BHARATHIAR UNIVERSITY: COIMBATORE-641046

B.SC. RENEWABLE ENERGY (CPOP)

(For the students admitted from the academic year 2012-2013 and onwards)

SCHEME OF EXAMINATION - CBCS PATTERN

Part	Study Components	Course title	Ins. hrs/ week	Examinations				Credit
				Dur.Hrs	CIA	Marks	Total Marks	
Semester I								
I	Language – I		6	3	25	75	100	4
II	English – 1		6	3	25	75	100	4
III	Core – 1 : Energy Resources		6	3	25	75	100	4
	Core – 2 : Fundamentals of Electricity		6	3	25	75	100	4
	Allied – 1 : Electrical Instruments & Measurements		4	3	25	75	100	4
IV	Environmental Studies		2	3	-	50	50	2
Semester – II								
I	Language – II		4	3	25	75	100	4
II	English – 1I		4	3	25	75	100	4
III	Core – 3 : Fundamentals of Electronics		6	3	25	75	100	4
	Core – 4 : Electrochemical Power Sources and Storage Devices		4	3	25	75	100	4
	Core Lab – 1 : Basic Electronics		4	3	40	60	100	4
	Allied – 2 : Renewable Energy Resources and improved Energy Utilization		4	3	25	75	100	4
IV	Value Education - Human Rights		2	2	-	50	50	2
Semester – III								
III	Core-5: Poly Phases & Harmonics		6	3	25	75	100	4
	Core-6 : Electro-Mechanical Energy Conversion		6	3	25	75	100	4
	Core Lab:2 Electrical Workshop		5	3	40	60	100	4
	Allied 3: Basic of Information Technology		6	3	25	75	100	4
IV	Skill based subject-1; - Transformers & AC Motors		5	3	20	55	75	3
IV	Tamil @ / Advanced Tamil# (OR)Non-major elective - I (Yoga for Hu*m*an Excellence)# / Women's Rights#		2	3	-	50	50	2

Semester - IV							
III	Core 7: Power Electronics	6	3	25	75	100	4
	Core 8: Analog Electronics	6	3	25	75	100	4
	Core Lab-3: Power & Analog Electronics	6	3	40	60	100	4
	Allied -4 : Management Information Systems	6	3	25	75	100	4
IV	Skill based Subject 2: Heat & Thermodynamics	4	3	30	45	75	3
IV	Tamil@/Advanced Tamil# (OR)Non-major elective (General Awareness #)	2	3	-	50	50	2
Semester – V							
III	Core 9: Solar PV -Technology	6	3	25	75	100	4
III	Core 10: Digital Electronics	6	3	25	75	100	4
III	Elective I : Fundamentals Of Microprocessor	6	3	25	75	100	4
	Core-Lab 4: Digital Electronics	4	3	40	60	100	4
	Core Lab 5: Fundamentals Of Microprocessor	5	3	40	60	100	4
IV	Skill based Subject 3 : Solar Energy Fundamentals and Modeling Techniques	3	3	20	55	75	3
Semester – VI							
III	Core 11 : PV-Testing & Evaluation	5	3	25	75	100	4
III	Elective II : Solar Power System Sizing	6	3	25	75	100	4
	Elective III : Solar Thermal System & Applications	5	3	25	75	100	4
	Industrial Project	16	3	-	-	250*	10
IV	Skill based subject 4 - Lab : Photo Voltaic Technology & Solar Energy Lab	4	3	30	45	75	3
V	Extension Activities @	-	-	50	-	50	2
	Total					3500	140

***** For Project work : 80% (200 marks) & Viva voce : 20% (50 marks)

Core 1 : Energy Resources

Unit – 1

An Introduction to Energy Sources:- Energy consumption as a measure of Prosperity - Worlds Energy demand –Energy sources and their availability - Renewable energy sources and their Prospects.

Solar Radiation Measurement:-Solar Constant - Solar radiation at Earth's surface - Solar Radiation Geometry-Solar Radiation Measurement - Solar Radiation Data -Estimation of Average solar radiation-Solar Radiation on Tilted Surface.

Unit – 2

Solar Energy Collectors:- Principles - Conversion of solar radiation into heat-Flat-plate Collectors-Transmissivity of cover system-Energy balance equation efficiency-Thermal analysis of Flat-plate - Concentrating Collector : Focusing Type-Merits and demerits of concentrating collectors, Types of Collectors- Focusing type- Flat Plate-Selective absorber coatings.

Solar Energy Storage Systems –Introduction of Solar Pond - Principles Operation and description of Non-convective solar pond – Extraction of thermal energy- Application of solar ponds

Unit – 3

Applications of Solar Energy: - Water heating - Space-heating - cooling -Solar thermal electric conversion – Solar Electric power Generation: Solar Photo-Voltaic - Agricultural and Industrial process heat – Distillation ,Pumping ,Furnace , Cooking , Green houses, Production of Hydrogen

Wind Energy: Basic principles of Wind Energy Conversion : The nature of the wind- Wind power - Forces on the blades- Estimation-Basic Components of a WECS -Classification of WEC Systems-merits and demerits of WECS- Analysis of Aerodynamic Forces Acting on the Blade -Generating Systems-Energy Storage-Applications of Wind Energy

Unit – 4

Energy from Biomass:-Biomass Conversion Technologies Biomass as a source of Energy-Methods for obtaining Energy from biomass-Thermal Gasification of biomass- Bio-logical Conversion of Solar Energy-Alternative Liquid Fuels.-Photosynthesis – Biogas Generation-Types of biogas plants-Construction Digesters-Biogas from plant waste-Community biogas plants-Fuel properties of biogas-Utilization of biogas

Unit – 5

Geothermal Energy:- Geothermal Energy in India : Prospects -Sources – estimation of Hydrothermal Resources-Geopressured Resources-Hot and Dry Rock Resources of petro thermal systems -Interconnection of Geothermal Fossil Systems-Prime Movers for Geothermal Energy Conversion - Applications of Geothermal Energy-Geothermal Exploration – Geothermal Well Drilling- Operation and Environmental problems

