾ and ½  PPR cutter  Insulation tape, cables, leak detector  Refrigeration thermometer  Refrigeration copper tube type L  Copper fittings (elbows, tee)  Brazing torch with horse pipe  Wrench Socket Spanner Set  Manifold gauge (with horses)  Charging valves  Flaring tool kit  Vacuum pump  MAPP gas  Copper brazing rod  Brazing White flux (500g)  Gloves (heavy duty) | 25 pcs for each | 1:1 |
|  | Maintenance materials | Wipes, spare batteries, sanitizer, service kits | 25 pcs for each | 1:1 |
|  | Assorted electrical components | Contactors, transformer, overload relays, timers | 25 pcs for each | 1:1 |
|  | Assorted instrumentation components | Sensors, transducers, actuators | 25 for each | 1:5 |
| **D** | **Tools and Equipment** | | | |
|  | Assorted tools and equipment | Side cutters, Side cutters, Pliers, Screw driver, Multi-meter, Allen keys set | 25 pcs for each | 1:1 |
|  | PPEs | Safety boots, overall, masks, gloves, antistatic shoes | 25 pcs for each | 1:1 |
|  | Hot air gun |  | 5 pcs | 1:5 |
|  | Water pumps |  | 5 pcs | 1:5 |
|  | Drilling machines |  | 5 pcs | 1:5 |
|  | laundry equipment |  | 2 pcs | 1:12 |
|  | Boiler assembly |  | 2 | 1:12 |
|  | Blower |  | 5 pcs | 1:5 |
|  | Drilling machines |  | 5 pcs | 1:5 |
|  | Oxygen Concentrator |  | 3 pcs | 1:8 |
|  | Suction Machine |  | 3 pcs | 1:8 |
|  | gas manifold |  | 5 pcs | 1:5 |

# MODULE IV

## ENTREPRENEURIAL SKILLS

**UNIT CODE:** 0413541 04B

**Relationship to occupational standards**

This unit addresses the unit of competency: Apply entrepreneurial skills.

**Duration of Unit:** 40 hours

**Unit Description:**

This unit covers the competencies required to demonstrate an understanding of entrepreneurship. It involves demonstrating an understanding of financial literacy, applying entrepreneurial concepts identifying entrepreneurship opportunities, applying business legal aspects, and developing business innovative strategies and business plans.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration in hours.** |
|  | To Apply Financial Literacy | 6 |
|  | To Apply the Entrepreneurial Concept | 4 |
|  | To Identify Entrepreneurship Opportunities | 6 |
|  | To Apply Business Legal Aspects | 6 |
|  | To Innovate Business Strategies | 6 |
|  | To Develop A Business Plan | 12 |
|  | **TOTAL** | **40** |

**Learning Outcomes, Content and Suggested Assessment Methods**

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Apply Financial Literacy | 1. Personal finance management 2. Balancing between needs and wants 3. Budget Preparation 4. Saving management 5. Factors to consider when deciding where to save 6. Debt management 7. Factors to consider before taking a loan 8. Investment decisions 9. Types of investments 10. Factors to consider when investing money 11. Insurance services 12. insurance products available in the market 13. Insurable risks | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Apply Entrepreneurial Concept | 1. Difference between Entrepreneurs and Business persons 2. Types of entrepreneurs 3. Ways of becoming an entrepreneur 4. Characteristics of Entrepreneurs 5. salaried employment and self-employment 6. Requirements for entry into self-employment 7. Roles of an Entrepreneur in an enterprise 8. Contributions of Entrepreneurship | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Identify Entrepreneurship Opportunities | 1. Sources of business ideas 2. Factors to consider when evaluating business opportunity 3. Business life cycle | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Apply Business Legal Aspects | 1. Forms of business ownership 2. Business registration and licensing processing 3. Types of contracts and agreements 4. Employment laws 5. Taxation laws | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Innovate Business Strategies | 1. Creativity in business 2. Innovative business strategies 3. Entrepreneurial Linkages 4. ICT in business growth and development | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Develop Business Plan | 1. Business description 2. Marketing plan 3. Organizational Management 4. plan 5. Production operation plan 6. Financial plan 7. Executive summary 8. Business plan presentation 9. Business idea incubation | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |

**Suggested Methods of Instruction**

* Direct instruction with active learning strategies
* Project (Business plan)
* Case studies
* Field trips
* Group Discussions
* Demonstration
* Question and answer
* Problem solving
* Experiential
* Team training
* Guest speakers

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Textbooks | J. Bird Electrical and Electronic Principles  V.K. Mehta & R. Mehta Basic Electrical Engineering | 5 pcs for each | 1:5 |
|  |  | Newspapers and Handouts | 5 pcs | 1:5 |
|  |  | Business Journals | 1 pc for each | 1:25 |
|  |  | Case studies | 5 pcs | 1:5 |
|  |  | Business plan templates | 5 pcs | 1:5 |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & Infrastructure** | | | |
|  | Lecture/theory room | 60m2 | 1 | 1:25 |
|  | Computer laboratory | 100m2 | 1 | 1:25 |

## ANALOGUE ELECTRONICS II

**UNIT CODE:** 0714441 13A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply analogue electronics II.

**Duration of Unit:** 70 HOURS

**UNIT DESCRIPTION**

This unit covers the competencies required in applying analogue electronics. It involves building amplifier circuits, constructing signal generators, signal filter circuits and applying opto-electronics.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
|  | **Learning Outcome** | **Duration in hours.** |
|  | To build amplifier circuits | 20 |
|  | To construct signal generators | 20 |
|  | To construct signal filter circuits | 20 |
|  | To apply Opto-Electronics | 10 |
|  | **TOTAL** | **70** |

**Learning Outcomes, Content and Suggested Assessment Methods**

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Build amplifier circuits | 1. Introduction to transistors 2. BJT transistors (NPN & PNP) 3. FET transistors (JFET & MOSFETs) 4. BJT transistors configurations 5. Biasing techniques 6. Transistor rating/limits 7. BJT and FET transistor applications 8. Amplifier Circuits 9. Operational amplifiers 10. Classical amplifier 11. Opamps 12. Amplifier ICs: 13. Common amplifier IC families, i.e., TDA, LM, LA series. 14. Benefits of ICs compared to discrete component amplifiers. 15. Assemble components, tools and equipment for amplifier circuit construction 16. Construct amplifier circuits 17. Single-stage CE amplifier 18. Two-stage amplifier 19. Op-Amp inverting and non-inverting amplifiers 20. Simple audio amplifiers using amplifier ICs 21. DC motor control 22. Test amplifier circuits 23. Measure voltage and current flow 24. Observe input and output voltage waveforms 25. Check for distortion 26. Confirm continuity and polarity using a multimeter | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Construct signal generators | 1. Introduction to: 2. Oscillators 3. Crystal oscillator (radio frequency generator) 4. Multivibrator circuits – bistable & astable (pulse generators) 5. Function generator 6. Assemble components, tools and equipment to construct signal generators 7. Assemble breadboards, resistors, capacitors, inductors, multimeters, power supplies, oscilloscopes, etc. 8. Signal generator circuits 9. Function generator 10. Radio Frequency generator 11. Audio signal generator 12. Pulse generator 13. Construct signal generator circuits 14. RC oscillator (sine waves) 15. Astable multivibrator (square waves) 16. Bistable multivibrator (square waves) 17. Generate waveforms using the function generator 18. Clock generator using the crystal oscillator 19. Audio frequency Opamp generator 20. Test signal generator circuits 21. Measure voltage, current, and display waveforms 22. Record the amplitude, frequency, and period | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Construct signal filter circuits | 1. Introduction to types of filters 2. Passive Filters, i.e., RC, RL, and LC filters. 3. Active Filters, i.e., op-amp-based filters (low-pass, high-pass, band-pass, band-stop). 4. Assemble components, tools and equipment to build signal filter circuits 5. resistors, capacitors, op-amps, breadboards, jumper wires, power supplies, multimeters and oscilloscopes. 6. Construct signal filter circuits; 7. Low-pass filter circuit 8. High-pass filter circuit 9. Band-pass filter circuit 10. Test signal filter circuits 11. Measure the output waveform 12. Verify the filter passes or blocks the correct frequency range. 13. Measure the cut-off frequency to match circuit specification. | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Apply opto-electronics | 1. Opto-electronic devices 2. LEDs 3. OLED 4. LASER diode 5. Photo transistors 6. Photo diodes 7. Optocoupler 8. LASCR 9. Liquid crystal displays 10. Dynamic scattering LCDs 11. Field effect scattering LCDs 12. LASERs and MASERs 13. Applications of optoelectronics | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group Discussions
* Role Play
* Interactive lectures
* Individual Assignments
* Industial Attachments
* Viewing of Related Videos
* Clinical and Hospital Trips

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
| 1. | Reference books | Mehta, V. K., & Mehta, R. (2020). Principles of electronics (12 edition). S. Chand and Company Limited, Theraja, B. L., & Theraja, A. K. (2005).  A textbook of electrical technology (1st multicolour ed., Multicolour illustrative ed., 23rd rev. multicoloured ed). S. Chand & Co.  Bird, J. O. (2022). Bird’s electrical and electronic principles and technology (Seventh edition). Routledge, Taylor & Francis Group.  Wilcher, D. (2015). Arduino electronics blueprints: make common electronic devices interact with an Arduino board to build amazing out-of-the-box projects. Packt Publishing.  Maini, A. K. (2008). Digital electronics: principles, devices and applications. Wiley India. | 10 pcs for each | 1:2.5 |
| 2. | Software | Assorted simulation software  e.g., Circuit wizard, Proteus, Multisim. | 25 | 1:1 |
| 3 | Audio visual presentations | Projector | 1 | 1:25 |
| **B** | **Learning Facilities & Infrastructure** | | | |
| 4 | Lecture/theory room | 60m2 | 1 | 1:25 |
| 5 | Workshop | 150m2 | 1 | 1:25 |
| 6 | Computer laboratory | 100m2 | 1 | 1:25 |
| **C** | **Consumable Materials** | | | |
| 7 | Resistors 1/4W rating | 1 Ω, 2.2 Ω, 3.3 Ω ,10 Ω, 22 Ω, 47 Ω, 68 Ω, 100 Ω, 120 Ω, 150 Ω, 220 Ω, 330 Ω, 470 Ω, 560 Ω 680 Ω, 1 kΩ, 1.2 kΩ, 2kΩ, 3.3 kΩ, 4.7 kΩ, 5.6kΩ, 10 kΩ, 22 kΩ, 33 kΩ, 47 kΩ, 100 kΩ, 220 kΩ, 330 kΩ, 470 kΩ, 1 MΩ, 2.2 MΩ | 100 pcs for each | 4:1 |
| 8 | Potentiometers | 1 kΩ, 10 kΩ, 50 kΩ, 100 kΩ | 50 pcs for each | 2:1 |
| 9 | Polarised electrolytic capacitors | **1µF**(16V, 25V, 50V), **4.7µF**(16V, 25V, 50V), **10µF**(16V, 25V, 50V, 63V), **22µF**(16V, 25V, 50V), **33µF**(25V, 35V, 50V), **47µF**(16V, 25V, 50V), **100µF**(16V, 25V, 35V, 50V), **220µF**(25V, 35V, 50V, 63V)  **470µF**(16V, 25V, 35V, 50V)  **1000µF**(16V, 25V, 35V, 50V), **2200µF**(25V, 35V, 50V), **4700µF**(25V, 35V, 50V) | 50 pcs for each | 2:1 |
| 10 | Ceramic capacitors assortment kit 10pf to 100nF (non-polarized) | **10pF**(100)**, 20pF**(200), **30pF**(300), **47pF**(470), **56pF**(560), **68pF**(680), **100pF**(101), **220pF**(221), **330pF**(331), **680pF**(681), **1nF**(102), **4.7nF**(472), **10nF**(101), **47nF**(471), **100nF**(104) | 50 pcs for each | 2:1 |
| 11 | Polyester film capacitor assortment kit - 0.22nF to 470nF / 100V (non-polarised) | **0.22nF**(221), **0.33nF**(331), **0.47nF**(471), **0.56nF**(561), **0.68nF**(681), **1nF**(102), **2.2nF**(222), **2.7nf**(272), **3.3nF**(332), **3.9nF**(392), **4.7nF**(472), **6.8nF**(682), **10nF**(103), **15nF**(153), **22nF**(223), **33nF**(333), **39nF**(393), **47nF**(473), **68nF**(683), **82nF**(823), **100nF**(104), **150nF**(154), **220nF**(224), **470nF**(474) | 50 pcs for each | 2:1 |
| 12 | Transformer | 120-240Vac, 12V-0-12V, 2A, 50Hz | 25 pcs for each | 1:1 |
| 13 | Rectifier diode | 1N4001, 1N4002. | 25 pcs for each | 2:1 |
| 14 | Zener diodes 0.5W | 5.1V, 7.5V, 12V, 18V, 24V | 25 pcs for each | 1:1 |
| 15 | Voltage regulators | L7805, L7809, L7812, L7815, L7824, L7905, L7912, | 25 pcs for each | 1:1 |
| 16 | MOSFET | IRFZ44N, IRF520, IRF540 | 25 pcs for each | 1:1 |
| 17 | Assorted colours of light emitting diodes (LEDs) | 3mm, 5mm | 500 pieces for each | 20:1 |
| 18 | Schottky diode | IN5817, IN5819 | 10 pcs for each | 1:3 |
| 19 | Strip boards | Stripboard 6.5cm x 14.5cm Single Sided | 50 pieces | 2:1 |
| 20 | Solder wire | 1mm-diameter, rosin activated, lead free soldering wire 50g | 2 pcs for each | 1:13 |
| 21 | Flux | Soldering paste flux 150g | 2 pcs for each | 1:13 |
| 22 | DIP IC sockets |  | 100 pieces | 4:1 |
| 23 | Assorted jumper wires (soft) for stripboard | Red, blue, green, yellow, black | 50 m for each | 2:1 |
| 24 | Assorted jumper wire (hard) for breadboard | Red, blue, green, black | 50 m for each | 2:1 |
| 25 | Audio connector jack pin |  | 50 pcs | 2:1 |
| 26 | Audio speaker |  | 25 pcs | 1:1 |
| 27 | Female - DC power connector |  | 25 pcs | 1:1 |
| 28 | Solder wire |  |  |  |
| 29 | Crocodile/ alligator clips | 50cm Test Leads Alligator Clips Double-end | 25 pcs for each | 1:1 |
| 30 | 555 Timer | NE555 IC DIP-8 | 25 pcs | 1:1 |
| 31 | Arduino 8-Bit Processor chip | Atmel's ATMega328P | 25 pcs | 1:1 |
| 32 | Arduino board | Arduino Uno R3 (with removable IC Chip) complete with USB Cable | 25 pcs | 1:1 |
| 33 | LCD display | LCD 20X4 (2004) | 25 pcs | 1:1 |
| 34 | Assorted jumpers with connector pins | M-M jumpers, M-F jumpers, F-F jumpers | 200 pcs for each | 8:1 |
| 35 | PIR Motion sensor module |  | 10 pcs | 1:3 |
| 35 | BJT (NPN) transistor | BC547, BC108, 2N3904, 2N2222, TIP31, | 50 pcs for each | 2:1 |
| 36 | BJT (PNP) transistor | BC557, 2N3906, 2N2907, TIP32, | 25 pcs for each | 1:1 |
| 37 | Light Dependent Resistor | LDR 12mm | 25 pcs | 1:1 |
| 38 | OPAMPs | LM358, LM741 | 25 pcs for each | 1:1 |
| 39 | Audio amplifier ICs | TDA2030, LM386, LA4445, LA4440 | 25 pcs for each | 1:1 |
| 40 | 74 series logic gates - TTL Logic | 7400, 7402, 7404, 7408, 7432, | 25 pcs for each | 1:1 |
| 41 | 4000-series CMOS ICs | CD4011, CD4013, CD4027, CD4026, CD4047, CD4060, CD4051, CD4052, CD4093 | 25 pcs for each | 1:1 |
| 42 | 74 series ICs | 74LS74, 74LS76, 74LS86, 74LS90, 74LS138, 74LS145, 74LS151, 74LS153 ICs | 25 pcs for each | 1:1 |
| 43 | SPDT Relay (125-250Vac) | 5V DC SPDT Relay, 12V DC SPDT Relay. | 25 pcs for each | 1:1 |
| 44 | Multi-channel Relay Module (125-250Vac) | 5V DC 4-Channel Relay,  12V DC 4-Channel Relay | 25 pcs for each | 1:1 |
| 45 | Push button non-self-locking | mini-switch | 25 | 1:1 |
| 46 | Push button self-locking | mini-switch | 25 | 1:1 |
| 47 | Slide switch SPDT 3 pins | mini-switch | 25 | 1:1 |
| 48 | DC motor | DC 3V-6V 2000RPM R140 motor | 10 pcs | 1:3 |
| 49 | NTC Thermistors | 10kΩ, 100kΩ | 25 pcs for each | 1:1 |
| 50 | Temperature sensor | Digital temperature sensor | 25 | 1:1 |
| 51 | Fluid level sensor | eTape Liquid Level Sensors | 2 pcs | 1:13 |
| 52 | Soil Moisture Sensor |  | 5 pcs | 1:5 |
| 53 | IR (infrared) sensor module |  | 13 pcs | 1:2 |
| 54 | Ultrasonic Sensor |  | 13 pcs | 1:2 |
| 55 | Temperature and Humidity Sensor |  | 13 pcs | 1:2 |
| 56 | Water Level Sensor Float Switch |  | 5 pcs | 1:5 |
| **D** | **Tools & Equipment** | | | |
| 57 | Computers |  | 25 pcs | 1:1 |
| 58 | Bread boards |  | 25 pcs | 1:1 |
| 59 | Assorted tools | Side cutters, Pliers, crimping, Tweezers, Long-nose, Assorted screw drivers. | 25 pcs for each | 1:1 |
| 60 | Solder gun/iron | Solder gun/iron 15W - 30W, Solder gun/iron 40W - 60W, | 25 pcs for each | 1:1 |
| 61 | Solder tip cleaning wire and holder |  | 25 pcs for each | 1:1 |
| 62 | Solder sucker |  | 25 pcs | 1:1 |
| 63 | Digital Oscilloscope, |  | 5 pcs | 1:5 |
| 64 | Digital Multimeter |  | 25 pcs | 1:1 |
| 65 | Digital functional generator |  | 5 pcs | 1:5 |
| 66 | Laser jet printer |  | 2 pcs | 1:13 |
| 67 | Variable power supply | With option for both voltage and current adjustment | 5 pcs | 1:5 |
| 68 | Power adapters | 5V Power adapters  9V Power adapters  12V Power adapters. | 10 pcs for each | 1:3 |
| 69 | Trainers kit | Analogue training kits, Digital training kits, | 5 pcs for each | 1:5 |
| 70 | PCB prototyping material | Copper board, ferrite chloride solution, see-through printing paper, HASL finishing PCB | 25 pcs for each | 1:1 |
| 71 | Drilling gun |  | 3 pcs | 1:8 |
| 72 | Work stations |  | 25 | 1:1 |
| **D** | **Software** | | | |
| 73 | Arduino IDE |  | Installed in 25 computers | 1:1 |
| 74 | Simulation software | Circuit wizard/Multisim/Proteus | Installed in 25 computers | 1:1 |

