

**II Year – II SEMESTER**

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**ENVIRONMENTAL STUDIES****Course Learning Objectives:**

The objectives of the course is to impart

1. Overall understanding of the natural resources.
2. Basic understanding of the ecosystem and its diversity.
3. Acquaintance on various environmental challenges induced due to unplanned anthropogenic activities.
4. An understanding of the environmental impact of developmental activities.
5. Awareness on the social issues, environmental legislation and global treaties.

**Course Outcomes:**

The student should have knowledge on

1. The natural resources and their importance for the sustenance of the life and recognise the need to conserve the natural resources.
2. The concepts of the ecosystem and its function in the environment. The need for protecting the producers and consumers in various ecosystems and their role in the food web.
3. The biodiversity of India and the threats to biodiversity, and conservation practices to protect the biodiversity.
4. Various attributes of the pollution and their impacts and measures to reduce or control the pollution along with waste management practices.
5. Social issues both rural and urban environment and the possible means to combat the challenges.
6. The environmental legislations of India and the first global initiatives towards sustainable development.
7. About environmental assessment and the stages involved in EIA and the environmental audit.

**Syllabus:****UNIT - I**

**Multidisciplinary nature of Environmental Studies:** Definition, Scope and Importance –Sustainability: Stockholm and Rio Summit–Global Environmental Challenges: Global warming and climate change, acid rains, ozone layer depletion, population growth and explosion, effects. Role of information Technology in Environment and human health.

**Ecosystems:** Concept of an ecosystem. - Structure and function of an ecosystem. - Producers, consumers and decomposers. - Energy flow in the ecosystem - Ecological succession. - Food chains, food webs and ecological pyramids. - Introduction, types, characteristic features, structure and function of Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems.

**UNIT - II**

**Natural Resources:** Natural resources and associated problems

Forest resources – Use and over – exploitation, deforestation – Timber extraction – Mining, dams and other effects on forest and tribal people.

Water resources – Use and over utilization of surface and ground water – Floods, drought, conflicts over water, dams – benefits and problems.

**Mineral resources:** Use and exploitation, environmental effects of extracting and using mineral resources.

**Food resources:** World food problems, changes caused by non-agriculture activities-effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity.

**Energy resources:** Growing energy needs, renewable and non-renewable energy sources use of alternate energy sources.

**Land resources:** Land as a resource, land degradation, Wasteland reclamation, man induced landslides, soil erosion and desertification. Role of an individual in conservation of natural resources. Equitable use of resources for sustainable lifestyles.

**UNIT - III**

**Biodiversity and its conservation:** Definition: genetic, species and ecosystem diversity- classification - Value of biodiversity: consumptive use, productive use, social-Biodiversity at national and local levels. India as a mega-diversity nation - Hot-spots of biodiversity - Threats to biodiversity: habitat loss, man-wildlife conflicts. - Endangered and endemic species of India – Conservation of biodiversity: conservation of biodiversity.

**UNIT - IV**

**Environmental Pollution:** Definition, Cause, effects and control measures

of Air pollution, Water pollution, Soil pollution, Noise pollution, Nuclear hazards. Role of an individual in prevention of pollution. - Pollution case studies.

**Solid Waste Management:** Sources, classification, effects and control measures of urban and industrial solid wastes. Consumerism and waste products.

## UNIT - V

**Social Issues and the Environment:** Urban problems related to energy - Water conservation, rain water harvesting-Resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions. Environmental Protection Act -Air (Prevention and Control of Pollution) Act. -Water (Prevention and control of Pollution) Act -Wildlife Protection Act -Forest Conservation Act-Issues involved in enforcement of environmental legislation. - Public awareness.

## UNIT - VI

**Environmental Management:** Impact Assessment and its significance various stages of EIA, preparation of EMP and EIS, Environmental audit. Ecotourism

The student should submit a report individually on any issues related to Environmental Studies course and make a power point presentation.

### Text Books:

1. Environmental Studies by R. Rajagopalan, 2<sup>nd</sup> Edition, 2011, Oxford University Press.
2. A Textbook of Environmental Studies by Shaashi Chawla, TMH, New Delhi.
3. Environmental Studies by P.N. Palanisamy, P. Manikandan, A. Geetha, and K. Manjula Rani; Pearson Education, Chennai.