References

1. Introduction to Renewable Energy**, Solar Energy International, 2012**
2. Renewable Energy: Power for a Sustainable Future, **Second Edition Godfrey Boyle, Oxford, United Kingdom, 2012**
3. Alternative Energy Sources**, Michaelides, Efstathios E. (Stathis), Springer, Germany, 2012**
4. Sustainable Energy Systems and Applications, **Dinçer, İbrahim, Zamfirescu, Calin, Springer, Germany, 2012**

Core 2 : Fundamentals of Electricity

Unit -1

Electric Current and Ohm's Law : Electron Drift Velocity-Charge Velocity and Velocity of Field Propagation- Electric Potential - Conductance and Conductivity- Ohm's Law-Resistance in Series- in Parallel-Types of Resistors-Nonlinear - Varistor-Short and Open Circuits- Series Circuit-Equivalent Resistance-Relative Potential-Voltage Divider Circuits

Unit – 2

Electrostatics: Static electricity-Absolute and Relative Permittivity of a Medium-Laws of Electrostatics-Electric Field-Electrostatic Induction-Electric Flux and Faraday Tubes-Electric Flux Density - Electric Displacement D-Gauss Law- Poisson and Laplace-Electric Potential and Energy-Potential and Potential Difference-Potential at a Point-Potential of a charged sphere-Equi potential Surfaces-Voltage and Dielectric Strength-Boundary Conditions

Unit – 3

Magnetism and Electromagnetism: Absolute and Relative Permeability of a Medium-Laws of Magnetic Force-Magnetic Field Strength (H)-Magnetic Potential-Weber and Ewing's Molecular Theory- Ampere's Work Law -Biot-Savart Law-Magnetic Circuit-definitions-Composite Series Magnetic Circuit-Comparison between magnetic and electric circuits-Parallel Magnetic Circuits--Magnetization Curves

Unit – 4

Electromagnetic Induction : Relation between Magnetism and Electricity-Production of Induced E.M.F. and Current-Faraday's Laws of Electromagnetic Induction- Lenz's Law-Induced E.M.F.-Dynamically-Statically-induced E.M.F.-Self-Inductance-Coefficient of Self-Inductance (L)-Mutual Inductance-Coefficient of Mutual Inductance (M)-Coefficient of Coupling-Inductances in Series and Parallel

Unit – 5

Magnetic Hysteresis- Area of Hysteresis Loop Properties and applications of Ferromagnetic Materials-Permanent magnet materials-Steinmetz Hysteresis Law-Energy Stored in Magnetic Field-Rate of Change of Stored Energy- - Lifting Power of Magnet-Rise and Decay of Current in Inductive Circuit- Transient Current Rise and decay *R-L* Circuit -Automobile Ignition System

References

1. **Electrical Technology**, Naidu-Kamakshaiah, Tata McGraw-Hill Education, 2006
2. Fundamentals of Electrical Engineering, **Rajendra Prasad, PHI Learning Pvt. Ltd., 2005**
3. A Text Book of Electrical Technology, **B.L. Theraja, S. Chand Limited, 2008**
4. Photovoltaics: Design and Installation Manual, **Solar Energy International, 2012**

Core 3 : Fundamentals of Electronics

Unit – 1

Electronics – Introduction- Applications-Current and Voltage Source-Physics of Semiconductor Materials –Structure of Atom-Energy band gap diagram of Conductors, Semiconductors and Insulators

Unit – 2

Semiconductor Diode: Types of semiconductors – P & N Types – charge carriers –P &N junction theory-VI characteristics –ideal diode-Rectifiers-types of rectifiers- Filters-C, LC and π – Regulators – Zener diode -voltage Regulator, Series voltage Regulator Different types of filters- clipping and clamping circuits –LED-7-segment –Photo diode-LDR

Unit – 3

Transistor-amplifying action-transistor configuration:-CB, CE,CC Configurations-comparison-thermal runway-heat sink- Transistor ratings -Transistor biasing and stabilization –selection of operating point-different biasing circuits

Unit – 4

Feedback amplifies – concept of positive and negative feedback – Negative feedback– types and characteristics of negative feedback amplifier-. Concept of power amplification – parameters-class A, class B, class AB and class C

Unit – 5

Oscillators – Types, Principle of sinusoidal oscillators, Barkhausen criteria RC oscillators– RC phase shift and Wein bridge oscillator, LC oscillators – Colpitts and Hartley oscillator.Crystal oscillator – circuits, Working, comparison and Applications

FET – introduction, Types, construction, operation, characteristics – FET Parameters– Comparison between FET and BJT– JFET, MOSFET – UJT Characteristics, features and Applications

References

1. **Basic Electronics and Linear Circuits**, Bhargava, Kurukshetra & Gupta Tata McGraw-Hill Publishing Ltd. 2007
2. **Applied Electronics**, R S Sedha, S. Chand and Company Ltd. 2008
3. **Principles of Electronics**, V.K. Mehta, S.Chand and Company Ltd.2005
4. **Electronics Service Technology** Vol-1. Saji A.G,Shaym Mohan , Ayodhya publications, 2007
5. **Integrated Electronics**, Jacob Millman and C. Halkias Mill, Tata McGraw-Hill Publishing Ltd. 2008

Core – 4 : Electrochemical Power Sources and Storage Devices

Unit – 1

Capacitance -Capacitor-Capacitance-Capacitance of an Isolated Sphere-Spherical Capacitor - Parallel- plate Capacitor-Special Cases of Parallel-plate Capacitor-Multiple and Variable Capacitors-Cylindrical Capacitor-Potential Gradient in Cylindrical

Capacitor-Capacitance Between two Parallel Wires-Capacitors in Series-Capacitors in Parallel-Cylindrical Capacitor with Compound Dielectric-Insulation Resistance of a Cable Capacitor