## ELECTRICAL PRINCIPLES III

**UNIT CODE:** 0713441 17A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply electrical principles III.

**Duration of Unit:** 80 HOURS

**UNIT DESCRIPTION**

This unit describes competences required to apply electrical principles III. It involves performing electrical measurements, applying basic electrical machines, applying three phase power supply and applying transients in dc circuits.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration in hours.** |
|  | To Perform electrical measurements. | 20 |
|  | To Apply basic electrical machines | 20 |
|  | To Apply three phase power supply | 20 |
|  | To Apply transients in DC Circuits | 20 |
|  | **TOTAL** | **80** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Perform electrical measurements | * 1. Types of transducers   2. Types of electrical instruments   3. Measurements of electrical quantities using Instruments   4. Calculations involving electrical instruments   5. Instrumental systematic errors   6. Calculations involving systematic errors | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Apply basic electrical machines | * 1. Electrical machines identification   2. electrical machines operations  1. DC motors 2. DC generators 3. AC single phase motors 4. AC three phase machines: Induction, Synchronous 5. Transformer    1. Derivation of generator e.m.f equation    2. Electrical machine control    3. Calculations involving electrical machines    4. Applications of electrical machines | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Apply three phase power supply | * 1. Principles of three phase power generation   2. Connections of three phase power supply  1. Star and delta connection    1. Calculations involving three phase power supply connections    2. Measurements of three phase power supply       1. One wattmeter method       2. Two wattmeter method       3. Three wattmeter method | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Apply transients in Electrical DC Circuits | * 1. Derivation of growth and decay equations in R-L and R-C circuits.   2. Sketching of Growth and decay curves in R-L and R-C circuits   3. Calculations involving Growth and decay in R-L and R-C circuits based on the time constants.   4. Application of the effect of time constant in switching inductive and capacitive loads   5. Analysis of Passive and active filters | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group Discussions
* Field trips
* On-job-training

s

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Textbooks | J. Bird Electrical and Electronic Principles  V.K. Mehta & R. Mehta Basic Electrical Engineering | 5 pcs | 1:5 |
|  | Installation manuals | Electronic components datasheets | 5 pcs | 1:5 |
|  | Charts | Circuit diagrams  Colour codes | 1 pcs for each | 1:25 |
|  | Scientific Calculators |  | 25 | 1:1 |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture/theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
| **C** | **Consumable materials** |  |  |  |
|  | Connector wires | Jumper wires, | 5 pkts | 1:5 |
|  | Insulation tapes |  | 25 pcs | 1:1 |
|  | Circuit boards | Bread board, copper strip boards | 25 pcs | 1:1 |
|  | Assorted electronic components | Resistors, diodes, capacitors, transistors, ICs, Transformers, Inductors, Batteries | 25 pcs | 1:1 |
|  | Soldering wires |  | 5 rolls | 1:5 |
| **D** | **Tools and Equipment** | | | |
| 1. 1. | Striping knives |  | 25 pcs | 1:1 |
| 1. 2. | Side cutters |  | 25 pcs | 1:1 |
| 1. 3. | Pliers |  | 25 pcs | 1:1 |
|  | Assorted Screw driver |  | 25 pcs | 1:1 |
|  | Crimping tools |  | 5 pcs | 1:5 |
|  | PPEs |  | 25 pcs | 1:1 |
|  | Multimeters |  | 5 pcs | 1:5 |
|  | Oscilloscope |  | 5 pcs | 1:5 |
|  | Function generator |  | 5 pcs | 1:5 |
|  | Spectrum analyser |  | 5 pcs | 1:5 |
|  | Variable power supply |  | 5 pcs | 1:5 |
|  | Solder guns |  | 25 pcs | 1:1 |
|  | Hot air gun |  | 5 pcs | 1:5 |
|  | Work stations |  | 25 | 1:1 |

## TECHNICAL DRAWINGS II

**UNIT CODE:** 0732441 20A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Prepare technical drawings II

**Duration of Unit:** 70 HOURS

**UNIT DESCRIPTION**

This unit covers competences required to prepare engineering drawings II. It involves Producing pictorial and orthographic drawings of components and electrical drawings.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration in hours.** |
|  | To Produce pictorial drawings of components | 15 |
|  | To Produce orthographic drawings of components | 15 |
|  | To Produce electrical drawings | 40 |
|  | **TOTAL** | **70** |

**Learning Outcomes, Content and Suggested Assessment Methods:**

| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| --- | --- | --- |
| 1. Produce pictorial drawings of components | 1. Meaning of pictorial drawings 2. Pictorial Drawings of Components 3. Isometric 4. Oblique 5. Cabinet Oblique 6. Meaning of symbols and abbreviations | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Produce orthographic drawings of components | 1. Drawing and interpretation of orthographic elevations 2. Dimensioning of orthographic elevations 3. Drawing objects in isometric view 4. Drawing objects in oblique view 5. Free hand sketching of different types of geometric forms, tools and equipment | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |
| 1. Produce electrical drawings | 1. Electrical symbols and abbreviations 2. Meaning of electrical drawings 3. Drawing of electrical diagrams e.g.  block, schematic, circuit, line and wiring 4. Drawing of Electrical and Electronic drawings using an appropriate CAD software e.g.  block, schematic, PCB, circuit, line and wiring 5. Simulation of Electrical and electronic drawings 6. Installation of Electrical components in a building plan using AutoCAD | * Practical Assessment * Project * Third Party Report * Portfolio of Evidence * Written Assessment * Oral Questioning |

**Suggested Methods of Delivery**

* Practical
* Projects
* Demonstrations
* Group discussions
* Interactive lectures
* Industrial attachment
* Viewing of related videos

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
| 1. | Textbooks | K.Morling Geometric and Engineering drawing | 5 pcs | 1:5 |
| 2. | Drawing instruments | T-squares, set squares, drawing sets, Masking tapes | 25 | 1:1 |
| 3. | Power point presentations | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
| 4. | Lecture/theory room | 50m2 | 1 | 1:25 |
| 5. | Computer Workshop | 200m2  Computers installed with relevant CAD packages | 1 | 1:25 |
| 6. | Drawing tables |  | 25 | 1:1 |

## DIAGNOSTIC AND LABORATORY EQUIPMENT I

**UNIT CODE:** 0914441 26A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Perform diagnostic and laboratory equipment maintenance I.

**Duration of Unit:** 80Hours

**Unit Description**

This unit specifies the competencies required to Perform diagnostic and laboratory equipment maintenance. It involves Performing vital-signs monitors maintenance, Microscope maintenance and centrifuge maintenance.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration in hours.** |
|  | To Perform vital-signs monitors maintenance | 40 |
|  | To Perform Microscope maintenance | 20 |
|  | To Perform Centrifuge Maintenance | 20 |
|  | **TOTAL** | **80** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Perform vital-signs monitors maintenance | 1. Meaning and function of a Blood Pressure Machine (BP) 2. Methods of blood pressure measurements 3. Types and parts of blood pressure machines 4. Blood pressure monitors 5. Stethoscope 6. Pulse sensors 7. Respiratory sensors 8. Common faults and maintenance of blood pressure machines and pressure monitors 9. Electromagnetic Blood Flowmeters 10. Blood Flow estimation by Radiographic method 11. Pulse Oximetery working and maintenance 12. Meaning and function of a Capnograph 13. Types of Capnograph machine 14. Parts of a Capnograph machine 15. Methods of Capnograph measurements 16. Common faults in Capnograph 17. Maintenance procedures 18. Blood gas analyzer working principle 19. Parts of a blood gas analyzer 20. Control devices of a blood gas analyzer 21. Maintenance procedures 22. Principles of EEG 23. Basic components of EEG 24. Maintenance procedures 25. Safety procedures 26. Calibration 27. Principles of ECG 28. Basic components of ECG 29. Maintenance procedures 30. Safety procedures 31. Calibration 32. Principles of glucometer 33. Basic components of glucometer 34. Maintenance procedures 35. Safety procedures 36. Calibration 37. Components of diagnostic set 38. Principles of bilirubinometer 39. Basic components of bilirubinometer 40. Maintenance procedures 41. Safety procedures 42. Calibration | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Microscope maintenance | 1. Principles of microscopy 2. Function of a microscope 3. Parts of a microscope 4. Base 5. Stage 6. Lenses 7. Adjustment knobs 8. Types of a microscope    1. Light microscope    2. Fluorescent microscope    3. Electron microscope 9. Operation principles of microscopes 10. Optical system of a microscope 11. Common faults 12. Maintenance procedures | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Centrifuge Maintenance | 1. Principles of centrifuge 2. Function of a centrifuge 3. Parts of a centrifuge 4. Types of a centrifuge 5. Manual centrifuge 6. Electrical centrifuge 7. Table top/bench top 8. Haematocrit 9. Ultracentrifuge 10. Refrigerated centrifuge 11. Operation principles of a centrifuge 12. Control devices of a centrifuge 13. Maintenance procedures 14. Safety procedures. | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group discussions
* Interactive lectures
* Industrial attachment
* Viewing of related videos