### Reference:

1. Text Book of Environmental Studies by Deeshita Dave & P. Udaya Bhaskar, Cengage Learning.
2. Environmental Studies by K.V.S.G. Murali Krishna, VGS Publishers, Vijayawada.
3. Environmental Studies by Benny Joseph, Tata McGraw Hill Co, New Delhi.
4. Environmental Studies by Piyush Malaviya, Pratibha Singh, Anoop singh: Acme Learning, New Delhi.

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**SWITCHING THEORY AND LOGIC DESIGN****UNIT – I****REVIEW OF NUMBER OF SYSTEMS & CODES:**

- Representation of numbers of different radix, conversion from one radix to another radix,  $r-1$ 's complements and  $r$ 's complements of signed members, problem solving.
- 4 bit codes, BCD, Excess-3, 2421, 84-2-1  $9^s$  complement code etc.,
- Logic operations and error detection & correction codes; Basic logic operations -NOT, OR, AND, Universal building blocks, EX-OR, EX-NOR - Gates, Standard SOP and POS, Forms, Gray code, error detection, error correction codes (parity checking, even parity, odd parity, Hamming code) NAND-NAND and NOR-NOR realizations.

**UNIT – II****MINIMIZATION TECHNIQUES:**

Boolean theorems, principle of complementation & duality, De-morgan theorems, minimization of logic functions using Boolean theorems, minimization of switching functions using K-Map up to 6 variables, tabular minimization, problem solving (code-converters using K-Map etc..).

**UNIT – III****COMBINATIONAL LOGIC CIRCUITS DESIGN :**

Design of Half adder, full adder, half subtractor, full subtractor, applications of full adders, 4-bit binary subtractor, adder-subtractor circuit, BCD adder circuit, Excess 3 adder circuit, look-a-head adder circuit, Design of decoder, demultiplexer, 7 segment decoder, higher order demultiplexing, encoder, multiplexer, higher order multiplexing, realization of Boolean functions using decoders and multiplexers, priority encoder, 4-bit digital comparator.

**UNIT – IV****INTRODUCTION OF PLD's :**

PROM, PAL, PLA-Basics structures, realization of Boolean function with PLDs, programming tables of PLDs, merits & demerits of PROM, PAL, PLA comparison, realization of Boolean functions using PROM, PAL, PLA, programming tables of PROM, PAL, PLA.

**UNIT – V****SEQUENTIAL CIRCUITS I:**

Classification of sequential circuits (synchronous and asynchronous); basic flip-flops, truth tables and excitation tables (nand RS latch, nor RS latch, RS flip-flop, JK flip-flop, T flip-flop, D flip-flop with reset and clear terminals). Conversion from one flip-flop to flip-flop. Design of ripple counters, design of synchronous counters, Johnson counter, ring counter. Design of registers - Buffer register, control buffer register, shift register, bi-directional shift register, universal shift register.

**UNIT – VI****SEQUENTIAL CIRCUITS II :**

Finite state machine; Analysis of clocked sequential circuits, state diagrams, state tables, reduction of state tables and state assignment, design procedures. Realization of circuits using various flip-flops. Meelay to Moore conversion and vice-versa.

**TEXT BOOKS:**

1. Switching Theory and Logic Design by Hill and Peterson Mc-Graw Hill TMH edition.
2. Switching Theory and Logic Design by A. Anand Kumar.
3. Digital Design by Mano PHI.

**REFERENCE BOOKS:**

1. Modern Digital Electronics by RP Jain, TMH.
2. Fundamentals of Logic Design by Charles H. Roth Jr, Jaico Publishers.
3. Micro electronics by Milliman MH edition.

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**PULSE & DIGITAL CIRCUITS****UNIT-I**

**Linear Wave Shaping:** High pass, low pass RC circuits-response to sinusoidal, step, pulse, square and ramp inputs. RC circuit as differentiator and integrator.

**Attenuators:** Basic attenuator circuit and compensated attenuator circuit.

**Switching characteristics of devices:** Diode as a switch, transistor as a switch-transistor at cutoff, the reverse collector saturation current  $I_{CBO}$ , Its variation with the junction temperature. The transistor switch in saturation. Design of transistor switch.

**UNIT-II**

**Non linear wave shaping:** Diode clippers, Transistor clipper, clippers at two independent levels-transfer characteristics of clippers-emitter coupled clipper, clamping operation, diode clamping circuits with source resistance and diode resistance -transient and steady state response for a square wave input, clamping circuit theorem-practical clamping circuit.