Unit – 2

Energy Stored in a Capacitor-Force of Attraction Between Oppositely-charged Plates-Current-Voltage Relationships in a Capacitor-Charging of a Capacitor-Time Constant-Discharging of a Capacitor-Transient Relations during Capacitor Charging Cycle-Transient Relations during Capacitor Discharging Cycle-Charging and Discharging of a Capacitor with Initial Charge

Unit – 3

Electrochemical Power Sources: Faraday's Laws of electrolysis-Polarisation or Back e.m.f.-Value of Back e.m.f.-:-Primary and Secondary Batteries-Classification of Secondary Batteries base on their Use-Classification of Lead Storage Batteries-Parts of a Lead-acid Battery-Active Materials of Lead-acid Cells-Chemical. Changes-Formation of Plates of Lead-acid Cells-Plante Process-Structure of Plante Plates-Faure Process-Positive Pasted Plates-Negative Pasted Plates-Structure of Faure Plates-Comparison : Plante and Faure Plates-Internal Resistance and Capacity of a Cell-Two Efficiencies of the Cell

Unit – 4

Electrical Characteristics of the Lead-acid Cell-Battery Ratings-Indications of a Fully-Charged Cell-Application of Lead-acid Batteries-Voltage Regulators-End-cell Control System-Number of End cells-Charging Systems-Constant-current System-Constant-voltage System-Trickle Charging-Sulphation-Causes and Cure-Maintenance of Lead-acid Cells

Unit – 5

Mains operated Battery Chargers-Car Battery Charger-Automobile Battery Charger-Static Uninterruptable Power Systems-Alkaline Batteries-Nickel-iron or Edison Batteries-Chemical Changes-Electrical Characteristics-Nickel-Cadmium Batteries-Chemical Changes—Comparison

Lead-acid and Edison Cells-Silver-zinc Batteries-High Temperature Batteries-Secondary Hybrid Cells-Fuel Cells-Hydrogen-Oxygen Fuel Cells-Batteries for Aircraft- Batteries for Submarines

References

1. **Energy Demand and Supply**, (Stathis) Michaelides, Efstathios E. Springer Germany, 2012
2. Solar Electricity Handbook - 2012 Edition: A Simple Practical Guide to Solar Energy - Designing and Installing Photovoltaic Solar Electric Systems, **Michael Boxwell, Greenstream Publishers, 2012**
3. Photovoltaics: Design and Installation Manual, **Solar Energy International, 2012**
4. Solar Electric Handbook: Photovoltaic Fundamentals and Applications, **Solar Energy International, 2012**

Core 5 : Poly Phases & Harmonics

Unit – 1

Polyphase Circuits: Generation of Polyphase Voltages-Phase Sequence-Interconnection of Three Phases-Star or Wye (Y) Connection-Voltages and Currents in Y-Connection-Delta (A) or Mesh Connection-Balanced Y/A and AIY Conversions-Star and Delta Connected Lighting Loads

Power Factor Improvement-Power Correction Equipment-Parallel" Loads-Power Measurement in 3-phase Circuits-Three Wattmeter Method-Two Wattmeter *Method-Balanced* or *Unbalanced load-Two* Wattmeter *Method-Balanced* Load-Variations in Wattmeter Readings-Leading Power Factor-Power *Factor-Balanced* Load-Balanced Load-LPF-Reactive Voltamperes with One Wattmeter- -Copper Required for Transmitting Power Under Fixed Conditions--Unbalance~Loads- Millman's Thereom-Application of Kirchhoff's Laws-Delta/Star and StarlDelta Conversions-Unbalanced Star-connected Non-inductive Load-Phase Sequence Indicators

Unit – 2

Harmonics: Fundamental Wave and Harmonics-Different Complex Waveforms-General Equation of a Complex Wave-R.M.S. Value of a. Complex Wave-Form Factor of a Complex Wave-Power Supplied by a Complex Wave-Harmonics in Single-phase A.C Circuits-Selective Resonance Due to Harmonics-Effect of Harmonics on Measurement of Inductance and Capacitance-Harmonics in Different Three-phase Systems-Harmonics in Single and 3-Phase Transformers

Unit – 3

Fourier series: Harmonic Analysis-Periodic Functions-Trigonometric Fourier Series-Alternate Forms of Trigonometric Fourier Series-Certain Useful Integral Calculus Theorems-Evaluation of Fourier Constants-Different Types of Functional Symmetries-Line or Frequency Spectrum-Procedure for Finding the Fourier Series of a Given Function-Wave Analyzer-Spectrum Analyzer-Fourier Analyzer-Harmonic Synthesis

Unit – 4

Transients : Types of Transients-Important Differential Equations-Transients in R-L Circuits (D.C.),-Short Circuit Current-Time Constant-Transients in R-L Circuits (A.C.)-Transients in R-C Series Circuits (D.C.)-Transients in R-C Series Circuits (A.C)-Double Energy Transients-Objective Tests

Unit – 5

Symmetrical Components :The Positive-sequence Components-The Negative-sequence components-The Zero-sequence Components-Graphical Composition of Sequence Vectors-Evaluation of Valor VI-Evaluation of *VA2*or V2-Evaluation *VAO* or vo-Zero Sequence Components of Current and Voltage-Unbalanced Star Load form Unbalanced Three-phase Three-Wire System-Unbalanced Star Load Supplied from Balanced Three-phase Three-wire System-Measurement of Symmetrical Components of Circuits-Measurement of Positive and Negative sequence Voltages-Measurement of Zero-sequence Component of Voltage

References

Text Book By BL.Therja

Core 6 : Electro-mechanical Energy Conversion

Unit – 1

Elements of Electro-mechanical Energy Conversion:-Salient aspects of conversions—Energy balance—Magnetic –field system: Energy and Co-energy—Linear System—A Simple Electromechanical System—In terms of Field Energy & Co-energy—Energy in terms of Electrical parameters—Rotary Motion—Description of Simple System—Energy stored in the coils—Different Categories—One coil each on Stator and on Rotor—Vital Role of Air-gap—Statically induced emf and Dynamically induced emf