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S No.** | **Category Item** | **Description Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Reference books | Principles of Instrumental Analysis by Douglas A. Skoog, F. James Holler, and Stanley R. Crouch  Electrical Measurements and Instrumentation 2nd edition | 5 pcs for each | 1:5 |
|  | Maintenance manuals | Assorted Systems component Maintenance reports, manufacture’s manuals and data sheets  Instrumentation Handbooks | 5 pcs for each | 1:5 |
|  | Charts | Assorted diagnostic and lab equipment diagrams  Equipment block diagram charts | 1 pcs for each | 1:25 |
|  | Software | Assorted installation software for the equipment | 25 for each | 1:1 |
|  | Audio visual presentations | Projector | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Computer laboratory | 100m2 | 1 | 1:25 |
|  | Clinical rotations | OPD, Diagnostic and Laboratory department | 1 | 1 |
| **C** | **Consumable materials** |  |  |  |
|  | Installation materials | Insulation tape, cables, assorted electronic components | 25 pcs for each | 1:1 |
|  | Maintenance materials | Wipes, , spare batteries ,sanitizer, service kits | 25 pcs for each | 1:1 |
|  | Assorted electrical components | Contactors, transformer, overload relays, timers, resistors, ics capacitors, diodes, breadboards | 25 pcs for each | 1:1 |
|  | Assorted instrumentation components | Sensors, transducers, actuators , cuvettes | 25 for each | 1:5 |
| **D** | **Tools and Equipment** | | | |
|  | Assorted tools and equipment | Side cutters, Side cutters, Pliers, Screw driver, Crimping tools, Multi-meter, Oscilloscope, Solder guns, Allen keys set | 25 pcs for each | 1:1 |
|  | PPEs | Safety boots, overall, masks, gloves, antistatic shoes | 25 pcs for each | 1:1 |
|  | Hot air gun |  | 5 pcs | 1:5 |
|  | Blower |  | 5 pcs | 1:5 |
|  | Drilling machines |  | 5 pcs | 1:5 |
|  | Patient monitor |  | 5 pcs | 1:5 |
|  | Endoscopy Equipment |  | 2 pcs | 1:12 |
|  | ECG, EEG machine |  | 1 pcs | 1:25 |
|  | Capnograph |  | 2 pcs | 1:12 |
|  | Diagnostic Set |  | 12 pcs | 1:2 |
|  | Blood Pressure Machines |  | 12 pcs | 1:2 |
|  | Pulse Oximeter |  | 12 pcs | 1:2 |
|  | Electrocardiogram |  | 2 pcs | 1:12 |
|  | Glucometer |  | 12 pcs | 1:2 |
|  | Bilirubinometer |  | 12 pcs | 1:2 |
|  | Microscope |  | 5 pcs | 1:5 |
|  | Centrifuge |  | 5 pcs | 1:5 |
|  | Bacteriological  Incubator |  | 3 pcs | 1:8 |
|  | Hematology Analyzer |  | 3 pcs | 1:8 |
|  | Biochemistry Analyzer |  | 3 pcs | 1:8 |
|  | Electrolyte Analyzer |  | 3 pcs | 1:8 |
|  | Biosafety Cabinet |  | 2 pcs | 1:12 |
|  | photometer |  | 3 pcs | 1:8 |

## OPERATION THEATRE EQUIPMENT

**UNIT CODE:** 0914451 28A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Perform operation theatre equipment maintenance.

**Duration of Unit:** 120Hours

**Unit Description**

This unit specifies the competencies required to performing operation theatre equipment maintenance. It involves performing surgical diathermy equipment maintenance, anaesthesia equipment maintenance, operating theatre table maintenance, operating theatre light maintenance, patient monitor maintenance, CSSD equipment maintenance, C-arm equipment maintenance, cath lab machine maintenance and heart lung machine maintenance.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration in hours.** |
|  | To Perform Surgical Diathermy Equipment maintenance | 10 |
|  | To Perform Anaesthesia Equipment maintenance | 20 |
|  | To Perform Operating Theatre Table maintenance | 10 |
|  | To Perform Operating Theatre Light maintenance | 10 |
|  | To Perform Patient Monitor maintenance | 15 |
|  | To Perform CSSD Equipment maintenance | 15 |
|  | To Perform C-ARM Equipment maintenance | 15 |
|  | To Perform Cath Lab machine maintenance | 15 |
|  | To Perform Heart lung machine maintenance | 10 |
|  | **TOTAL** | **120** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Perform Surgical Diathermy Equipment maintenance | 1. Operation theatre layout 2. Methods and electrosurgery equipment. 3. High frequency thermal effect 4. Monopolar coagulation 5. Bipolar coagulation 6. Fulguration 7. Cutting (Blended cut) 8. Components of a typical electrosurgical Unit (ESU)    1. High frequency oscillators    2. Output power intensity control    3. Patient plate monitor    4. Modulating and output stage circuits    5. Neutral and active electrodes 9. Effects of current on biological tissue    1. Thermal effect    2. Faradic effect    3. Electrolytic effect 10. Maintenance procedure 11. User maintenance 12. Electrode care 13. Patient plate monitor positioning and care 14. Output power intensity adjustment 15. Technician maintenance 16. Electrode cleaning 17. Patient plate monitor alarm 18. Control circuitry 19. Safety precautions of electro-surgery | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Anaesthesia Equipment maintenance | 1. Principle of anaesthesia    1. Patient situation during operation    2. Anaesthesia effect during operation    3. Risks of anaesthesia 2. Main parts of anaesthetic machine 3. Anaesthesia gases 4. Vaporizers 5. BOYLES anaesthetic unit 6. Vaporizer 7. Ventilator 8. Scavenging System 9. Patient Monitor 10. Bellows 11. Flowmeter 12. Flowmeter tubes 13. Pressure regulator 14. Check valves 15. O-rings 16. Oxygen Sensor 17. Regulators 18. Breathing attachments 19. Operational principles of anaesthetic machine 20. Fault diagnosis 21. Maintenance of anaesthetic machine 22. Safety     1. Pin index     2. Connector system 23. Colour coding | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Operating Theatre Table maintenance | 1. Uses of operation theatre table 2. Types of operation theatre tables 3. Mechanical system 4. Hydraulic system 5. Electrical system 6. Main parts of operation theatre table 7. Arm rest 8. Head rest 9. Clamps 10. Base 11. Column 12. Requirements of operation theatre table 13. Fault diagnosis of theatre table 14. Maintenance procedures of typical faults. 15. Safety test | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Operating Theatre Light maintenance | 1. Requirements of operation theatre lamp 2. Main parts of theatre lamp    1. Arm rest    2. Head rest    3. Clamps    4. Base    5. Column 3. Features of theatre lamp    * 1. Focusing      2. Positioning      3. Dimmers      4. Filters 4. Mounting facilities 5. Electrical system    * 1. Switches      2. Relays      3. Change over systems 6. Fault diagnosis 7. Maintenance procedures of typical faults | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Patient Monitor maintenance | 1. Functions of patient monitors 2. Parts of patient monitoring system    1. ECG leads    2. Probes    3. NIBP Cuff    4. Display 3. Types of patient monitors    1. Electro-cardiogram (ECG)    2. Vital signs monitor    3. Pulmonary analyzer 4. Principle of operations of patient monitors 5. Fault diagnosis 6. Maintenance procedures 7. Safety procedures | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform CSSD Equipment maintenance | 1. CSSD equipment 2. Autoclave 3. Oven 4. Ultrasonic washer 5. UV steriliser 6. Autoclave general operation and working principle 7. Types of autoclaves 8. Vertical 9. Horizontal 10. Oven general operation and working principle 11. Ultrasonic washer general operation and working principle 12. UV sterilizer general operation and working principle. 13. (CSSD) Equipment Fault diagnosis 14. (CSSD) Equipment Maintenance procedures 15. (CSSD) Equipment Safety procedures | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform C-ARM Equipment maintenance | 1. Principle of C-arm Machine 2. Physical properties 3. Electrical electronic properties 4. Application of fluoroscopy 5. Diagnosis 6. Therapeutic 7. Parts of the C-arm machine 8. Maintenance procedures 9. Safety procedures | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Cath Lab machine maintenance | 1. Principle of Cath Lab Machine 2. Application of Cath Lab machine 3. Catheterization 4. Angioplasty 5. Parts of the Cath Lab machine 6. Maintenance procedures 7. Safety procedures | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Heart lung machine maintenance | 1. Functions of Heart lung machine 2. Parts of Heart lung machine 3. Principle of operations of Heart lung machine 4. Fault diagnosis 5. Maintenance procedures 6. Safety procedures | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group discussions
* Direct instructions
* Role playing
* Interactive lectures
* Individual assignments
* Industrial attachment
* Viewing of related videos

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S No.** | **Category Item** | **Description Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Reference books | Sound Design for the Theatre by David Grenfell:  Principles of Instrumental Analysis by Douglas A. Skoog, F. James Holler, and Stanley R. Crouch  Electrical Measurements and Instrumentation 2nd edition | 5 pcs for each | 1:5 |
|  | Maintenance manuals | Assorted Systems component Maintenance reports, manufacture’s manuals and data sheets  Instrumentation Handbooks | 5 pcs for each | 1:5 |
|  | Charts | Assorted Theatre equipment diagrams  Equipment block diagram charts | 1 pcs for each | 1:25 |
|  | Software | Assorted installation software for the equipment | 25 for each | 1:1 |
|  | Audio visual presentations | Projector | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Simulation Lab | 100m2 | 1 | 1:25 |
|  | Clinical Rotations | Operating theatre room | 1 | 1:25 |
| **C** | **Consumable materials** |  |  |  |
|  | Installation materials | Insulation tape, cables, | 25 pcs for each | 1:1 |
|  | Maintenance materials | Wipes, spare batteries ,sanitizer, service kits | 25 pcs for each | 1:1 |
|  | Assorted electrical components | Contactors, transformer, overload relays, timers | 25 pcs for each | 1:1 |
|  | Assorted instrumentation components | Sensors, transducers, actuators , cuvettes | 25 for each | 1:5 |
| **D** | **Tools and Equipment** | | | |
|  | Assorted tools and equipment | Side cutters, Side cutters, Pliers, Screw driver, Crimping tools, Multi-meter, Oscilloscope, Solder guns, Allen keys set | 25 pcs for each | 1:1 |
|  | PPEs | Safety boots, overall, masks, gloves, antistatic shoes | 25 pcs for each | 1:1 |
|  | Hot air gun |  | 5 pcs | 1:5 |
|  | Blower |  | 5 pcs | 1:5 |
|  | Drilling machines |  | 5 pcs | 1:5 |
|  | Surgical Diathermy |  | 2 pcs | 1:12 |
|  | Anaesthesia machine |  | 2 pcs | 1:12 |
|  | Operating Theatre |  | 3 pcs | 1:8 |
|  | Operating Theatre Light |  | 2 pcs | 1:12 |
|  | Patient Monitor |  | 5 pcs | 1:5 |
|  | CSSD Equipment | Assorted | 2 pcs for each | 1:12 |
|  | C-ARM Equipment |  | 1 pcs | 1:25 |
|  | Heart lung machine |  | 1pcs | 1:25 |

# MODULE V

## ENGINEERING TECHNICIAN MATHEMATICS III

**UNIT CODE:** 0541541 07A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply engineering technician mathematics III.

**Duration of Unit**: 80 hours.

**Unit Description**

This unit describes the competencies required by a technician in order to apply engineering technician mathematics III. It enables the learner to; apply differentiation, integration, solve partial differential and ordinary differential equations.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration in hours.** |
|  | To Apply differentiation | 10 |
|  | To Apply integration | 10 |
|  | To Solve partial differential and ordinary differential equations | 20 |
|  | **TOTAL** | **40** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply differentiation | * 1. Definition of derivatives of a function   2. Differentiation from fist principle   3. Tables of some common derivatives   4. Rules of differentiation      1. Sum and difference rule      2. Product rule      3. Quotient rule      4. Chain rule      5. Parametric differentiation      6. Implicit differentiation   5. Rate of change and small change   6. Stationery points of functions of two variables. | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Apply integration. | * 1. Definition of integration   2. Indefinite and definite integral   3. Methods of integration application of integration.      1. Substitution      2. Reduction formula      3. By parts      4. Partial fractions   4. Integrals of hyperbolic and inverse functions   5. Application of integration | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Solve partial differential equations and Ordinary differential equations | * 1. First order partial derivatives   2. Second order partial derivatives   3. Rates of change and small changes   4. Stationery points of functions of two variables   5. Types of first order differential equations      1. Separable variables      2. Exact      3. Linear      4. Homogeneous   6. Formation of first order differential equation   7. Solution of first order differential equations   8. Application of first order differential equations  1. Second order differential equations 2. Method of undetermined coefficients    1. D- operator method | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |

**Suggested Delivery Methods**

* Demonstration
* Discussions
* Practical
* Project work
* Direct instruction

**List of Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/**  **Specifications** | **Quantity** | **Recommended**  **Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Textbooks | Engineering Mathematics by K.A. Stroud  Advanced Engineering Mathematics by Erwin Kreyszig | 5 pcs  5 pcs | 1:5  1:5 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture/theory room | 60m2 | 1 | 1:25 |
|  | Computer | Operating System: 64-bit Windows 11 or 10 version 1809 or above  Processor: 2.5 GHz (3+ GHz recommended),  Memory: 8 GB (32GB recommended)  Disk space: 10 GB  Display: 1920 x 1080 resolution  Display Card: 2 GB GPU (8 GB recommended) and DirectX 11 compliant (DirectX 12 recommended) | 25 pcs | 1:1 |
|  | Projector |  | 1 | 1:25 |
|  | Interactive screen | Specifications: 77-inch interactive whiteboard with touch and pen functionality. | 1 | 1:25 |
| **C** | **Software** | | | |
|  | MATLAB | License: Educational licenses available.  Features: Matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, interfacing with programs in other languages. | Installed in 25 computers | 1:1 |
|  | GeoGebra | License: Free educational software.  Interactive geometry, algebra, statistics, and calculus applications | Installed in 25 computers | 1:1 |
| **D** | **Consumables** |  |  |  |
|  | Pens, pencils, rulers and paper | Whiteboard markers, 2H pencils, plastic rulers, A2 white papers | Enough |  |

## ELECTRICAL PRINCIPLES IV

**UNIT CODE:** 0713 541 18A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply electrical principles IV.

**Duration of Unit:** 60 HOURS

**Unit Description**

This unit describes competences required to apply electrical principles IV. It involves Apply illumination principles, apply two port networks and apply electromagnetic field.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
|  | **Learning Outcome** | **Duration in hours.** |
|  | To Apply illumination principles | 10 |
|  | To Apply Two Port networks | 20 |
|  | To Apply Electromagnetic field. | 30 |
|  | **TOTAL** | **60** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply Illumination Principles | * 1. Application of Laws of lighting   2. Calculations on Light requirements as laws of lighting   3. Selection of Electric luminaires   4. Design of lighting schemes | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Use Two Port networks | * 1. Analysis of basic passive networks based on black box technique   2. Determination of characteristic impedance   3. Derivation of ABCD constants   4. Application of cascaded networks as per network parameters.   5. Types of transmission lines and their applications | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Apply Electromagnetic field Theory | * 1. Identification of Electromagnetic radiation sources as per EN 300386 v1.6.1   2. Identification of detectors of Electromagnetic radiations as per EN 300386 v1.6   3. Application of electromagnetic waves as per EN 300386 v1.6.1   4. Identification of electromagnetics Laws based on Maxwell’s equation.   5. Calculations of   6. Electromagnetic wave parameters based on Maxwell’s equation.  1. Wavelength 2. Velocity 3. Frequency    1. Behaviours and effects of Electromagnetic waves    2. Identification of electrostatics terms.    3. Identification of Magneto statics terms    4. Identification of of Electrodynamics laws    5. Identification of Energy conservation theorem as per the Internal energy    6. Calculation of Electromagnetic Energy flow as per the Maxwell’s equations.    7. Calculation of Energy flow in an antenna as per the E-H propagation. | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group Discussions
* Field trips
* On-job-training