**UNIT-III**

**Multi vibrators:**

**Bistable multi vibrators:**

A basic binary circuit-explanation. Fixed-bias transistor binary, self-biased transistor binary, binary with commutating capacitors-analysis. Non saturated binary-symmetrical triggering, schmitt trigger circuit-emitter coupled binary circuit.

**Monostable multi vibrator:**

Basic circuit-collector coupled monostable multivibrator- emitter coupled monostable multivibrator-triggering of monostable multivibrator.

**Astable multi vibrator:**

The Astable collector coupled multivibrator, the Astable emitter coupled multivibrator.

**UNIT-IV**

**Digital logic circuits:** Introduction, positive and negative logic, Diode OR gate, Diode AND gate, An inverter circuit with transistor, DTL, TTL, ECL,

AOI logic, NMOS logic, PMOS logic, CMOS logic-analysis and problem solving.

## NIT-V

### Time base generators:

**Voltage time base generators**-Introduction, definitions of sweep speed error, displacement error, transmission error, various methods of generating time- base waveforms, UJT time base generator, transistor constant current sweep.

**Miller time base generators:** General considerations, The miller sweep-general considerations of bootstrap time base generator-basic principles, transistor bootstrap time base generator.

## UNIT-VI

### Synchronization and frequency division:

Pulse synchronization of relaxation devices, frequency division of the sweep circuit-synchronization of Astable multi, Monostable multivibrator, synchronization of sweep circuit with symmetrical signals-sine wave frequency division with a sweep circuit.

**Sampling Gates:** Basic operating principle, Unidirectional diode gate circuits, bi-directional gates using transistors. A bidirectional diode gate, Four- diode gate.

### Text books:

1. "Pulse, Digital and switching wave forms" by Milliman and Taub Mc Graw Hill.
2. Micro electronics by MilliMan –Mc Graw Hill .

### References:

1. MS PrakashRao "Pulse and Digital Circuits" Tata McGraw Hill.
2. David J.Comer, "Digital Logical State Machine Design", Oxford university press, 2008, third edition.
3. Venkatrao, K.Ramasudha, K.Manmadharao. G, "Pulse and Digital Circuits", pearson education, 2010.
4. Pulse and digital circuitsby Anandkumar, PHI.

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**POWER SYSTEMS-I****Preamble :**

Electrical Power plays significant role in day to day life of entire mankind. The aim of this course is to allow the students to understand the concepts of the generation and distribution of power along with economic aspects.

**Learning objectives :**

- To study the principle of operation and function of different components of a thermal power station.
- To study the principle of operation and function of different components of a Nuclear power station.
- To study the concepts of DC and AC distribution systems along with voltage drop calculations.
- To study the constructional details, principle of operation and function of different components of an Air and Gas Insulated substations.
- To study the constructional details and classification of cables with necessary numerical calculations.
- To study the concepts of different types of load curves and types of tariffs applicable to consumers.

**UNIT-I Thermal Power Stations**

Selection of site, general layout of a thermal power plant showing paths of coal, steam, water, air, ash and flue gasses, ash handling system, Brief description of components: Boilers, Super heaters, Economizers, electrostatic precipitators steam Turbines : Impulse and reaction turbines, Condensers, feed water circuit, Cooling towers and Chimney.

**UNIT-II Nuclear Power Stations**

Location of nuclear power plant, Working principle, Nuclear fission, Nuclear fuels, Nuclear chain reaction, nuclear reactor Components : Moderators, Control rods, Reflectors and Coolants. Types of Nuclear reactors and brief description of PWR, BWR and FBR. Radiation: Radiation hazards and Shielding, nuclear waste disposal.



### UNIT-III Distribution Systems

Classification of distribution systems, design features of distribution systems, radial distribution, ring main distribution, voltage drop calculations: DC distributors for following cases - radial DC distributor fed at one end and at both ends (equal / unequal voltages), ring main distributor, stepped distributor and AC distribution, comparison of DC and AC distribution.

### UNIT-IV Substations

Classification of substations: **Air Insulated Substations** - Indoor & Outdoor substations, Substations layouts of 33/11 kV showing the location of all the substation equipment.

Bus bar arrangements in the Sub-Stations: Simple arrangements like single bus bar, sectionalized single bus bar, double bus bar with one and two circuit breakers, main and transfer bus bar system with relevant diagrams.