Unit – 2

D.C. Generators: Generator Principal—Practical Generator—Yoke—Pole Cores and Pole Shoes—Pole Coils—Armature Core—Armature Windings—Bushes and Bearings—Types of Generators—Brush Contact Drop—Generated E.M.F of E.M.F

Equation of a Generator—Iron Loss in Armature—Total loss in a D.C. Generator—Stray Losses—Constant or standing Losses—Power Stages—Condition for Maximum Efficiency

Unit – 3

Armature Reaction and Commutation:-Armature Reaction—Demagnetizing and Cross-magnetizing Conductors—Cross magnetizing AT per pole—Compensating Windings—No. of Compensating Windings—Parallel Operation of Shunt Generators-Paralleling D.C.Generator—Load Sharing—Procedure for Paralleling D.C. Generators—Compound Generators in Parallel—Series Generators in Parallel

Generator Characteristics: Characteristics of D.C. Generators— Separately-excited Generator & its No-load—Critical Speed—Voltage Build up of a Shunt Generator- Other factors Affecting Voltage Building of a D.C. Generator

Unit – 4

D.C. Motor: Motor Principle-Comparison of Generator and Motor Action-Significance of the Back e.m.f-Motor:-Voltage Equation, Maximum Power, torque, Speed -Motor Characteristics—Characteristics of Series Motors, Shunt Motors, Compound Motors—Losses and Efficiency—Power Stages

Unit – 5

Speed Control of D.C. Motors: Factors controlling Motor speed—Speed control of shunt motors & series motors—Merits and demerits of Rheostatic Control method—Series-Parallel Control—Electric braking—Electric braking of Shunt motors & Series motors—Electronic speed control method for D.C. Motors—Uncontrolled & Controlled Rectifies—Thyristor:-Choppers , Inverters, Speed control of separately-excited D.C. Motor-Full-wave speed control of a shunt motor—Thyristor control of a Shunt motor & speed control of a series D.C. Motor—Necessity of starter—Starter:- Shunt motor ,Three-point , Four-point -Starting and speed control of Series motors—Grading of starting resistance—shunt motors—Series motor starters—Thyristor controller starters

Testing of D.C. Machines: Brake test—Swinburnes test & its Advantage & Disadvantages—Regenerative of Hopkinson's test—Alternative connections for Hopkinson's test—Merits of Hopkinson's Test—Retardation of running Down Test—Field's test for series Motors

References

Text Book By BL.Therja

Core 7 : Power Electronics

Unit -1

Power Devices -Introduction, SCR, DIAC and TRIAC – Construction and operation – SCR triggering methods and circuits – series and parallel connections of SCRs – TRIAC triggering circuits.-Protection of Thyristors. PUT, GTO, LASCR. Power diode, Power BJT, IGBT, MOSFET–Construction and operation, switching characteristics, applications, Comparison

Unit – 2

Controlled rectifiers and Commutation of SCR -Controlled rectifiers – Principles of phase controlled converters – Half controlled-Semi controlled-full controlled-Dual converters, principles of cycloconverters, Single phase series converter. Introduction to commutation, Class A, B, C, D, E & F

Unit - 3

Inverters and Static Switches -Single phase bridge inverter –Half bridge- Full Bridge Inverters. Voltage and frequency control of single phase inverters. Concept of PWM. Introduction – Single phase ac switches, Three phase ac switches – 3 phase reversing switches, ac switches for bus transfer – dc switches – solid state relays – AC voltage controller – Principles of ON/OFF control –principle of phase control

Unit – 4

DC Choppers and Power supplies -Introduction to choppers - principles and control techniques–classification. Switching regulator – buck, boost regulator, buck boost regulator – cuk regulator – comparison between switching regulator and linear regulator. SMPS – Fly back, Push pull, half bridge and Full bridge converters. Bidirectional power supply – ac power supply–Inverters, UPS – types

Unit – 5

Applications of Power Electronics Battery charging - Illumination control using TRIAC. DC motor drives –single phase drives –half wave, full wave, dual converter. Electric braking-industrial heating –Electrical welding-HVDC

References

1. *B R Gupta, V Singhal," Power Electronics", S K Kataria & Sons*
2. *M.H. Rashid," Power Electronics Circuit Devices and Application",Pearson Education*
3. *Biswanath Paul," Industrial Power Electronics and control", PHI New Delhi*
4. *PC Sen," Power Electronics", Tata McGraw Hill*

Core 8 : Analog Electronics

Unit – 1

Basic Differential Amplifier Circuit – Operation – AC and DC Analysis, Block Diagram of typical operational Amplifiers – Ideal Op-amp characteristics – Op amp Parameters – Inverting and Non-Inverting Amplifier – Voltage Follower- Summing Amplifier-Differential Amplifier- Instrumentation Amplifier – V to I and I to V converter- Integrator – Differentiator – Typical circuits – Applications

Unit – 2

Introduction – First order – Butter worth – Low pass, High pass, Band pass, Band Reject, Notch and All pass Filters – Typical circuits- Applications. Wave form generators –Square wave generator- Triangular and Saw tooth wave generators – sine wave oscillators (Phase shift, Wien Bridge and Quadrature Oscillators)

Unit – 3

Basic comparator – Characteristics – Typical comparator circuits using op amp – zero crossing detector – Schmitt trigger – Typical Circuits – Operation – Application

Unit – 4

Introduction to Timer-Monostable and Astale Multivibrator using 555-Application of Monostable and Astable Multivibrator- Voltage controlled oscillator (VCO), PLL – block diagram, Operating principle, parameters, pin out, function, applications and typical circuits

Unit – 5

Basic circuit configuration and characteristics of voltage regulators – Basic blocks of linear voltage regulator – three terminal fixed regulators (78XX and 79XX), Adjustable Positive voltage Regulator(LM 317) and Adjustable Negative voltage Regulator(LM 337)- variable voltage Regulators (723) – Typical circuits –Applications