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Textbooks | J. Bird Electrical and Electronic Principles  V.K. Mehta & R. Mehta Basic Electrical Engineering | 5 pcs | 1:5 |
|  | Installation manuals | Electronic components datasheets | 5 pcs | 1:5 |
|  | Charts | Circuit diagrams  Colour codes | 1 pcs for each | 1:25 |
|  | Scientific Calculators |  | 25 | 1:1 |
|  | Power point presentations | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture/theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
| **C** | **Consumable materials** |  |  |  |
|  | Connector wires | Jumper wires, | 5 pkts | 1:5 |
|  | Insulation tapes |  | 25 pcs | 1:1 |
|  | Circuit boards | Bread board, copper strip boards | 25 pcs | 1:1 |
|  | Assorted electronic components | Resistors, diodes, capacitors, transistors, ICs, Transformers, Inductors, Batteries | 25 pcs | 1:1 |
|  | Soldering wires |  | 5 rolls | 1:5 |
| **D** | **Tools and Equipment** | | | |
|  | Striping knives |  | 25 pcs | 1:1 |
|  | Side cutters |  | 25 pcs | 1:1 |
|  | Pliers |  | 25 pcs | 1:1 |
|  | Assorted Screw driver |  | 25 pcs | 1:1 |
|  | Crimping tools |  | 5 pcs | 1:5 |
|  | PPEs |  | 25 pcs | 1:1 |
|  | Multimeters |  | 5 pcs | 1:5 |
|  | Oscilloscope |  | 5 pcs | 1:5 |
|  | Function generator |  | 5 pcs | 1:5 |
|  | Spectrum analyser |  | 5 pcs | 1:5 |
|  | Variable power supply |  | 5 pcs | 1:5 |
|  | Solder guns |  | 25 pcs | 1:1 |
|  | Hot air gun |  | 5 pcs | 1:5 |
|  | Work stations |  | 25 | 1:1 |

## MEASUREMENT AND CONTROL

**UNIT CODE:** 0914541 21A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply measurement and control.

**Duration of Unit:** 120 Hrs

**Unit Description**

This unit covers the competencies required to apply measurement and control. It involves Applying concepts of measurements, basic concepts of control systems, system modelling, system performance, system compensation and servo systems.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/** | **Learning Outcome** | **Duration in hours.** |
|  | To Apply concepts of measurements | 25 |
|  | To Apply basic concepts of control systems | 25 |
|  | To Apply system modelling | 20 |
|  | To Apply system performance | 20 |
|  | To Apply system compensation | 10 |
|  | To Apply servo systems | 20 |
|  | **TOTAL** | **120** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply concepts of measurements | 1. Basics of measurement    1. Data classes    2. Measurement standards    3. Variation and error    4. Categories of measurement    5. Direct    6. Indirect    7. Null 2. Factors in measurement (biometrics)    1. Measurement errors    2. Category of errors    3. Dealing with measurement errors    4. Error contribution analysis. 3. Principles of Measurement of Vital Signs    1. Cardiovascular measurements    2. Blood pressure    3. Blood flow    4. Heart sounds    5. Temperature. 4. Transducers 5. Pressure measurement instruments    1. Manometer    2. Bourdon tubes    3. Bellows    4. Diaphragm    5. Bell gauges    6. Ring balance gauges 6. Level measurement methods    1. Float-Based    2. Hydrostatic Pressure    3. Capacitance    4. Ultrasonic    5. Radar (Microwave)    6. Laser    7. Magnetic    8. Conductive/Resistive    9. Weight-based (Load Cells) 7. Flow meter types    1. Positive Displacement    2. Differential Pressure    3. Turbine    4. Electromagnetic    5. Coriolis    6. Ultrasonic 8. Clinical safety    1. Classes and types of equipment    2. Electrical safety    3. Radiation safety | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Apply basic concepts of control systems | 1. Types of control systems    1. Man-made system    2. Natural system    3. Hybrid system    4. Controlled variable 2. Open and closed loop systems 3. Feedback    1. Positive feedback    2. Negative feedback    3. Effects of feedback on overall gain, sensitivity, stability and noise. 4. Block diagrams 5. Basic elements of block diagram 6. Block diagram representation of electrical systems 7. Block diagram algebra 8. Series connection 9. Parallel connection 10. Feedback connection 11. Simplification of block diagrams     1. Canonical forms     2. Transfer functions     3. Superposition 12. Signal flow graphs     1. Basic elements of signal flow graphs     2. Construction of signal flow graphs 13. Simplification of system loops     1. Masons rule     2. Complex loop     3. Loop reduction 14. Conversion of block diagrams to signal flow graphs 15. Nodes 16. Sinks | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Apply system modelling | 1. Need for modelling 2. Mathematical models 3. Differential equation model 4. Transfer function model 5. State space model 6. Derivation of transfer functions for simple networks    1. Electrical    2. Mechanical    3. Laplace transforms, jω, D-operations 7. Electrical-mechanical analogy    1. Force- Voltage    2. Force – current    3. Translational vs Rotational 8. Modelling of practical systems    1. Generators    2. Temperature control systems    3. Calculations | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Apply system performance | 1. Time response analysis 2. Transient response 3. Steady state response 4. Test signals    1. Unit step    2. Unit ramp    3. Unit parabolic    4. Unit impulse 5. Dynamic response for 1st and 2nd order systems    1. Response terms    2. Standard 2nd order equation    3. Response graphs    4. Derivation of dimensionless 2nd order equation 6. Damping methods    1. Velocity feedback    2. Error rate    3. Viscous friction damping    4. Effects of damping ratio    5. Calculation of limiting values 7. Time domain specifications 8. Delay time 9. Rise time 10. Peak time 11. Peak overshoot 12. Settling time 13. Types of system stability 14. Relative stability 15. Absolute stability 16. Asymptotic Stability 17. Marginal Stability 18. Bounded input-bounded output 19. System stability analysis methods 20. Routh’s stability criterion 21. Nyquist diagrams 22. Bode plots 23. Nichol’s chart 24. Root locus 25. Process control strategies 26. Proportional (P), 27. Integral (I), 28. Derivative (D), 29. Proportional plus Integral (PI), 30. Proportional plus Derivative (PD), 31. Proportional plus Integral plus Derivative (PID) | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Apply system compensation | 1. Need for compensation 2. Compensating networks transfer functions    1. Lead compensator    2. Lag compensator    3. Lead-lag compensator 3. Designing a Bode compensator 4. Compensation using 3-term controller | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Apply servo systems | 1. Servo mechanisms    1. Position    2. Speed    3. Acceleration 2. AC and DC Servo amplifiers    1. Linear    2. Pulse-width modulation    3. Digital 3. Operation of stepper motors    1. Construction    2. Control circuits    3. Calculations    4. Interfacing    5. Applications 4. Characteristics curves of ac and dc servo motors    1. Torque Vs Speed curve    2. Torque Vs Current curve    3. Efficiency Vs Load curve 5. Calculations | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group discussions
* Interactive lectures
* Industrial attachment
* Viewing of related videos

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S No.** | **Category Item** | **Description Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Textbooks | S.K.B Pearson Control Systems Theory and Application  Control systems by Yousef Zadek | 5 pcs of each | 1:5 |
|  | Installation manuals | Electrical machine manuals | 5 pcs | 1:5 |
|  | Charts | Single line diagram  Motor starting circuits  Circuit diagrams  Colour codes | 1 pcs for each | 1:25 |
|  | Softwares | PLC software  Arduino IDE  Matlab |  |  |
|  | Projector and screen | For trainer’s use | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Computer Laboratory | 100m2 | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Electrical wires | 1.5mm2(red, black green) | 1 rolls | 1:5 |
| 2.5mm2(red, black green) | 5 rolls | 1:5 |
| 4.0 mm2(red, black green) | 3 rolls | 1:10 |
| 6.0 mm2(red, black green) | 2 rolls | 1:12 |
| 10 mm2(red, black green) | 2 rolls | 1:12 |
|  | Cables | USB, Ethernet, UART, 4-20mA current loop cable | 5 pcs | 1:5 |
|  | Insulation tapes |  | 25 pcs | 1:1 |
|  | Accessories | Sensors, Actuators, Limit switches, Push buttons, Timers, Relays, input output modules, keyboard | 25 pcs | 1:1 |
|  | Pipes and trunkings | PVC conduits, Mini trunking | 25 pcs | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | PLC module |  | 5 | 1:5 |
|  | Microcontroller tool kit |  | 5 | 1:5 |
|  | PPEs |  | 25 pcs | 1:1 |
|  | Multimeter |  | 5 pcs | 1:5 |
|  | Oscilloscope |  | 5 pcs | 1:5 |
|  | Servomotors |  | 5 pcs | 1:5 |

## DIAGNOSTIC AND LABORATORY EQUIPMENT II

**UNIT CODE:** 0914551 27A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Perform diagnostic and laboratory equipment II.

**Duration of Unit:** 120 Hours

**Unit Description**

This unit specifies the competencies required to Install and Maintain diagnostic and laboratory equipment. It involves Installing and Maintaining vital-signs monitors, Microscope, centrifuge, hematology analyzer, biochemistry analyzer, electrolyte analyzer, bacteriological incubator, biosafety cabinet and Endoscopy Equipment.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration in hours.** |
|  | To Perform Hematology Analyzer Maintenance | 20 |
|  | To Perform Biochemistry Analyzer Maintenance | 20 |
|  | To Perform Electrolyte Analyzer Maintenance | 20 |
|  | To Perform Bacteriological Incubator Maintenance | 20 |
|  | To Perform Biosafety Cabinet Maintenance | 20 |
|  | To Perform Endoscopy Equipment Maintenance | 20 |
|  | **TOTAL** | **120** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Perform Hematology Analyzer Maintenance | 1. Function of a hematology analyser 2. Operation principles of a hematology analyser 3. Cell counters. 4. Parts of a hematology analyzer 5. Types of a hematology analyser 6. Manual 7. Semi-automated 8. Fully automated 9. Maintenance procedures 10. Safety procedures. | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Biochemistry Analyzer Maintenance | 1. General operation principles and its controlling mechanism. 2. Spectrophotometry. 3. Types of instruments 4. Semi auto type 5. Fully automatic type 6. Photometric 7. Electrochemical 8. Immunoassay 9. Maintenance procedures 10. Safety procedures 11. Calibration of biochemistry analyzers. | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Electrolyte Analyzer Maintenance | 1. General operation principles and its controlling mechanism. 2. Photometry 3. Ion selective electrode. 4. Types of Electrolyte Analyzers 5. Ion-Selective Electrode (ISE) Analyzers 6. Flame Photometry Analyzers 7. Maintenance procedures 8. Safety procedures 9. Calibration of Electrolyte Analyzer | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Bacteriological Incubator Maintenance | 1. Function of a Bacteriological Incubator 2. Parts of a Bacteriological Incubator 3. Operation principles of a Bacteriological Incubator 4. General Purpose 5. CO2 Incubators 6. Cooled Incubators (Refrigerated Incubators) 7. Control devices of a Bacteriological Incubator 8. Maintenance procedures 9. Safety procedures. | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Biosafety Cabinet Maintenance | 1. Function of a biosafety cabinet 2. Parts of a biosafety cabinet    1. HEPA filter    2. Hood    3. UV Lamp    4. Exhaust Duct 3. General operation and its controlling mechanism. 4. Types of instruments    1. Class 1    2. Class 2    3. Class 3    4. Laminar air flow (Horizontal Vertical flow),    5. Clean bench type 5. Maintenance procedures 6. Calibration of a biosafety cabinet 7. Maintenance procedures 8. Safety procedures. | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Endoscopy Equipment Maintenance | 1. Function of the endoscopy equipment 2. Endoscope 3. Laparoscopy 4. Bronchoscope 5. Colonoscope 6. Hysteroscope 7. Components of the endoscopy equipment 8. Principle of operation of the endoscopy equipment 9. Types of instruments 10. Simple portable 11. Advance with fully auto control 12. Maintenance procedures 13. Safety procedures and standards 14. Calibration of endoscopy equipment | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group discussions
* Interactive lectures
* Industrial attachment
* Viewing of related videos

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S No.** | **Category Item** | **Description Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Reference books | Principles of Instrumental Analysis by Douglas A. Skoog, F. James Holler, and Stanley R. Crouch  Electrical Measurements and Instrumentation 2nd edition | 5 pcs for each | 1:5 |
|  | Maintenance manuals | Assorted Systems component Maintenance reports, manufacture’s manuals and data sheets  Instrumentation Handbooks | 5 pcs for each | 1:5 |
|  | Charts | Assorted diagnostic and lab equipment diagrams  Equipment block diagram charts | 1 pcs for each | 1:25 |
|  | Software | Assorted installation software for the equipment | 25 for each | 1:1 |
|  | Audio visual presentations | Projector | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Computer laboratory | 100m2 | 1 | 1:25 |
|  | Clinical rotations | OPD, Diagnostic and Laboratory department | 1 | 1 |
| **C** | **Consumable materials** |  |  |  |
|  | Installation materials | Insulation tape, cables, assorted electronic components | 25 pcs for each | 1:1 |
|  | Maintenance materials | Wipes, , spare batteries ,sanitizer, service kits | 25 pcs for each | 1:1 |
|  | Assorted electrical components | Contactors, transformer, overload relays, timers, resistors, ics capacitors, diodes, breadboards | 25 pcs for each | 1:1 |
|  | Assorted instrumentation components | Sensors, transducers, actuators , cuvettes | 25 for each | 1:5 |
| **D** | **Tools and Equipment** | | | |
|  | Assorted tools and equipment | Side cutters, Side cutters, Pliers, Screw driver, Crimping tools, Multi-meter, Oscilloscope, Solder guns, Allen keys set | 25 pcs for each | 1:1 |
|  | PPEs | Safety boots, overall, masks, gloves, antistatic shoes | 25 pcs for each | 1:1 |
|  | Hot air gun |  | 5 pcs | 1:5 |
|  | Blower |  | 5 pcs | 1:5 |
|  | Drilling machines |  | 5 pcs | 1:5 |
|  | Bacteriological  Incubator |  | 3 pcs | 1:8 |
|  | Hematology Analyzer |  | 3 pcs | 1:8 |
|  | Biochemistry Analyzer |  | 3 pcs | 1:8 |
|  | Electrolyte Analyzer |  | 3 pcs | 1:8 |
|  | Biosafety Cabinet |  | 2 pcs | 1:12 |
|  | photometer |  | 3 pcs | 1:8 |

## OPHTHALMIC AND ENT EQUIPMENT

**UNIT CODE:** 0914551 33A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Perform Ophthalmic and ENT Equipment maintenance.