**Gas Insulated Substations (GIS)** – Advantages of Gas insulated substations, different types of gas insulated substations, single line diagram of gas insulated substations, constructional aspects of GIS, Installation and maintenance of GIS, Comparison of Air insulated substations and Gas insulated substations.

### UNIT-V Underground Cables

Types of Cables, Construction, Types of insulating materials, Calculation of insulation resistance, stress in insulation and power factor of cable, Numerical Problems.

Capacitance of single and 3-Core belted Cables, Numerical Problems. Grading of Cables-Capacitance grading and Intersheath grading, Numerical Problems.

### UNIT-VI Economic Aspects of Power Generation & Tariff

**Economic Aspects** - Load curve, load duration and integrated load duration curves, discussion on economic aspects: connected load, maximum demand, demand factor, load factor, diversity factor, power capacity factor and plant use factor, Base and peak load plants, Numerical problems.

**Tariff Methods** - Costs of Generation and their division into Fixed, Semi-fixed and Running Costs, Desirable Characteristics of a Tariff Method, Tariff Methods: Simple rate, Flat Rate, Block-Rate, two-part, three-part, and power factor tariff methods, Numerical problems.

### Learning Outcomes:

- i. Students are able to identify the different components of thermal power plants.

- ii. Students are able to identify the different components of nuclear Power plants.
- iii. Students are able to distinguish between AC & DC distribution systems and also estimate voltage drops in both types of distribution systems.
- iv. Students are able to locate the different components of an air and gas insulated substations.
- v. Students are able to identify single core and multi core cables with different insulating materials.
- vi. Students are able to analyse the effect of load factor, demand factor and diversity factor on the cost of generation of electrical power and also able to identify the types of tariff applicable to consumers based on their load demand.

**TEXT BOOKS:**

1. A Text Book on Power System Engineering by M.L.Soni, P.V.Gupta, U.S.Bhatnagar and A. Chakrabarti, Dhanpat Rai & Co. Pvt. Ltd.
2. Generation, Distribution and Utilization of Electric Energy by C.L.Wadhawa New age International (P) Limited, Publishers.

**REFERENCE BOOKS:**

1. Electrical Power Distribution Systems by - V. Kamaraju, Tata Mc Graw Hill, New Delhi.
2. Elements of Electrical Power Station Design by – M V Deshpande, PHI, New Delhi.

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**ELECTRICAL MACHINES – II****Preamble:**

This course covers the topics on single-phase transformers, three-phase transformers and 3-phase induction motor which have wide application in power systems. The main aim of the course is to provide detail concepts, operation and performance of transformers and 3-phase induction motors. A complete design procedure for the design of transformers and 3-phase induction motors can be developed based on basic concepts discussed in unit-VI.

**Learning objectives:**

- Appreciate the concept of operation and performance of single-phase transformers.
- Understand the methods of testing of single-phase transformer.
- Distinguish between single-phase and three-phase transformers.
- Understand the concept of operation and performance of 3-phase induction motor.
- Appreciate the relation between torque and slip, performance of induction motor and induction generator.
- Understand the basic concepts of design of transformers and 3-phase induction motors.

**UNIT-I****Single-phase Transformers**

Types and constructional details - principle of operation - emf equation - operation on no load and on load – lagging, leading and unity power factors loads - phasor diagrams of transformers – equivalent circuit – regulation – losses and efficiency – effect of variation of frequency and supply voltage on losses – All day efficiency.

**UNIT-II****Single-phase Transformers Testing**

Tests on single phase transformers – open circuit and short circuit tests – Sumpner's test – separation of losses – parallel operation with equal voltage

ratios – auto transformer - equivalent circuit – comparison with two winding transformers.

## **UNIT-III**

### **3-Phase Transformers**

Polyphase connections - Y/Y, Y/ $\Delta$ ,  $\Delta$ /Y,  $\Delta$ / $\Delta$  and open  $\Delta$  -- Third harmonics in phase voltages - three winding transformers: determination of  $Z_p$ ,  $Z_s$  and  $Z_t$  -- transients in switching - off load and on load tap changers -- Scott connection.

## **UNIT-IV**

### **3-phase Induction Motors**

construction details of cage and wound rotor machines - production of a rotating magnetic field - principle of operation - rotor emf and rotor frequency - rotor current and pf at standstill and during running conditions - rotor power input, rotor copper loss and mechanical power developed and their inter relationship – equivalent circuit – phasor diagram.