References

1. *Ramakant A. Gayakwad ,"Op-amp and Linear ICs", Prentice-Hall of India Private LTD*
2. *K.R Botkar," Integrated Circuits",* Khanna Publishers; Year: 2010; Edition: Fifth
3. *Allen Mottershed," Electronic Devices and circuits",* Prentice-Hall of India Books In India
4. *Millman & Halkias,"Integrated Electronic", Tata McGraw-Hill Publishing LTD*
5. *Tobey & Buelsman,"Op-amp Design and Application*

Core 9 : Solar PV Technology

Unit – 1

Solar Power System Physics -A Brief History of the Photoelectric Phenomenon -Solar Cell Physics -Solar Cell Electronics -Types of Solar Cells Technologies -Other Technologies -Concentrators -Solar Panel Arrays -Solar Power System Components

Solar Power Technologies -Crystalline Solar Photovoltaic Module Production -Amonix Mega concentrators -Film Technologies -Solar Photovoltaic System Power Research and Development in the United States

Unit – 2

Solar Power System Design Considerations -Solar Power System Components and Materials -Solar Power System Configuration and Classifications -Storage Battery Technologies-Solar Power System Wiring -Entrance Service Considerations for Grid-Connected Solar Power systems -Lightning Protection -Central Monitoring and Logging System Requirements -Ground-Mount Photovoltaic Module Installation and Support Hardware -Roof-Mount Installations -Electric Shock Hazard and Safety Considerations -Maintenance -Photovoltaic Design Guidelines

Unit – 3

Introduction to Solar Power System Design - Insulation -Shading Analysis and Solar Energy Performance Multiplier-Site Evaluation -Solar Power Design

Unit – 4

Solar Power Generation Project Implementation -Designing a Typical Residential Solar Power System -Example of Typical Solar Power System Design and Installation Plans for a Single Residential Unit -Commercial Applications - Small-Scale Solar Power Pumping Systems - Large-Capacity Solar Power Pumping Systems -Pump Operation Characteristics -Semitropic Open Field Single-Axis Tracking System PV Array—Technical Specifications

Unit – 5

Energy Conservation - General Energy - Saving Measures - Power Factor Correction - A Few Words about Power Generation and Distribution Efficiency - Computerized Lighting Control - California Title - Electric Energy Compliance - Indoor Lighting Compliance - Outdoor Lighting and Signs – Performance Occupancy and Daylight Sensors – Web - Based Display Monitoring System - Solar Power Facts

References

Text book:-*solar power in building design, the engineer's complete design resource*

Core 10 : Digital Electronics

Unit – 1

Digital Computer and Digital Systems – Number Systems: Binary Numbers – Number Base Conversion – Octal and Hexa Decimal Numbers – Complements:1s and 2s complement – Binary Codes: Decimal Codes- Binary Coded Decimal- Error Detecting Codes- Reflected / Gray Code- Excess-3-Code -ASCII Alphanumeric Code

Unit – 2

Boolean algebra and Logic Gates : Basic Definitions – Axiomatic Definition of Boolean Algebra Boolean Functions – Canonical and Standard Forms – Other Logical Operations – Digital Logic Gates – IC Digital Logic Families – Semiconductor Memories – Bipolar – CMOS – ROM –RAM –PROM – EPROM

Unit – 3

Simplification of Boolean Functions – The map method – product of Sums – sum of products – simplifications – NAND and NOR implementation. Don't Care Conditions – the tabulation method

Unit – 4

Combinational Logic Circuits: Introduction – Adders: Half and Full Adders- Subtractors: Half and Full subtractors – Code conversion: Conversion from BCD to Excess-3-Code-- Binary Parallel Adder – Decimal Adder – Decoder – encoder – Multiplexers – De-Multiplexers

Unit – 5

Sequential Logic Circuits – Flip Flops – Flip Flop excitation tables – Design counters – Registers, Counters. Registers – shift Registers. – Ripple Counters

References

1. Morris Mano, "Digital Logic and Computer Design" – Prentice Hall of India – 1998
2. *Digital fundamentals - Thomals Floyd*- Pearson Education India, 01-Sep-2005
3. *Salivahanan. S. Digital Circuits and Design, Vikas Publishing Hosue*
4. *Roth CH, Fundamentals of logic design, Jaico*
5. *Digital Integrated circuits - Taub and Schillin*
6. *Digital Logic Design - Elsevier - Brain Holds Worth - dove words*
7. Morris Mano, "Computer System Architecture" – Prentice Hall of India – 1998
8. *Digital Design - Basic concepts and Principles - Mohammed A Karim and Xinghao Chen - CRC Press*

ELECTIVE I: Fundamentals of Microprocessor

Unit – 1

MICROPROCESSOR: Introduction of Microprocessor , Block Diagram of Micro Computer , Block Diagram of CPU with system Bus -Architecture–Bus Organization–Bus Organization in Microprocessor , Pin Detail , Diagram of Microprocessor , Data & Address deviation , Generate Control Signal in Microprocessor , Detail of Microprocessor- Functional diagram and pin out diagram of 8085

Unit – 2

Addressing modes of 8085 – Direct addressing Mode-Indirect Addressing Mode-Data Transfer -Instruction set of 8085 – simple programs

Unit – 3

I/O Schemes – Peripherals and Interfaces .Input – Output Organization: Input – output interface – I/O Bus and Interface – I/O Bus Versus Memory Bus – Isolated Versus Memory – Mapped I/O – Example of I/O Interface. Asynchronous data transfer: Strobe Control and Handshaking – Priority Interrupt: Daisy-Chaining Priority, Parallel Priority Interrupt. Direct Memory Access: DMA Controller, DMA Transfer. Input – Output Processor: CPU-IOP Communication

Unit – 4

Memory Organization: Memory Hierarchy – Main Memory- Associative memory: Hardware Organization, Match Logic, Read Operation, Write Operation. Cache Memory: Associative, Direct, Set associative Mapping – Writing into Cache Initialization. Virtual Memory: Address Space and Memory Space, Address Mapping Using Pages, Associative Memory Page Table, Page Replacement