**Duration of Unit:** 120Hours

**Unit Description**

This unit specifies the competencies required to Perform ophthalmic and ENT equipment maintenance. It involves performing ophthalmoscope maintenance, slit lamp maintenance, performing autorefractor maintenance, performing ophthalmic operating microscope maintenance, performing audiometer maintenance and performing ENT headlight equipment maintenance.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration in hours.** |
|  | To Perform Ophthalmoscope Maintenance | 10 |
|  | To Perform Slit Lamp Maintenance | 10 |
|  | To Perform Autorefractor Maintenance | 20 |
|  | To Perform Ophthalmic Operating Microscope Maintenance | 20 |
|  | To Perform lensometer Equipment Maintenance | 20 |
|  | To Perform ENT Headlight Equipment Maintenance | 20 |
|  | To Perform Audiometer Maintenance | 20 |
|  | **TOTAL** | **120** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Perform Ophthalmoscope Maintenance | 1. Ophthalmoscope parts 2. Viewing window 3. Filter switch 4. Aperture dial 5. Diopter dial 6. Rheostat 7. Principle of operation 8. Optical Systems 9. Lenses 10. Mirrors 11. Light sources 12. Detectors 13. Projection screens 14. Dispensing devices 15. Fibre-optics 16. Types of ophthalmology Equipment     1. Keratometer     2. Retinoscope     3. Visual field analyzer 17. Application of ophthalmology equipment 18. Maintenance procedures 19. Safety procedures | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Slit Lamp Maintenance | 1. Functions of Slit Lamp 2. Parts of Slit Lamp 3. Illuminating unit 4. Condensing Lens 5. Adjusting slit 6. Aperture 7. Eye pieces 8. Objective lens 9. Reflecting mirror 10. Filter 11. Operation of Slit Lamp 12. Maintenance procedures 13. Safety procedures. | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Autorefractor Maintenance | 1. Functions of Autorefractor 2. Parts of Autorefractor 3. Infrared Light source 4. Fixation target 5. Badal Lens System 6. Operation of Autorefractor 7. Maintenance procedures 8. Safety procedures | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Ophthalmic Operating Microscope Maintenance | 1. Principles of Ophthalmic Operating microscopy 2. Function of an Ophthalmic Operating microscope 3. Direct 4. Indirect 5. Parts of an Ophthalmic Operating microscope 6. Operation principles of Ophthalmic Operating microscope 7. Optical system of an Ophthalmic Operating microscope 8. Common faults 9. Maintenance procedures | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform lensometer Equipment Maintenance | 1. Meaning and functions of lensometer 2. Parts of lensometer 3. Operation of lensometer 4. Maintenance procedures 5. Safety procedures. | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform ENT Headlight Equipment Maintenance | 1. Meaning and functions of ENT Headlight 2. Parts of ENT Headlight 3. Housing 4. Light intensity control 5. Adjustment knob 6. Heat sink 7. LED 8. Operation of ENT Headlight 9. Maintenance procedures 10. Safety procedures. | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Audiometer Maintenance | 1. Principle of audiometry 2. Properties of sound 3. Audiometer parts 4. Oscillator 5. Amplifier 6. Attenuator 7. Earphones 8. Mask 9. Filters 10. Types of audiometers 11. Functions of audiometers 12. Maintenance procedures 13. Calibration of audiometers 14. Hearing aids implants | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group discussions
* Role playing
* Interactive lectures
* Individual assignments
* Industrial attachment
* Viewing of related videos

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S No.** | **Category Item** | **Description Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Reference books | Ophthalmic Equipment: A Manual for Health Professionals by Theo L. Wright  Atlas of Ophthalmology: Basic Instruments and Diagnostic Techniques | 5 pcs for each | 1:5 |
|  | Maintenance manuals | Assorted Systems component Maintenance reports, manufacture’s manuals and data sheets  Instrumentation Handbooks | 5 pcs for each | 1:5 |
|  | Charts | Assorted ophthalmic and ENT equipment diagrams  Equipment block diagram charts | 1 pc for each | 1:25 |
|  | Software | Assorted installation software for the equipment | 25 for each | 1:1 |
|  | Audio visual presentations | Projector | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Simulation Lab | 100m2 | 1 | 1:25 |
|  | Clinical Rotations | ophthalmic and ENT departments | 1 | 1:25 |
| **C** | **Consumable materials** |  |  |  |
|  | Installation materials | Insulation tape, cables, | 25 pcs for each | 1:1 |
|  | Maintenance materials | Wipes, spare batteries, sanitizer, service kits | 25 pcs for each | 1:1 |
|  | Assorted electrical components | Contactors, transformer, overload relays, timers | 25 pcs for each | 1:1 |
|  | Assorted instrumentation components | Sensors, transducers, actuators, cuvettes | 25 for each | 1:5 |
| **D** | **Tools and Equipment** | | | |
|  | Assorted tools and equipment | Side cutters, Side cutters, Pliers, Screw driver, Crimping tools, Multi-meter, Oscilloscope, Solder guns, Allen keys set | 25 pcs for each | 1:1 |
|  | PPEs | Safety boots, overall, masks, gloves, antistatic shoes | 25 pcs for each | 1:1 |
|  | Hot air gun |  | 5 pcs | 1:5 |
|  | Blower |  | 5 pcs | 1:5 |
|  | Ophthalmoscope |  | 12 pcs | 1:2 |
|  | Slit Lamp |  | 2 pcs | 1:12 |
|  | Autorefractor |  | 2 pcs | 1:12 |
|  | Ophthalmic Operating Microscope |  | 2 pcs | 1:12 |
|  | lensometer |  | 2 pcs | 1:12 |
|  | ENT Headlight |  | 5 pcs | 1:5 |
|  | Audiometer |  | 1 pcs | 1:25 |

# MODULE VI

## DIGITAL ELECTRONICS

**UNIT CODE:** 0714541 14A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply digital electronics.

**Duration of Unit:** 130 Hours

**Unit Description**

This unit describes competences required to apply digital electronics. It involves applying knowledge of number systems, applying knowledge of binary code, logic gates and Boolean algebra concepts, constructing digital logic circuits, constructing advance digital logic circuits, applying knowledge of converters (ADC and DAC) and managing computer memories.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration in hours.** |
|  | To apply knowledge of number systems | 25 |
|  | To apply knowledge of binary codes | 20 |
|  | To apply Logic gates and Boolean algebra concepts | 20 |
|  | To apply knowledge of digital logic circuits | 25 |
|  | To apply knowledge of advance digital logic and converter circuits | 20 |
|  | To manage computer memories | 20 |
|  | **TOTAL** | **130** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply knowledge of number systems | 1. Numbers systems e.g. 2. Decimal 3. Octal 4. Hexadecimal 5. Binary 6. Number system representation 7. Conversion of number systems | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Apply knowledge of binary codes | 1. BCD (Binary Coded Decimal) 2. Gray Code 3. Excess 3 code | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Apply Logic gates and Boolean algebra concepts | 1. Basic gates 2. Universal gates 3. Special purpose gates 4. laws of Boolean algebra 5. Logic expressions simplification 6. K-MAPS | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Apply knowledge of digital logic circuits | 1. Combinational logic circuits design and minimization 2. Logic families. 3. Bipolar Families 4. MOS Families 5. Hybrid Family 6. Sequential logic circuits 7. Flip flops | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Apply knowledge of advance digital logic and converter circuits | 1. Counters 2. Data handling devices    1. Decoders    2. Encoders    3. Multiplexers    4. Demultiplexers    5. Shift registers 3. Arithmetic circuits 4. Digital converters (ADC)(DAC) | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Manage computer memories | * 1. Introduction to Computer Memory systems   2. Types of memory devices   + RAMs   + ROMs   + EEPROM   + EPROM   1. Memory organization.   2. Memory expansion | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group discussions
* Interactive lectures
* Industrial attachment
* Viewing of related videos

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S No.** | **Category Item** | **Description Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Reference books | Digital Electronics: Principles, Devices and Applications  By Anil K. Maini | 5 pcs | 1:5 |
|  | Installation manuals | Assorted Systems component Manufacturer’s manuals and data sheets  Instrumentation Handbooks | 5 pcs | 1:5 |
|  | Charts | Assorted Circuit diagrams  charts | 1 pcs for each | 1:25 |
|  | Software | Assorted simulation software  e.g Deeds, | 25 | 1:1 |
|  | Audio visual presentations | Projector | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Computer laboratory | 100m2 | 1 | 1:25 |
| **C** | **Consumable materials** |  |  |  |
|  | Assorted electronics components | ICs, resistors, capacitors | 25 pcs | 1:1 |
| **D** | **Tools and Equipment** | | | |
|  | Assorted tools and equipment | Side cutters, Side cutters, Pliers, Screw driver, Multi-meter, Oscilloscope, Solder guns, breadboards | 25 pcs | 1:1 |
|  | PPEs | Safety boots, overall | 25 pcs | 1:1 |
|  | Function generator |  | 5 pcs | 1:5 |
|  | Variable power supply |  | 5 pcs | 1:5 |
|  | Trainers kit | Assorted logic gate, combinational circuits trainer kits with component Manufacturer’s manuals and data sheets | 5 pcs | 1:5 |
|  | Hot air gun |  | 5 pcs | 1:5 |
|  | Work stations |  | 25 | 1:1 |

## ENGINEERING TECHNICIAN MATHEMATICS IV

**UNIT CODE:** 0541541 08A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply engineering technician mathematics IV.

**Duration of Unit**: 60 hours.

**Unit Description**

This unit describes the competencies required by a technician in order to apply engineering technician mathematics IV. It involves applying complex numbers, loci, laplace transforms and performing co-ordinate geometry.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration in hours.** |
|  | To Apply complex numbers | 5 |
|  | To Perform co-ordinate geometry | 10 |
|  | To Apply loci | 10 |
|  | To Apply Laplace transforms | 15 |
|  | **TOTAL** | **40** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply complex numbers | * 1. Introduction to Complex Numbers  1. Definition of a complex number 2. Real and imaginary parts. 3. Complex plane: Argand diagram    1. Arithmetic Operations 4. Addition, subtraction, multiplication, and division of complex numbers. 5. Conjugate of a complex number.    1. Polar and Exponential Forms 6. Polar form of a complex number. 7. Conversion between Cartesian and polar forms. 8. Exponential form using Euler’s formula.    1. Complex Number Operations       1. Powers and Roots          1. Powers of complex numbers using De Moivre’s Theorem.          2. Finding roots of complex numbers.       2. Complex Exponential Functions          1. Definition and properties.          2. Applications in solving differential equations.    2. Solving Equations Using Complex Numbers 9. Quadratic Equations 10. Solving quadratic equations with complex coefficients. 11. Nature of roots 12. Real and complex 13. Systems of Linear Equations     * + 1. Using complex numbers to solve linear systems.         2. Applications in AC circuit analysis. | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform coordinate geometry | * 1. Polar equations      1. Definition of polar coordinates      2. Definition and examples of polar equations.      3. Representing curves using polar equations.   2. Cartesian equation      1. Definition of Cartesian coordinates.      2. Definition of a point in cartesian coordinates      3. Relationship between Cartesian and polar coordinates.      4. Definition and examples of Cartesian equations.      5. Representing lines, circles, parabolas, ellipses, and hyperbolas using Cartesian equations.      6. Conversion Between Polar and Cartesian Equations.   3. Graphs of polar equations      1. Plotting Polar Equations         1. Definition of a point in polar coordinates         2. Steps to graph polar equations.         3. Using symmetry and periodicity in polar graphs.      2. Analyzing Polar Graphs         1. Identifying key features intercepts, maxima, minima      3. Applications in engineering   4. Normal and tangents      1. Tangents to Curves         1. Definition of a tangent line.         2. Finding the slope of a tangent to a curve at a given point.      2. Normals to Curves         1. Definition of a normal line.         2. Finding the equation of a normal to a curve at a given point.      3. Tangents and Normals in Polar Coordinates   5. Techniques for finding tangents and normals to curves defined by polar equations. | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Apply loci | * + 1. Introduction to Loci        1. Definition of Locus        2. Understanding the concept of a locus.        3. Importance of loci in engineering.     2. Locus in Relation to a Circle        1. Equations and properties of loci relative to circles.        2. Common loci problems involving circles     3. Applications in Engineering        1. Using loci to solve engineering problems: robotic arm movement        2. Analyzing Loci of Points: tracing the path of a point on a rotating arm     4. Using loci to optimize mechanical systems: designing cams, robotic path planning. | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Apply Laplace transforms | 1. Meaning of Laplace transforms deriving Laplace transforms from first principles 2. State properties of Laplace transform 3. Determination of inverse LT of simple transforms and partial fractions 4. Solution of differential equation by LT 5. Solution of simultaneous differential equation by given initial conditions 6. Applications of laplace transforms in electrical circuits | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |

**Suggested Delivery Methods**

* Demonstration
* Discussions
* Practical
* Project work
* Direct instruction

**List of Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/**  **Specifications** | **Quantity** | **Recommended**  **Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Textbooks | Engineering Mathematics by K.A. Stroud  Advanced Engineering Mathematics by Erwin Kreyszig | 5 pcs  5 pcs | 1:5  1:5 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture/theory room | 60m2 | 1 | 1:25 |
|  | Computer | Operating System: 64-bit Windows 11 or 10 version 1809 or above  Processor: 2.5 GHz (3+ GHz recommended),  Memory: 8 GB (32GB recommended)  Disk space: 10 GB  Display: 1920 x 1080 resolution  Display Card: 2 GB GPU (8 GB recommended) and DirectX 11 compliant (DirectX 12 recommended) | 25 pcs | 1:1 |
|  | Projector |  | 1 | 1:25 |
|  | Interactive screen | Specifications: 77-inch interactive whiteboard with touch and pen functionality. | 1 | 1:25 |
| **C** | **Software** | | | |
|  | MATLAB | License: Educational licenses available.  Features: Matrix manipulations, plotting of functions and data, implementation of algorithms, creation of user interfaces, interfacing with programs in other languages. | Installed in 25 computers | 1:1 |
|  | GeoGebra | License: Free educational software.  Interactive geometry, algebra, statistics, and calculus applications | Installed in 25 computers | 1:1 |
| **D** | **Consumables** |  |  |  |
|  | Pens, pencils, rulers and paper | Whiteboard markers, 2H pencils, plastic rulers, A2 white papers | Enough |  |

## MICROCONTROLLERS AND MICROPROCESSORS I

**UNIT CODE:** 0714541 22A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply microcontrollers and microprocessors I.