## **UNIT-V**

### **Characteristics, starting and testing methods of Induction Motors**

Torque equation - expressions for maximum torque and starting torque - torque slip characteristic - double cage and deep bar rotors - crawling and cogging - no load and blocked rotor tests - circle diagram for predetermination of performance - methods of starting – starting current and torque calculations – induction generator operation.

## **UNIT-VI**

### **Design of transformer and 3-phase induction motor**

Transformer: Design concept – output equation – choice of windings – calculation of number of turns – length of mean turn of winding - calculation of resistance and leakage reactance.

Three phase induction motor: Design concept – choice of specific electric and magnetic loadings – output equation – stator design – number of slots – conductor dimensions – type of winding – number of rotor slots – conductor dimensions.

### **Learning outcomes:**

- i. Able to explain the operation and performance of single phase transformer.
- ii. Able to explain the regulation losses and efficiency of single phase transformer.

- iii. Able to explain types of three phase transformer connection, tap changing methods and 3-phase to 2-phase transformation.
- iv. Able to explain the operation and performance of three phase induction motor.
- v. Able to analyze the torque-speed relation, performance of induction motor and induction generator.
- vi. Able to explain design procedure for transformers and three phase induction motors.

**TEXT BOOKS:**

1. The performance and design of alternating current machines – M.G. Say, CBS publishers & distributors, New Delhi.
2. Electrical Machines – P.S. Bimbra, Khanna Publishers.

**REFERENCE BOOKS:**

1. Electrical Machines by J.B.Guptha, S.K.Kataria & Sons.
2. Electrical Machines by D. P.Kothari, I. J. Nagarth, Mc Graw Hill Publications, 4<sup>th</sup> edition.
3. Electrical Machines by R.K.Rajput, Lakshmi publications, Fifth edition.
4. Electrical Machine Design by Sawhney, Dhanpath Rai Publications.
5. Electrical Machines by Smarajit Ghosh, Pearson Publications.

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**CONTROL SYSTEMS****Preamble :**

This course introduces the elements of linear control systems and their analysis. Classical methods of design using frequency response are included. The state space approach for modeling and analysis is the added feature of this course.

**UNIT – I:****Learning Objective:**

To learn the mathematical modeling of physical systems and to use block diagram algebra and signal flow graph to determine overall transfer function.

**MATHEMATICAL MODELING OF CONTROL SYSTEMS**

Open Loop and closed loop control systems and their differences, Classification of control systems, Feed-Back Characteristics, transfer function of linear system, Differential equations of electrical networks, Translational and Rotational mechanical systems, Transfer Function of DC Servo motor - AC Servo motor- Synchro-transmitter and Receiver, Block diagram algebra – Representation by Signal flow graph - Reduction using Mason's gain formula.

**Outcome:**

Ability to derive the transfer function of physical systems and determination of overall transfer function using block diagram algebra and signal flow graphs.

**UNIT-II:****Learning Objective:**

To analyze the time response of first and second order systems and improvement of performance by proportional plus derivative and proportional plus integral controllers.

**TIME RESPONSE ANALYSIS**

Standard test signals - Time response of first order systems –Time response of second order systems - Time domain specifications - Steady state errors and error constants – Effects of proportional derivative, proportional integral systems.

**Outcome:**

Capability to determine time response specifications of second order systems and to determine error constants.

**UNIT – III:****Learning Objective :**

To investigate the stability of closed loop systems using Routh's stability criterion and the analysis by root locus method.

**STABILITY AND ROOTLOCUS TECHNIQUE**

The concept of stability – Routh's stability criterion –limitations of Routh's stability – The root locus concept - construction of root loci (Simple problems).

**Outcome:**

Acquires the skill to analyze absolute and relative stability of LTI systems using Routh's stability criterion and the root locus method.

**UNIT-IV:****Learning Objective :**

To present the Frequency Response approaches for the analysis of linear time invariant (LTI) systems using Bode plots, polar plots and Nyquist stability criterion.

**FREQUENCY RESPONSE ANALYSIS**

Introduction, Frequency domain specifications-Bode diagrams- transfer function from the Bode Diagram-Phase margin and Gain margin-Stability Analysis from Bode Plots, Polar Plots, Nyquist Stability criterion.

**Outcome:**

Capable to analyze the stability of LTI systems using frequency response methods.