Unit – 5

Introduction to 8086: Pin out diagram -Functional Block diagram of 8086 –Architecture-instruction set-comparison with 8085 & 8086: Interfacing IC –RISC & CISC

References

1. Microprocessor Architecture programming & application with 8085 & 8080 – by Ramesh.s.Gaonkar –Wiley eastern
2. Introduction to microprocessors – Adithya.P.Mathus – TMH Publication
3. Microprocessor interfaces – Douglas Hall – MC Graw Hill
4. *8086/8088 family Design, programming and interfacing by John Utter Bery – PHI*
5. *8086/8088 microprocessors - Brey – PHI*
6. *Microprocessors PC Hardware and interfacing –N.Mathivanan –PHI*

Core 11 : PV-Testing & Evaluation

Unit – 1

Photovoltaic Basics: PV array systems and PV applications -Stand-alone systems-Grid-connected systems -**Solar radiation** - The sun as an energy source - Distribution of solar radiation - Direct and diffuse radiation - Angle definition - Solar altitude and solar spectrum - Ground reflection- How solar radiation is measured - Tracking PV arrays

The photovoltaic effect and how solar cells work - How a solar cell works- Design and functioning of a crystalline silicon solar cell - **Solar cell types** Crystalline , Mono-crystalline.Poly crystalline ,Ribbon-pulled ,Anti-reflective coating -Front contacts - Back contacts-High-performance cells -Thin-film cell technology -Amorphous silicon cells-Copper indium diselenide (CIS) cells -Cadmium telluride (CdTe) cells-Thin-film solar cells made from crystalline silicon -Concentrating systems -Hybrid cells: HIT solar cells -Comparison of solar cell types and trends -**Electrical properties of solar cells** -Equivalent circuit diagrams of solar cells -Spectral sensitivity -Efficiency of solar cells and PV modules

Unit – 2

PV Modules and Other Component s of Gr id-Connected Systems: Cell stringing , encapsulation

Types of modules-Design options for PV modules -Module cable outlets and junction boxes - Wiring symbols -Characteristic *I-V* curves for modules -Irradiance dependence and temperature characteristics -Hot spots, bypass diodes and shading -Electrical characteristics of thin-film modules -Quality certification for modules

PV array combiner/junction boxes, string diodes and fuses -Grid-connected inverters - Wiring symbol and method of operation -Grid-controlled inverters -Self-commutated inverters - characteristic curves and properties of grid-connected inverters-Further developments in grid-connected inverter technology

Cabling, wiring and connection systems - Module and string cables -Connection systems - DC main cable -AC connection cable -**Direct current load switch (DC main switch) -AC switch disconnector**

Unit – 3

Site Surveys and Shading Analysis-On-site visit and site survey -Consulting with the customer

Shadow types-Temporary shading -Shading resulting from the location -Shading resulting from the building -**Shading analysis**-Using a site plan and sun path diagram-Using a sun path diagram on acetate

Shade analysis tools using software-Shading, PV-array configuration and system concept -Connection in series -& in parallel-Comparison of connection concepts

Shading with Ree-standing/rack-mounted PV arrays -Reducing the mutual shading losses of rack-mounted PV modules -**Checklists for building survey**

Unit – 4

Planning and Sizing Gr id-Connected Photovoltaic Systems System size and module choice -System concepts -Central inverter, Sub-array and string, Module -**Inverter installation site**

Sizing the inverter -Choosing the number and power rating of inverters -Determining the number of strings -Sizing using simulation programs-**Selecting and sizing cables for grid-tied PV systems** -Cable voltage ratings -Cable current carrying capacity -Minimizing the

cable losses/voltage drops – Sizing the module and string cabling -Sizing the DC main cable-Sizing the AC connection cable 171
Selection and sizing of the PV array combiner/junction box and the DC main disconnect/isolator switch -Lightning protection, earthing/grounding and surge protection

Unit – 5
System Sizing, Design and Simulation Software -Use of sizing, design and simulation programs -Checking the simulation results -Simulation of shading-Market overview and classification -Programme descriptions &Calculation - Design and service programs - Web-based simulation programs

References
"SOLAR HOUSE GUIDE &SOLAR CELL TECHNOLOGY"
BY SOFT TERRY.

ELECTIVE II : Solar Power System Sizing

Unit – 1

Mounting Systems and Building Integration-Roof Basics - tasks , shapes ,constructions ,skin ,Sloping ,Flat roof, **Sloping roofs-**On-roof systems-In-roof systems -**Flat roofs-**On-roof systems for flat roofs-Roof-integrated systems -**Facade basics -**External wall structure - Facade structures and construction methods -Fastenings -Joints and joint sealing - **Photovoltaic facades -**Mounting modules on existing facades-**Glass roofs -Solar protection devices** -Module fixing -Fixed solar shading -Moveable solar shading -**Mounting systems for free-standing installations**

Unit – 2

Installing, Commissioning and Operating Grid-Connected Photovoltaic Systems-General installation notes -Example installation of a grid-connected PV system - Preparation -System installation: Step by step -**Guarantee -Breakdowns, typical faults and maintenance for PV systems** -Maintenance and upkeep checklist-**Troubleshooting - Monitoring operating data and presentation** -Internet-based system evaluation - Web-based data transmission and evaluation -Presentation and visualization -**Long-term experience and quality -**Long-term behavior of PV modules -Quality and reliability of inverters

Unit – 3

Stand-alone Photovoltaic Systems:- Modules , Batteries -How lead-acid batteries work:- construction and operating principles -Operating behavior and characteristics of lead-acid batteries -Ageing effects -Selection criteria -Battery safety and maintenance-Recycling - **Charge controllers -**Series controllers -Shunt controllers -MPP charge controllers-**Stand-alone inverters -**Sine-wave inverters -'Modified sine-wave' inverters -Square-wave inverters - Application criteria for inverters in stand-alone systems