**Duration of Unit:** 80 Hours

**UNIT DESCRIPTION**

This unit covers competences required to apply micro control systems. It involves conducting installation site survey, establishing complexity of the task, selecting micro control device and selecting micro control programming software.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration in hours.** |
|  | To Conduct installation site survey | 20 |
|  | To Establish complexity of the task | 30 |
|  | To Select micro control device | 5 |
|  | To Select micro control programming software | 25 |
|  | **TOTAL** | **80** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Conduct installation site survey | 1. Health and safety procedures 2. Standard operating procedure in PPE 3. Rules and regulations 4. Hazards 5. Site condition evaluation 6. Temperature 7. Distance 8. Dust 9. Light intensity 10. Pressure 11. Installation Layout Preparation: 12. Create a physical layout for component placement. 13. Use technical drawings (schematics and wiring diagrams) to represent the controller system installation. 14. Measure and document key dimensions for hardware placement (e.g., controllers, sensors). 15. Site survey report | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Establish complexity of the task | 1. Introduction to process control systems 2. Term and definitions 3. Types of process control systems 4. Process Control Components 5. Sensors and transducers    1. Inductive sensors    2. Capacitive sensors    3. Resistive sensors 6. Actuators    1. Electric motors    2. Hydraulic and Pneumatic actuators    3. Electromechanical actuators 7. Indicators 8. Signal processing 9. Signal conditioning 10. Display 11. Need for process control system 12. Introduction to microcontroller technology 13. Term and definitions 14. Block diagram of microcontroller system 15. Microcontroller Architecture 16. Memory Organization 17. Peripherals     1. System clock     2. Communication channels        1. Serial communication           1. UART           2. SPI           3. I2C           4. Ethernet           5. CAN           6. USB        2. Parallel Communication           1. Parallel Data Bus           2. PIA           3. PPI           4. PCI        3. Wireless communication           1. Bluetooth/BLE           2. GPRS           3. WiFi 18. GPIO 19. Interrupt Controller 20. Timers and Counters 21. ADC/DAC 22. PWM 23. Watch Dog Timer 24. Real-time clock 25. Capture/Compare/PWM (CCP) Modules 26. Touch Sensing 27. LCD controller 28. Estimation of materials 29. Bill of quantities | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Select micro control device | 1. Factor to consider when selecting a microcontroller    1. Power rating    2. Communication Protocols.    3. Processing Speed    4. Interfacing    5. Scalability    6. Portability    7. Time to market | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Select micro control programming software | 1. Operating System Requirements: 2. Install microcontroller-related software (e.g., Arduino IDE, VSCode). 3. User Interface and Communication Systems: 4. Select communication modules (e.g., Ethernet for industrial automation, Bluetooth for home systems). 5. Licensing and support of the software. 6. Software Configuration | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group discussions
* Interactive lectures
* Industrial attachment
* Viewing of related videos

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
| 1. | Textbooks | Susnea, I., & Mitescu, M. (2005). Microcontrollers in Practice. Springer. https://buku.app/book/144497 | Online | 1:1 |
| 2. | Installation manuals and datasheets | ATMEL, Cortex-M3, Intel 8051, Arduino Nano, Arduino Mega, ESP32, Raspberry pi A4 | 5 pcs for each | 1:5 |
| **B** | **Learning Facilities & Infrastructure** | | | |
| 3. | Lecture/Theory  room | 60m2 | 1 | 1:25 |
| 4. | Workshop | 150m2 | 1 | 1:25 |
| 5. | Projector |  | 1 pc | 1:25 |
| 6. | Interactive display  screen | 75 inches | 1 pc | 1:25 |
| 7. | Computers with Internet access | Processor: Intel Core i5/i7 or equivalent  RAM: 8GB or higher  Storage: 256GB SSD or higher | 25 pcs | 1:25 |
| 9. | Microcontroller | ATMEL328P/CORTEX-M3/INTEL-8051 | 25 pcs for each category | 1:1 for each category |
| 9. | LCD panels | 1.3″ Inch I2C IIC OLED LCD Module 4pin- Blue,  16x2 LCD Display Module(Blue) 5V | 5 pcs/5 pcs/5  pcs/5 pcs | 1:5 for each category |
| 10. | Limit switches | Mechanical, optical, inductive, capacitive | 25 pcs each  category | 1:1 for each category |
| 11. | Industrial pressure  sensors | 0-10 bar, 4-20mA output | 25 pcs | 1:1 |
| 12. | Proximity sensors | NPN/PNP, 10-30V DC | 25 pcs | 1:1 |
| 13. | Industrial  temperature sensors | RTD/PT100, -50 to 200°C | 25 pcs | 1:1 |
| 14. | Flow sensors | 4-20mA, 0-10V, RS485 | 25 pcs | 1:1 |
| 15. | Level sensor | Ultrasonic 4-20mA, 0-10V | 25 pcs | 1:1 |
| 16. | Power supply units | Output Voltage: 24V DC  Output Current: 5A or higher Input Voltage: 220V AC | 10 pcs | 1:2.5 |
| 17. | Adjustable  wrenches | Metric and standard sizes | 10 pcs | 1:2.5 |
| 18. | Sets of  combinational wrenches | Metric and standard sizes | 5 sets | 1:5 |
| 19. | Assorted size socket  wrenches | Metric and standard sizes | 5 sets | 1:5 |
| 20. | Assorted sizes of  screw drivers | Insulated, flathead | 5 sets | 1:5 |
| 21. | Assorted sizes of  Allen keys | Metric and standard sizes | 5 sets | 1:5 |
| 22. | Wire Strippers | Suitable for 0.5 mm² to 4 mm² wires | 10 pcs | 1:2 |
| 26. | Cordless drills | 16 V | 5 pcs | 1:5 |
| 27. | Relays | 24V DC coil, 10A contacts | 25 pcs | 1:1 |
| 28. | Solenoid valves | 24V DC, 1/4" or 1/2" connections | 25 pcs | 1:1 |
| 29. | DC motors | 24V DC | 25 pcs | 1:1 |
| 30. | DC motor drives | 12V/24V | 25 pcs | 1:1 |
| 31. | Push buttons | Voltage:24V DC coil/230V AC coil Contact Configuration: 1 NO or 1 NC Illumination: Non-illuminated or LED illuminated  Color Options: Red, Green, Yellow,  Blue, Black | 100 pcs | 1:4 |
| 32. | Select switches | Voltage:24V DC coil/230V AC coil Contact Configuration: 2 NO, 2 NC,  or 1 NO + 1 NC  Positions: 2-position or 3-position Illumination: Non-illuminated or LED illuminated  Color Options: Black, Red, Green | 100 pcs | 1:4 |
| 33. | Digital multimeters | With voltage, current, and resistance  measurement | 25 pcs | 1:1 |
| 37. | Network switches | Cisco 24 ports | 2 | 1:12.5 |
| 38. | Routers | TP link | 10 | 1:2.5 |
| **C** | **Consumable materials** | | | |
| 39. | Writing materials | Pens, pencils, paper | enough |  |
| 40. | Signal cables | 0.5 mm² to 1.5 mm², shielded | 200  metres for  each category | 50m:1 for each category |
| 41. | Jumper cables |  | 200  metres for each  category | 50m:1 for each category |
| 42. | Communication  cables | Cat6 Ethernet cables | 200 m | 50m:1 |
| 47. | First aid kit | Full kits | 5 pcs | 1:5 |
| **D** | **Software** | | | |
| 48. | Programming  and simulation software | Arduino IDE, Mbed | Installed  in 25 Computers | 1:1 |

## ICU AND RENAL EQUIPMENT

**UNIT CODE:** 0914541 32A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Perform ICU and Renal Equipment maintenance.

**Duration of Unit:** 120Hours

**Unit Description**

This unit specifies the competencies required to Perform ICU and Renal Equipment maintenance. It involves Perform Patient Monitor maintenance, Defibrillator maintenance, Ventilator maintenance, Infusion and Syringe Pump maintenance, ICU Bed maintenance, Nebulizer maintenance, Hemodialysis machine maintenance and Reserve Osmosis (RO) water plant maintenance.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration in hours.** |
|  | To Perform Patient Monitor | 15 |
|  | To Perform Defibrillator | 15 |
|  | To Perform Ventilators | 20 |
|  | To Perform Infusion and Syringe Pump | 15 |
|  | To Perform Nebulizer | 15 |
|  | To Perform ICU Bed | 15 |
|  | To Perform Haemodialysis Machine | 15 |
|  | To Perform Reverse Osmosis (RO) Water Plant | 10 |
|  | **TOTAL.** | **120** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Perform Patient Monitor | 1. Functions of patient monitors 2. Parts of patient monitoring system 3. Types of patient monitors    1. Electro-cardiogram (ECG)    2. Vital signs monitor    3. Pulmonary analyzer 4. Principle of operations of patient monitors | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Defibrillator | 1. Mechanism of fibrillation 2. Mechanism of defibrillation 3. Types of defibrillators 4. AED Defibrillator 5. ICD Defibrillator 6. Manual External Defibrillator 7. Manual Internal Defibrillator 8. Components of defibrillator    1. Capacitor    2. Inductor    3. Power supply 9. Function of defibrillators 10. Operating principle 11. Patient safety | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Ventilators | 1. Function of Ventilators 2. Ventilator parts 3. Respiratory tubings 4. Humidifier chambers 5. Filters 6. Main types of Ventilators    1. Mechanical control    2. Electronic steered 7. Operation principle of Ventilators    1. Respiration    2. Loss of respiration (Natural Artificial)    3. Positive pressure ventilation    4. Manual Ventilators 8. Respirators 9. Need of spirometers    1. Measurement of lung parameters    2. Importance of lung parameters 10. Principle of operation of spirometers     1. Lung parameters     2. Lung measurement     3. Recording 11. Fault diagnosis 12. Maintenance procedures 13. Service kit components 14. O-rings 15. Oxygen Sensor 16. Filters 17. Calibrations | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Infusion and Syringe Pump | 1. Function of Infusion Pumps 2. Parts of Drugs Infusion Systems 3. Function of Syringe Pump 4. Parts of Drugs Syringe Pump 5. Fault diagnosis 6. Maintenance procedures 7. Calibrations | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Nebulizer | 1. Working principle of Nebulizers 2. Types and components of Nebulizers 3. Maintenance procedures 4. Safety procedures 5. Calibration | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform ICU Bed | 1. Main parts ICU bed 2. Uses of ICU Bed 3. Types of ICU Beds 4. Requirements of ICU Bed 5. Fault diagnosis of ICU Bed 6. Maintenance procedures of typical faults. 7. Safety test | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Haemodialysis Machine | 1. Renal anatomy and physiology 2. Major physiological functions of kidneys. 3. Renal failure and its management    1. Acute renal failure    2. Chronic renal failure 4. General operation of Hemodialysis Machine and its controlling mechanism. 5. Parts of Hemodialysis Machine 6. Mechanism of Dialyzer 7. Operation of Hemodialysis Machine 8. Maintenance procedures 9. Safety procedures. | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Reverse Osmosis (RO) Water Plant | 1. Purpose and importance of water treatment in dialysis 2. Components and parts of a water treatment plant 3. Pressure regulator 4. Carbon filter 5. Valves 6. RO Membrane 7. Pressurized Storage Tank 8. Filters 9. Terminologies used in the dialysis water treatment system operation 10. Methods of water treatment 11. Mechanical components 12. Operation and maintenance of water treatment plant 13. Microbiological monitoring 14. Electrolyte monitoring | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group discussions
* Role playing
* Interactive lectures
* Individual assignments
* Industrial attachment
* Viewing of related videos

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S No.** | **Category Item** | **Description Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Reference books | Sound Design for the Theatre by David Grenfell:  Principles of Instrumental Analysis by Douglas A. Skoog, F. James Holler, and Stanley R. Crouch  Electrical Measurements and Instrumentation 2nd edition | 5 pcs for each | 1:5 |
|  | Maintenance manuals | Assorted Systems component Maintenance reports, manufacture’s manuals and data sheets  Instrumentation Handbooks | 5 pcs for each | 1:5 |
|  | Charts | Assorted ICU and renal equipment diagrams  Equipment block diagram charts | 1 pcs for each | 1:25 |
|  | Software | Assorted installation software for the equipment | 25 for each | 1:1 |
|  | Audio visual presentations | Projector | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Simulation Lab | 100m2 | 1 | 1:25 |
|  | Clinical Rotations | Renal, ICU departments | 1 for each | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Installation materials | Insulation tape, cables, | 25 pcs for each | 1:1 |
|  | Maintenance materials | Wipes, spare batteries, sanitizer, service kits | 25 pcs for each | 1:1 |
|  | Assorted electrical components | Contactors, transformer, overload relays, timers | 25 pcs for each | 1:1 |
|  | Assorted instrumentation components | Sensors, transducers, actuators, cuvettes | 25 for each | 1:5 |
| **D** | **Tools and Equipment** | | | |
|  | Assorted tools and equipment | Side cutters, Side cutters, Pliers, Screw driver, Crimping tools, Multi-meter, Oscilloscope, Solder guns, Allen keys set | 25 pcs for each | 1:1 |
|  | PPEs | Safety boots, overall, masks, gloves, antistatic shoes | 25 pcs for each | 1:1 |
|  | Hot air gun |  | 5 pcs | 1:5 |
|  | Blower |  | 5 pcs | 1:5 |
|  | Drilling machines |  | 5 pcs | 1:5 |
|  | Haemodialysis Machine |  | 2 pcs | 1:12 |
|  | Defibrillator |  | 2 pcs | 1:12 |
|  | Patient Monitor |  | 5 pcs | 1:5 |
|  | RO water plant |  | 2 pcs | 1:12 |
|  | Nebulizer |  | 12 pcs | 1:2 |
|  | Ventilators |  | 2 pcs | 1:12 |
|  | Infusion and syringe Pump |  | 5 pcs | 1:5 |
|  | ICU Bed |  | 2 pcs | 1:12 |

## RADIOLOGY AND IMAGING EQUIPMENT

**UNIT CODE:** 0914551 31A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Perform Radiology and Imaging Equipment maintenance.