**UNIT-V:****Learning Objective :**

To discuss basic aspects of design and compensation of linear control systems using Bode plots.

**CLASSICAL CONTROL DESIGN TECHNIQUES**

Lag, Lead, Lag-Lead compensators, design of compensators – using Bode plots.

**Outcome:**

Able to design Lag, Lead, Lag-Lead compensators to improve system performance from Bode diagrams.

**UNIT–VI:****Learning Objective:**

Ability to formulate state models and analyze the systems. To present the concepts of Controllability and Observability.

**STATE SPACE ANALYSIS OF CONTINUOUS SYSTEMS**

Concepts of state, state variables and state model, state space representation of transfer function, Diagonalization- Solving the Time invariant state Equations- State Transition Matrix and it's Properties – Concepts of Controllability and Observability.

**Outcome:**

Ability to represent physical systems as state models and determine the response. Understanding the concepts of controllability and observability.

**TEXT BOOKS:**

1. Modern Control Engineering, Kotsuhiko Ogata, Prentice Hall of India.
2. Automatic control systems, Benjamin C.Kuo, Prentice Hall of India, 2<sup>nd</sup> Edition

**REFERENCE BOOKS:**

1. Control Systems, Manik Dhanesh N, Cengage publications .
2. Control Systems principles and design, M.Gopal, Tata Mc Graw Hill education Pvt Ltd., 4<sup>th</sup> Edition.
3. Control Systems Engineering, S.Palani, Tata Mc Graw Hill Publications.



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**ELECTRICAL MACHINES – I LAB**

**Any 10 of the following experiments are to be conducted:**

1. Magnetization characteristics of DC shunt generator. Determination of critical field resistance and critical speed.
2. Load test on DC shunt generator. Determination of characteristics.
3. Brake test on DC shunt motor. Determination of performance curves.
4. Load test on DC compound generator. Determination of characteristics.
5. Hopkinson's test on DC shunt machines. Predetermination of efficiency.
6. Fields test on DC series machines. Determination of efficiency.
7. Swinburne's test and Predetermination of efficiencies as Generator and Motor.
8. Speed control of DC shunt motor by Field and armature Control.
9. Brake test on DC compound motor. Determination of performance curves.
10. Load test on DC series generator. Determination of characteristics.
11. Retardation test on DC shunt motor. Determination of losses at rated speed.
12. Separation of losses in DC shunt motor.

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**ELECTRONIC DEVICES & CIRCUITS LAB****PART A: Electronic Workshop Practice**

1. Identification, Specifications, Testing of R, L, C Components (Colour Codes), Potentiometers, Coils, Gang Condensers, Relays, Bread Boards.
2. Identification, Specifications and Testing of active devices, Diodes, BJTs, JFETs, LEDs, LCDs, SCR, UJT.
3. Soldering Practice- Simple circuits using active and passive components.
4. Study and operation of Ammeters, Voltmeters, Transformers, Analog and Digital Multimeter, Function Generator, Regulated Power Supply and CRO.

**PART B: List of Experiments****(For Laboratory Examination-Minimum of Ten Experiments)**

1. P-N Junction Diode Characteristics  
Part A: Germanium Diode (Forward bias& Reverse bias)  
Part B: Silicon Diode (Forward Bias only)
2. Zener Diode Characteristics  
Part A: V-I Characteristics  
Part B: Zener Diode as Voltage Regulator
3. Rectifiers (without and with c-filter)  
Part A: Half-wave Rectifier  
Part B: Full-wave Rectifier
4. BJT Characteristics(CE Configuration)  
Part A: Input Characteristics  
Part B: Output Characteristics
5. FET Characteristics(CS Configuration)  
Part A: Drain Characteristics  
Part B: Transfer Characteristics
6. SCR Characteristics
7. UJT Characteristics
8. Transistor Biasing

9. CRO Operation and its Measurements
10. BJT-CE Amplifier
11. Emitter Follower-CC Amplifier
12. FET-CS Amplifier

### **PART C: Equipment required for Laboratory**

1. Boxes
2. Ammeters (Analog or Digital)
3. Voltmeters (Analog or Digital)
4. Active & Passive Electronic Components
5. Regulated Power supplies
6. Analog/Digital Storage Oscilloscopes
7. Analog/Digital Function Generators
8. Digital Multimeters
9. Decade Résistance Boxes/Rheostats
10. Decade Capacitance