Planning and designing stand-alone systems -Direct coupling of PV array, battery and loads -**Measuring electricity consumption -Sizing the PV array -**Model for calculating the yield of a PV array -Cable, conversion and adjustment losses -Summary of the design outcome -**Sizing of the cable cross sections - Battery sizing -Use of an inverter-Photovoltaic's in decentral electricity grids/mini-grids** DC-coupled & AC-coupled systems

Unit – 4

Economics and Environmental Issues:-Cost trends -Technological trends -Economic Assessment -Power production costs -**Environmental impact -**Energy payback and harvest factor -Pollutants in the production process-Module recycling concepts

Unit – 5

Marketing and Promotion:-Marketing PV:-Customer orientation: The central theme -The iceberg principle-The pull concept -**Greater success through systematic marketing-**The benefits come first -The four pillars of the marketing concept

Range of marketing options -Six steps to the target -**A good sales talk is fun -**Build a bridge-Find out the customer's requirements-Offer solutions -Achieve the result

References:

"SOLAR ENERGY UTILIZATION" BY
G.D.RAI

ELECTIVE III : Solar Thermal System & Applications

Unit 1

Solar is a critical part of the global renewable mix - Energy futures - Environmental philosophy - New construction or rehab - Examples of the design process - Business philosophy - **Site location -**Solar insulation - Weather and microclimates - Heating/cooling needs - PV power production

Unit – 2

Thermal mass – heated by solar and by ground-coupled - Amount and distribution of thermal mass - Thermal energy storage - Re-radiation and release of heat at night or in cloudy weather-Thermal mass – heated/cooled by ground-coupling-Passive solar home – putting together the solar effects

Attached greenhouse passive heating -Split greenhouse design -Fixed section – the solarium - Controlled vent section – the solar greenhouse-Vegetables - Starting early seed plants

Unit – 3

Domestic hot water - House DHW usage patterns - DHW tank storage capacity - Plumbing configuration -Insulation -Temperature monitoring locations – Controls

Combined DHW and swimming pool heating -Synergistic relationship -Collector capacity -Swimming season and pool temperature -Smart controls -Solar PVs to supply power to swimming pool-pump and chlorinator

Unit – 4

Space heating -Seasonal heat demand -Solar thermal collector heat utilization in winter Design of building envelope -Radiant floors -Living comfort-Geothermal heat pump and location of underground coils-Thermal zone controls -Wood fireplace backup heat -Ceiling fans in wall up flow –Ambiance

Unit – 5

Space cooling -Cooling radiant floors is not recommended -Nocturnal cooling strategy-PV-powered attic fan is only a part-solution -Ceiling fans in wall down flow -Geothermal heat pump cooling of room air-Thermal transient/capacity of ground coils-Thermal zone controls

REFEREENCES :

"SOLAR ENERGY PRINCIPLES"
OF THERMAL COLLECTION AND STORAGE" BY
S.P.SUKHATME&
J.K. NAYAK

CORE LAB - 1 : BASIC ELECTRONICS LAB

1. Characteristics of PN junction diode
2. Characteristics of Zener diode
3. Characteristics of LED
4. Characteristics of Photo diode
5. Characteristics of LDR
6. Common base Transistor characteristics
7. Common emitter Transistor characteristics
8. Characteristics of UJT
9. Characteristics of JFET
10. Familiarization of Rectifier Circuits
11. Study of capacitor filter, inductor filter and π filter
12. Diode clipper & diode clamper
13. Zener diode voltage regulator
14. RC Differentiator & Integrator
15. RC coupled amplifier
16. Emitter follower
17. RC phase shift oscillator using BJT
18. UJT Relaxation Oscillator
19. A stable Multi-vibrator using BJT

Reference

1. **Electronics Lab Manual Vol. I**, T.D. Kuryachan and Shyam Mohan S., Ayodhya publications, 2007
2. **Printed Circuits Board Design and Manufacturing**, Walter C. Bosshart, Tata McGraw-Hill Publishing Ltd. 2008

CORE LAB 2 : ELECTRICAL WORKSHOP

1. ELECTRICAL WORKSHOP

- Electrical and Electronic symbols use in Electrical and Electronic installations like light, power, alarm and control circuits etc
- Study of wiring cables and electrical accessories – Electrical and Electronics symbols
- Wiring and estimation of one lamp and one plug, Control of two lamps in series and in parallel
- Study and wiring of distribution board including power plug using isolator, MCB and ELCB
- Estimation of a typical 1BHK house wiring system
- Study of different types of sources of light and make connections and to Measure intensity of light with flux meter
- Measurement of the induced emf of a separately excited DC machine as a function of the field current
- Measurement of the terminal voltage of a separately excited DC machine as a function of the load current
- Measurement of the terminal voltage of a DC shunt generator as a function of the load current
- Study of DC series motor with starter (to operate the motor at no load for a moment

- Determination of the efficiency of a DC shunt motor by separate measurement of the losses (Swinburne's method)
- Determination of the efficiency of a DC motor by direct method
- Experiments on study of various instruments such as galvanometer, PMMC, moving iron, induction type, digital meters, CRO and measurement of voltage, current, power, power-factor, frequency, resistance, inductance, capacitance, magnetic flux
- Experiments on testing of transformer, connection of three-phase transformer, separation of losses of transformer, characteristics of DC generators and motors, Speed control of DC motors, testing of DC machines
- Study of constructional details of 1-phase energy meter and to calibrate 1-phase energy meter by direct loading method
- Study of constructional details, working of a meggar and measurement of insulation resistance of a given motor
- To perform open circuit and circuit and short circuit test determining equivalent circuit parameter of a transformer
- Checking the polarity of the windings of a three phase transformer and connecting the windings in various configurations
- Finding the voltage and circuit and current relationships and secondary of a three phase transformer under balanced load in various configurations conditions
- Reversing the direction of rotation of a ceiling fan
- Study of construction of a a.c. series motor, reluctance motor and hysteresis motor
- Study of welding equipment and its accessories
- To calculate 1phase energy meter by direct loading method
- To measure the value of earth resistance
- To measure power, power factor in a 1phase circuit using wattmeter and power factor meter and verify results with calculations
- To make an extensive board with two 5 A sockets and one 15 A socket controlled by their respective switches. Also to provide a fuse and an indicator
- Insulation megger - earth megger, measurement of insulation resistance and earth resistance
- Simple wiring circuits- A light is controlled by a single pole single throw (S.P.S.T) switch, addition of a plug point in the light circuit and addition of a calling bell in the wiring circuit
- Circuit with Fluorescent tube light, Circuits to control a lamp from two independent positions
- Wiring of D.B with ELCB and MCB
- To observe phase sequence of three phase circuit using Rotating type Phase Sequence indicator
- To measure circuit parameters and three phase load by PF Meter by LCR Meter
- To make a switch board containing at least two switches. One fan regulator and a socket
- Testing of circuits - testing of ON/OFF conditions using a tester, test lamp, and location of phase and neutral
- Study of analog and digital millimeters and other electronic meters
- Connections of Ammeter. Voltmeter, wattmeter, frequency meter, energy meter in an electrical circuit
- Study of CRO for the measurements of voltage, phase angle. Frequency etc
- Soldering practice – Soldering of circuits (Half wave and Full wave Rectifiers with and without RC filter circuits - Zener Voltage regulator)
- Fault finding and repair of a tube light circuit, 3 phase motors and their rectification