**Duration of Unit:** 150Hours

**Unit Description**

This unit specifies the competencies required to Perform Radiology and Imaging Equipment maintenance. It involves performing general X-Ray Equipment maintenance, Orthopantomogram equipment (OPG) maintenance, mammography equipment maintenance, Computed Tomography Equipment (CT) maintenance, Fluoroscopy Machine maintenance, diagnostic Ultrasound Equipment maintenance and bone densitometer Equipment maintenance.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration in hours.** |
| 1. 1. | To Perform General X-Ray Equipment maintenance | 35 |
|  | To Perform Orthopantomogram equipment (OPG) Equipment maintenance | 15 |
|  | To Perform Mammography Equipment maintenance | 20 |
|  | To Perform Computed Tomography Equipment maintenance | 20 |
|  | To Perform Fluoroscopy Machine maintenance | 20 |
|  | To Perform diagnostic Ultrasound Equipment maintenance | 25 |
|  | To Perform bone densitometer Equipment maintenance | 15 |
|  | **TOTAL** | **150** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Perform General X-Ray Equipment maintenance | 1. Physics of X-rays    1. Definition    2. Discovery    3. Electromagnetic spectrum    4. Condition for production    5. Units of x-ray radiations 2. X-ray sources    1. X-ray tube    2. X-ray radiation source 3. X-ray tubes    1. Single focus cathode    2. Double focus cathode    3. Stationary anode    4. Rotating anode 4. Main parts of an X-ray tube    1. Cathode    2. Focusing cup    3. Filament    4. Anode    5. Vacuum glass envelope    6. Oil tank    7. High tension cables    8. Control cables 5. X-rays generation    1. Electron source    2. Acceleration    3. Target 6. Components of X-ray generators    1. Rectification    2. High tension transformer    3. Oil tank 7. Block diagram of X-ray machine 8. Electric circuits and controls 9. Main supply 10. Main switch 11. Main contractor 12. Control circuit 13. Control relays 14. Timer 15. Interlock system 16. Operation of control     1. KV selector     2. Line voltage compensation     3. mAs selector     4. Meter reading     5. Timber operations 17. X-ray image intensifier system 18. Bucky table 19. Radiation protection 20. Dosimetry 21. Effects of x-ray     1. Biological     2. Ionization     3. Fluorescence 22. Fault diagnosis 23. Maintenance procedures     1. High tension cables     2. X-ray generator 24. Safety procedures | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Orthopantomogram equipment (OPG) Equipment maintenance | 1. Meaning and overview of OPG 2. Principles of OPG Imaging 3. Images formation 4. Concepts of focal trough, magnification, and distortion. 5. Uses of OPG 6. Fault diagnosis 7. Maintenance procedures 8. Safety procedures | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Mammography Equipment maintenance | 1. Meaning and overview of mammography 2. Structure of the breast, glandular tissue, ducts, lymph nodes, and the significance in imaging. 3. Principles of mammography 4. Special Techniques and Modalities 5. Tomosynthesis 6. Fault diagnosis 7. Maintenance procedures 8. Safety procedures | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Computed Tomography Equipment maintenance | 1. Principle of CT scan 2. Measurement procedure 3. Image reconstruction 4. Limitation of x-ray images 5. Tomography 6. contrast scale | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Fluoroscopy Machine maintenance | 1. Principle of Fluoroscopy Machine    1. Physical properties    2. Electrical electronic properties 2. Application of fluoroscopy machine    1. Diagnosis    2. Therapeutic 3. Parts of the fluoroscopy machine    1. Fluorescent screen    2. Image intensifier 4. Maintenance procedures 5. Safety procedures | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform diagnostic Ultrasound Equipment maintenance | 1. Principle of ultrasound imaging 2. Physics of ultrasonic waves 3. Technical features distinguishing individual probes 4. Doppler mode 5. Artifacts 6. Application of different scan | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform bone densitometer Equipment maintenance | 1. Principle of bone densitometer 2. Physics of densitometry 3. Technical features 4. Maintenance procedures 5. Safety procedures | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group discussions
* Role playing
* Interactive lectures
* Individual assignments
* Industrial attachment
* Viewing of related videos

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S No.** | **Category Item** | **Description Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** |  |  |  |
|  | Reference books | Sound Design for imaging by David Grenfell:  Principles of Instrumental Analysis by Douglas A. Skoog, F. James Holler, and Stanley R. Crouch  Electrical Measurements and Instrumentation 2nd edition | 5 pcs for each | 1:5 |
|  | Maintenance manuals | Assorted Systems component Maintenance reports, manufacture’s manuals and data sheets  Instrumentation Handbooks | 5 pcs for each | 1:5 |
|  | Charts | Assorted Radiology and Imaging equipment diagrams  Equipment block diagram charts | 1 pcs for each | 1:25 |
|  | Software | Assorted installation software for the equipment | 25 for each | 1:1 |
|  | Audio visual presentations | Projector | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** |  |  |  |
|  | Lecture theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Simulation Lab | 100m2 | 1 | 1:25 |
|  | Clinical Rotations | Radiology departments |  |  |
| **C** | **Consumable materials** |  |  |  |
|  | Installation materials | Insulation tape, cables, | 25 pcs for each | 1:1 |
|  | Maintenance materials | Wipes, Allen keys set, spare batteries, sanitizer, service kits | 25 pcs for each | 1:1 |
|  | Assorted electrical components | Contactors, transformer, overload relays, timers | 25 pcs for each | 1:1 |
|  | Assorted instrumentation components | Sensors, transducers, actuators, cuvettes | 25 for each | 1:5 |
| **D** | **Tools and Equipment** |  |  |  |
|  | Assorted tools and equipment | Side cutters, Side cutters, Pliers, Screw driver, Crimping tools, Multi-meter, Oscilloscope, Solder guns | 25 pcs for each | 1:1 |
|  | PPEs | Safety boots, overall, masks, gloves, antistatic shoes | 25 pcs for each | 1:1 |
|  | Hot air gun |  | 5 pcs | 1:5 |
|  | Blower |  | 5 pcs | 1:5 |
|  | Drilling machines |  | 5 pcs | 1:5 |
|  | Dosimeters |  | 2 pcs | 1:12 |
|  | general X-Ray |  | 2 pcs | 1:12 |
|  | Orthopantomogram |  | 3 pcs | 1:8 |
|  | Mammography Equipment |  | 2 pcs | 1:12 |
|  | diagnostic Ultrasound |  | 2 pcs | 1:12 |

# MODULE VI

## MICROCONTROLLERS AND MICROPROCESSORS II

**UNIT CODE:** 0714541 37A

**Relationship to Occupational Standards**

This unit addresses the unit of competency: Apply Microcontrollers and Microprocessors II.

**Duration of Unit:** 80 Hours

**UNIT DESCRIPTION**

This unit covers competences required to apply micro control systems. It involves performing controller programming, interfacing micro control system, performing controller system test and inspection.

**Summary of Learning Outcome**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration in hours.** |
|  | To Perform Controller Programming | 40 |
|  | To Interface Micro Control System | 20 |
|  | To Perform Controller system test and inspection | 20 |
|  | **TOTAL** | **80** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Perform controller programming | 1. Introduction to hardware programming    1. Terms and definitions    2. Programming concepts    3. Program design methods       1. Top-Down Design       2. Bottom-Up Design       3. Modular Design       4. Structured Programming       5. Object-Oriented Design (OOD)       6. Event-Driven Design       7. Data-Driven Design       8. Functional Design       9. Component-Based Design 2. Types of hardware programming languages    1. Object-Oriented Languages (OOP)    2. Functional Programming Languages    3. Scripting Languages 3. Hardware programming methods 4. Bare-Metal Programming 5. Register-Level Programming 6. Interrupt-Driven Programming 7. Real-Time Programming 8. In-Circuit Programming (ICP) 9. In-System Programming (ISP) 10. Event-Driven Programming 11. Hardware Abstraction Layer (HAL) Programming 12. Low-Power and Sleep Mode Programming 13. Program Development: 14. Memory addressing (Variables, Data pointers and registers) 15. Functions and Methods 16. Classes and structures 17. Loop structures, conditionals, and branching 18. Compilation and Debugging 19. Preprocessing 20. Compilation 21. Assembly 22. Linking 23. Binary file 24. Hex file 25. Program Documentation 26. Document the program thoroughly with comments explaining the functionality of each section. | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Interface micro control system | 1. Types of I/O 2. Analogue vs digital 3. Active vs passive 4. Sourcing vs sinking 5. Types of interfacing ports 6. Pin Headers (Male or Female) 7. Jumper Wires 8. IDC Connectors 9. DB9 Connector 10. FTDI USB to Serial Cable 11. FPC/FFC Connectors 12. JST Connectors 13. Screw Terminal Connectors 14. USB Type A/B/C,Micro-USB, Mini-USB 15. JTAG Port 16. 10-Pin or 20-Pin IDC Connector 17. RJ45 Connector 18. RS-232 Port 19. Wi-Fi/Bluetooth Module Ports | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform controller system test and inspection | 1. Importance of testing 2. Meaning of terms 3. Inspection 4. Testing 5. Types of tests e.g. 6. Electrical tests 7. Functionality tests 8. Test Signal Conditioning Elements 9. Test Signal Processing elements 10. Test Data presentation elements 11. Testing tools and equipment 12. Multimeter 13. Oscilloscope 14. Signal generators 15. Troubleshooting techniques 16. Performance characteristics 17. Statics and dynamics 18. Error and loading effects 19. Accuracy 20. Precision 21. Linearity 22. Sensitivity 23. Resolution 24. Response time 25. Drift 26. Calibration 27. Functional integration 28. Need for end user training 29. Commissioning documents 30. Safety documentation 31. Handover report | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group discussions
* Interactive lectures
* Industrial attachment
* Viewing of related videos

**Recommended Resources for 25 trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S/No.** | **Category/Item** | **Description/ Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
| 1. | Textbooks | Susnea, I., & Mitescu, M. (2005). Microcontrollers in Practice. Springer. https://buku.app/book/144497 | Online | 1:1 |
| 2. | Installation manuals and datasheets | ATMEL, Cortex-M3, Intel 8051, Arduino Nano, Arduino Mega, ESP32, Raspberry pi A4 | 5 pcs for each | 1:5 |
| **B** | **Learning Facilities & Infrastructure** | | | |
| 3. | Lecture/Theory  room | 60m2 | 1 | 1:25 |
| 4. | Workshop | 150m2 | 1 | 1:25 |
| 5. | Projector |  | 1 pc | 1:25 |
| 6. | Interactive display  screen | 75 inches | 1 pc | 1:25 |
| 7. | Computers with Internet access | Processor: Intel Core i5/i7 or equivalent  RAM: 8GB or higher  Storage: 256GB SSD or higher | 25 pcs | 1:25 |
| 9. | Microcontroller | ATMEL328P/CORTEX-M3/INTEL-8051 | 25 pcs for each category | 1:1 for each category |
| 9. | LCD panels | 1.3″ Inch I2C IIC OLED LCD Module 4pin- Blue,  16x2 LCD Display Module(Blue) 5V | 5 pcs/5 pcs/5  pcs/5 pcs | 1:5 for each category |
| 10. | Limit switches | Mechanical, optical, inductive, capacitive | 25 pcs each  category | 1:1 for each category |
| 11. | Industrial pressure  sensors | 0-10 bar, 4-20mA output | 25 pcs | 1:1 |
| 12. | Proximity sensors | NPN/PNP, 10-30V DC | 25 pcs | 1:1 |
| 13. | Industrial  temperature sensors | RTD/PT100, -50 to 200°C | 25 pcs | 1:1 |
| 14. | Flow sensors | 4-20mA, 0-10V, RS485 | 25 pcs | 1:1 |
| 15. | Level sensor | Ultrasonic 4-20mA, 0-10V | 25 pcs | 1:1 |
| 16. | Power supply units | Output Voltage: 24V DC  Output Current: 5A or higher Input Voltage: 220V AC | 10 pcs | 1:2.5 |
| 17. | Adjustable  wrenches | Metric and standard sizes | 10 pcs | 1:2.5 |
| 18. | Sets of  combinational wrenches | Metric and standard sizes | 5 sets | 1:5 |
| 19. | Assorted size socket  wrenches | Metric and standard sizes | 5 sets | 1:5 |
| 20. | Assorted sizes of  screw drivers | Insulated, flathead | 5 sets | 1:5 |
| 21. | Assorted sizes of  Allen keys | Metric and standard sizes | 5 sets | 1:5 |
| 22. | Wire Strippers | Suitable for 0.5 mm² to 4 mm² wires | 10 pcs | 1:2 |
| 26. | Cordless drills | 16 V | 5 pcs | 1:5 |
| 27. | Relays | 24V DC coil, 10A contacts | 25 pcs | 1:1 |
| 28. | Solenoid valves | 24V DC, 1/4" or 1/2" connections | 25 pcs | 1:1 |
| 29. | DC motors | 24V DC | 25 pcs | 1:1 |
| 30. | DC motor drives | 12V/24V | 25 pcs | 1:1 |
| 31. | Push buttons | Voltage:24V DC coil/230V AC coil Contact Configuration: 1 NO or 1 NC Illumination: Non-illuminated or LED illuminated  Color Options: Red, Green, Yellow,  Blue, Black | 100 pcs | 1:4 |
| 32. | Select switches | Voltage:24V DC coil/230V AC coil Contact Configuration: 2 NO, 2 NC,  or 1 NO + 1 NC  Positions: 2-position or 3-position Illumination: Non-illuminated or LED illuminated  Color Options: Black, Red, Green | 100 pcs | 1:4 |
| 33. | Digital multimeters | With voltage, current, and resistance  measurement | 25 pcs | 1:1 |
| 37. | Network switches | Cisco 24 ports | 2 | 1:12.5 |
| 38. | Routers | TP link | 10 | 1:2.5 |
| **C** | **Consumable materials** | | | |
| 39. | Writing materials | Pens, pencils, paper | enough |  |
| 40. | Signal cables | 0.5 mm² to 1.5 mm², shielded | 200  metres for  each category | 50m:1 for each category |
| 41. | Jumper cables |  | 200  metres for each  category | 50m:1 for each category |
| 42. | Communication  cables | Cat6 Ethernet cables | 200 m | 50m:1 |
| 47. | First aid kit | Full kits | 5 pcs | 1:5 |
| **D** | **Software** | | | |
| 48. | Programming  and simulation software | Arduino IDE, Mbed | Installed  in 25 Computers | 1:1 |

## HOSPITAL ORGANIZATION AND MAINTENANCE PRINCIPLES

**UNIT CODE:** 0715 541 25A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply Hospital Organization and Maintenance Principles.

**Duration of Unit:** 50Hours`

**Unit Description**

This unit specifies the competencies required to manage hospital organization and maintenance. It involves competencies to apply leadership and management skills, apply concept of hospital maintenance in hospital, manage Maintenance department of a hospital, classify maintenance and Install and Maintenance indices, implement Planned Preventive Maintenance (PPM) in hospitals and administer HMU (Hospital Maintenance Unit)

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration in hours.** |
|  | To Apply leadership and management skills | 10 |
|  | To Apply concept of hospital maintenance in hospital | 8 |
|  | To Manage Maintenance department of a hospital | 8 |
|  | To Classify maintenance and Performance indices | 8 |
|  | To Implement Planned Preventive Maintenance (PPM) in hospitals | 8 |
|  | To Administer HMU (Hospital Maintenance Unit) | 8 |
|  | **TOTAL** | **50** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Apply leadership and management skills | 1. Introduction to leadership and management    1. Concepts    2. Theories    3. Styles    4. Practices 2. Principles of management    1. core values    2. policies    3. group dynamics    4. definitions    5. concepts of change management 3. Organization of Healthcare Services 4. Organization structure    1. Purpose    2. Types    3. Functions    4. Organizational 5. Structure of the health care system    1. Structures    2. Functions 6. Health services delivery    1. Levels of service    2. Health services at each level    3. Actors    4. Cadres    5. Referral system in Kenya. | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Apply concept of hospital maintenance in hospital | 1. Concepts of hospital maintenance 2. Definition of maintenance 3. Scope of maintenance 4. Prerequisite of effective maintenance 5. Objectives of hospital maintenance 6. Maintenance action 7. Maintenance management 8. Failure analysis 9. Classification of equipment failure 10. Improvement of function reliability 11. Productivity improvement 12. Benefits and difficulties in hospital maintenance | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Manage Maintenance department of a hospital | 1. Objectives and functions of maintenance department 2. Duties of maintenance personnel 3. Centralised and decentralised maintenance 4. Traits and training of maintenance staff 5. Maintenance programmes 6. Maintenance costs and policy 7. Contract in-house maintenance 8. Materials and standard spares | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Classify maintenance and performance indices | 1. Classification of maintenance and performance indices    1. Routine maintenance    2. Scheduled maintenance    3. Repair maintenance    4. Organized maintenance    5. Emergency maintenance    6. Planned maintenance    7. Breakdown maintenance    8. Corrective maintenance    9. Design out maintenance    10. Operational maintenance    11. Planned shutdown maintenance    12. Renovative maintenance    13. Preventive maintenance    14. Fixed time maintenance    15. Zero breakdown maintenance    16. Continuous maintenance    17. Total maintenance 2. Predictive condition maintenance | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Implement Planned Preventive Maintenance(PPM) in hospitals | 1. Meaning of PPM 2. Reasons for implementing PPM 3. Procedure in PPM 4. Features, policy, objectives and activities of PPM 5. Prerequisites for success of preventive maintenance 6. Basic components of PPM 7. Programme, drawbacks, frequency, schedule and strategies of PPM 8. Tools used in PPM    1. Job cards    2. Counter requisition and issue voucher    3. Request slip    4. Section checklist    5. Equipment checklist    6. Equipment history sheet    7. Schedule planner    8. Service schedule 9. Maintenance instructions | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Administer HMU (Hospital Maintenance Unit) | 1. Tasks of maintenance officer in charge 2. Financial accounting systems and mechanisms    1. Accounting documents       1. Imprest       2. Vouchers       3. per diem       4. Facility Improvement Fund (FIF)       5. Salary       6. Allowances       7. Vote Books       8. Budget types 3. Preparation of budgetary proposals    1. Sources of funds for maintenance activities    2. Stating and costing annual requirements | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group discussions
* Interactive lectures
* Industrial attachment
* Viewing of related videos

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S No.** | **Category Item** | **Description Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Reference books | Hospital and Healthcare Facility Design" by Richard L. Miller and Earl S. Swensson:  Essentials of Health Care Facility Management" by Peter J. Houts: | 5 pcs | 1:5 |
|  | Installation manuals | Assorted Systems component Manufacturer’s manuals and data sheets | 5 pcs | 1:5 |
|  | Audio visual presentations | Projector | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture theory room | 60m2 | 1 | 1:25 |
|  | Computer laboratory | 100m2 | 1 | 1:25 |
| **C** | **Tools and Equipment** | | | |
|  | Assorted tools and equipment | Files and sample documentations | 25 pcs | 1:1 |

## RESEARCH METHODS

**UNIT CODE:** 0914541 24A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Apply Research Methods

**Duration of Unit:** 60Hours

**Unit Description**

This unit covers the competencies required to apply research methods. It involves Identifying research problem, conducting literature review, Developing Research Methodology, Analyzing collected data and preparing research report.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
|  | **Learning Outcome** | **Duration in hours.** |
|  | To Identify Research Problem | 10 |
|  | To Conduct Literature Review | 15 |
|  | To Develop Research Methodology | 15 |
|  | To Analyze Collected Data | 15 |
|  | To Prepare Research Report | 5 |
|  | **TOTAL** | **60** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Identify research problem | 1. Methods of identifying research problem 2. Gathering background information 3. Research variables 4. Research objectives 5. Formulating research questions 6. Significance of research 7. Establishment of scope of study | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Conduct literature review | 1. Sources of literature review 2. Primary 3. Secondary 4. Keywords and phrases 5. Ethical research guidelines on referencing and citation 6. Organization and reporting of collected literature | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Develop Research Methodology | 1. Types of research designs 2. Descriptive 3. Correlational 4. Experimental 5. Longitudinal 6. Cross-sectional 7. Identification of study population 8. Sampling techniques 9. Simple random 10. Systematic 11. Stratified 12. Clustered 13. Research proposal and budget preparation | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Analyze collected data | 1. Methods of data collection 2. Surveys and questionnaires 3. Interviews 4. Focus groups 5. Observations 6. Case studies 7. Research guidelines on data collection 8. Data cleaning 9. Data analysis tools 10. Statistical software 11. Qualitative analysis software 12. Spreadsheet software 13. Data presentation 14. Data visualization tools 15. Presentation software | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Prepare research report | 1. Discussion of research findings 2. Drawing of conclusions based on findings 3. Recommendations 4. Referencing systems 5. APA 6. MLA 7. Havard 8. IEEE 9. Appendices 10. Research report presentation | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group discussions
* Interactive lectures
* Industrial attachment
* Viewing of related videos

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S No.** | **Category Item** | **Description Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Reference books | * Research Methodology: A Step-by-Step Guide for Beginners by Ranjit Kumar * Research Methodology: Tools And Techniques   By Dr. Prabhat Pandey  and Dr. Meenu Mishra Pandey | 5 pcs for each | 1:5 |
|  | Charts | Research design flow chart | 1 pc for each | 1:25 |
|  | Software | Data analysis software i.e SPSS, Microsoft Excel  Data presentation software i.e. Microsoft powerpoint, Tableau, Canva, Microsoft Excel.  Planning and management software. i.e. Google Calendar | 25 | 1:1 |
|  | Audio visual presentations | Projector | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture theory room | 60m2 | 1 | 1:25 |
|  | Research Centre | 100m2 | 1 | 1:25 |
| **C** | **Consumable materials** | | | |
|  | Field research materials | Sampling supplies i.e. soil, bags, notebook, battery and fuel | 25 pcs for each | 1:1 |
|  | Social research materials | Surveys and questionnaires | 25 pcs for each | 1:1 |
|  | Laboratory research materials | Chemical reagents, glassware and plastic ware | 25 for each | 1:5 |
| **D** | **Tools and Equipment** | | | |
|  | Assorted research and data collection tools and equipment | Camera, Digital storage device, computer, | 25 pcs | 1:1 |

## PHYSIOTHERAPY AND ORTHOPAEDIC EQUIPMENT

**UNIT CODE:** 0914541 34A

**Relationship to Occupational Standards**

This unit addresses the Unit of Competency: Perform Physiotherapy and Orthopaedic Equipment

**Duration of Unit:** 120Hours

**Unit Description**

This unit specifies the competencies required to Perform Physiotherapy and OrthopaedicEquipment. It involves Performing Short Wave Diathermy Machine maintenance, Electrotherapy equipment maintenance, Infrared Therapy Lamp maintenance, Hydro-Collator Unit, Muscle Stimulator maintenance, Massage Therapy Equipment maintenance, Orthopedic Oscillator maintenance, Hot Air Oven maintenance and Traction Therapy Machine maintenance.

**Summary of Learning Outcomes**

|  |  |  |
| --- | --- | --- |
| **S/No** | **Learning Outcome** | **Duration in hours.** |
|  | To Perform Short Wave Diathermy Machine | 10 |
|  | To Perform electrotherapy equipment | 20 |
|  | To Perform Infrared Therapy Lamp | 10 |
|  | To Perform Hydro-Collator Unit | 10 |
|  | To Perform Massage Therapy Equipment | 20 |
|  | To Perform Orthopaedic Oscillator | 20 |
|  | To Perform Hot Air Oven | 20 |
|  | To Perform Traction Therapy Machine | 10 |
|  | **q** | **120** |

**Learning Outcomes, Content and Suggested Assessment Methods**

|  |  |  |
| --- | --- | --- |
| **Learning Outcome** | **Content** | **Suggested Assessment Methods** |
| 1. Perform Short Wave Diathermy Machine | 1. Main parts of short-wave diathermy machine 2. Oscillator 3. Applicator 4. Uses of short-wave diathermy machine 5. Types of operation short-wave diathermy machine 6. Fault diagnosis of short-wave diathermy machine 7. Maintenance procedures of typical faults. 8. Safety tests. 9. Calibration | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform electrotherapy equipment | 1. Electrodiagnosis 2. Types of Currents used 3. Treatment with low frequency currents 4. Electrotherapy. 5. Current therapy 6. Electrotherapy equipment parts 7. Contact pads/electrodes 8. Battery 9. Electrical stimulation equipment 10. Fault diagnosis of electrotherapy 11. Maintenance procedures of typical faults. 12. Safety tests. 13. Calibration | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Infrared Therapy Lamp | 1. Principles nature of infrared radiation 2. Sources of infrared 3. Types of infrared radiation 4. Parts of infrared radiation 5. Lamp 6. Lamp holder 7. Intensity regulator 8. Effects of infrared radiation 9. Fault diagnosis of infrared therapy lamp 10. Maintenance procedures of typical faults. 11. Safety tests. 12. Calibration | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Hydro-Collator Unit | 1. Main parts of hydro-collator unit 2. Uses of hydro-collator unit 3. Types of hydro-collator unit 4. Parts of hydro-collator unit 5. Heating elements 6. Water packs 7. Thermostat 8. Fault diagnosis of hydro-collator unit 9. Maintenance procedures of typical faults. 10. Safety tests. | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Massage Therapy Equipment | 1. Main parts of massage therapy machine 2. Uses of massage therapy machine 3. Types of massage therapy machine 4. Types of massage therapy machine 5. Motor 6. Hammer mechanism 7. Speed control 8. Fault diagnosis of massage therapy machine 9. Maintenance procedures of typical faults. 10. Safety tests. | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Orthopaedic Oscillator | 1. Main parts of Orthopaedic Oscillator 2. Motor 3. Oscillating blade 4. Uses of Orthopaedic Oscillator 5. Types of Orthopaedic Oscillator 6. Fault diagnosis of Orthopaedic Oscillator 7. Maintenance procedures of typical faults. 8. Safety tests. | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Hot Air Oven | 1. Main parts of Hot Air Oven 2. Uses of Hot Air Oven 3. Types of massage therapy machine 4. Fault diagnosis of Hot Air Oven 5. Maintenance procedures of typical faults. 6. Safety tests. | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |
| 1. Perform Traction Therapy Machine | 1. Main parts of traction therapy machine 2. Uses of traction therapy machine 3. Types of traction therapy machine 4. Fault diagnosis of traction therapy machine 5. Maintenance procedures of typical faults. 6. Safety tests. | * Practical Assessment * Project * Third Party Report * Portfolio Of Evidence * Written Assessment * Oral Questioning |

**Suggested Methods of Instruction**

* Practical
* Projects
* Demonstrations
* Group discussions
* Role playing
* Interactive lectures
* Individual assignments
* Industrial attachment
* Viewing of related videos

**Recommended Resources for 25 Trainees**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **S No.** | **Category Item** | **Description Specifications** | **Quantity** | **Recommended Ratio**  (Item: Trainee) |
| **A** | **Learning Materials** | | | |
|  | Reference books | Dental Instruments: A Pocket Guide by Linda R. Bartolomucci-Boyd:  Modern Dental Assisting by Doni L. Bird and Debbie Robinson: | 5 pcs for each | 1:5 |
|  | Maintenance manuals | Assorted Systems component Maintenance reports, manufacture’s manuals and data sheets  Instrumentation Handbooks | 5 pcs for each | 1:5 |
|  | Charts | Assorted Physiotherapy and Orthopaedic equipment diagrams  Equipment block diagram charts | 1 pcs for each | 1:25 |
|  | Software | Assorted installation software for the equipment | 25 for each | 1:1 |
|  | Audio visual presentations | Projector | 1 | 1:25 |
| **B** | **Learning Facilities & infrastructure** | | | |
|  | Lecture theory room | 60m2 | 1 | 1:25 |
|  | Workshop | 150m2 | 1 | 1:25 |
|  | Simulation Lab | 100m2 | 1 | 1:25 |
|  | Clinical Rotations | Physiotherapy, OT departments | 1 | 1:25 |
| **C** | **Consumable materials** |  |  |  |
|  | Installation materials | Insulation tape, cables, | 25 pcs for each | 1:1 |
|  | Maintenance materials | Wipes, spare batteries, sanitizer, service kits | 25 pcs for each | 1:1 |
|  | Assorted electrical components | Contactors, transformer, overload relays, timers | 25 pcs for each | 1:1 |
|  | Assorted instrumentation components | Sensors, transducers, actuators, cuvettes | 25 for each | 1:5 |
| **D** | **Tools and Equipment** | | | |
|  | Assorted tools and equipment | Side cutters, Side cutters, Pliers, Screw driver, Crimping tools, Multi-meter, Oscilloscope, Solder guns, Allen keys set | 25 pcs for each | 1:1 |
|  | PPEs | Safety boots, overall, masks, gloves, antistatic shoes | 25 pcs for each | 1:1 |
|  | Short Wave Diathermy |  | 2 pcs | 1:12 |
|  | electrotherapy machine tens |  | 5 pcs | 1:5 |
|  | Infrared Therapy |  | 5 pcs | 1:5 |
|  | Hydro-Collator |  | 2 pcs | 1:12 |
|  | Massage Therapy |  | 2 pcs | 1:12 |
|  | Orthopaedic Oscillator |  | 3 pcs | 1:8 |
|  | Hot Air Oven |  | 2 pcs | 1:12 |
|  | Traction Therapy Machine |  | 1 pc | 1:25 |