- Three phase motor winding
- Power cable jointing & laying of underground cable
- Installation of 3phase motor with main switch and starter

2. MEASUREMENTS AND INSTRUMENTATION LAB

- Resistance measurement using Kelvin's Double Bridge and Wheatstones's Bridge
- Calibration of ammeter using slide-wire potentiometer
- Calibrations of voltmeter, wattmeter using vernier dial potentiometer
- Calibration of single phase energy-meter by direct and phantom loading
- Calibration of three phase energy meter using phase-shifter
- Plotting the magnetizing curves of (i) ring specimen (ii) transformer core
- Simulation of Hysteresis Loop on the CRO
- Characteristics of LVDT, Load-cell
- Characteristics of Thermistor
- Characteristics of Thermocouple, RTD

3. POWER SYSTEM LAB

- Power frequency testing of electrical equipment like insulators, fuses, AB switches lightning arresters etc
- Determination of string efficiency of string insulators
- Calibration of HV measuring equipment using sphere gap
- Impulse voltage test on insulators, lightning arresters etc
- Measurement of dielectric strength of air, solid and liquid insulating materials
- Determine the characteristic, pick up time etc. of different types of electromagnetic relays
- Determine the characteristic, pick up time etc. of different types of static relays
- Measurement of earth resistance and soil resistivity
- Testing of insulation of 3 core and 4 core cable
- Characteristics of Current Transformers and Potential Transformers
- Power measurement using current transformer & potential transformer
- Power factor improvement with capacitor banks
- Testing of energy meters

References

1. Testing, Commissioning Operation and Maintenance of Electrical Equipment by S Rao, Khanna Technical Publication ,New Delhi
2. Preventive Maintenance of Electrical Apparatus by SK Sharotri, Katson Publishing House Ludhiana
3. A Course in Electrical Measurement and Measuring Instruments by AK Sawhney and PL Bhatia;Dhanpat Rai and sons,New Delhi
4. Electrical Measurement and Measuring Instruments by E W Golding and Widdis;Wheller Publishing House ,New delhi
5. Electrical Measurement and Measuring Instruments by SK Sahdev Unique International Publications ,Jalandhar
6. Experiments in Basic Electrical Measurement by SK Bhattacharya and KM Rasstogi ,New Delhi
7. Electric Instrumentation by Umesh sinha
8. Basic Electrical Measurements by Melville B
9. Electrical Machines by SK Bhattacharya,Tata Mc Graw Hill,New Delhi
10. Electrical Machines by SK Sahdev ,unique International Publications, Jalandhar

CORE LAB 3 : POWER & ANALOG ELECTRONICS

1. Analog Electronics Lab

- Inverting and non-inverting op-amp configuration and its characteristics
- Differentiator and integrator circuit characteristics
- Summing and difference amplifiers
- Voltage follower and instrumentation amplifier
- Low pass and High pass filters and frequency response
- Band pass filter and Band rejection filter and their frequency response
- Schmitt trigger-measurement of UTP and LTP
- Triangle wave generator
- Symmetrical and asymmetrical square wave generation using 555
- Oscillators: 1) Wein bridge 2) RC phase shift
- IC-79XX & 78XX fixed voltage regulation and characteristics
- IC 723 variable voltage regulator

2. Power Electronics lab

- Characteristics of SCR
- Characteristics of DIAC
- Characteristics of TRIAC
- Resistance triggering SCR
- RC Phase shift triggering SCR
- UJT Triggering of SCR
- AC MOTOR Control using SCR
- Power control using SCR
- Automatic street light using DIAC & TRIAC

References

1. *T.D. Kuryachan & Shyam Mohan S,"Electronics Lab Manual, Vol.II", Ayodhya publications*

CORE LAB 4: DIGITAL LAB EXPERIMENTS

- **Familiarization of Logic Gates :** To familiarize the different logic gate IC chips and verification of their truth table 7400, 7402, 7404, 7408, 7432, 7486
- **Study of Universal Gates :** To implement the basic logic gate AND, OR, NOT, etc gates
- **Adders :** To implement the Half adder and Full –Adder
- **Subtractors ;** To implement the half substractor & full substractor
- **Comparators :** To implement 4 bit magnitude comparator 7485
- **Decoders** :To implement 2 -4 decoder
- **Seven Segment Displays :**To familiarize the BCD 70 decimal Decoder IC7442, BCD to Seven Segment Decoder 7448, Seven Segment Display LT 542, BCD to Binary 74154 and Decimal to Binary priority and 74147
- **Encoder :** To implement 4-2 encoder
- **Multiplexers :** To implement a 4:1 multiplexer, 8:1 Multiplexer 74151
- **De-multiplexers :** 1:4 De-multiplexer circuits
- **Latches :** To familiarize SR-Latch, D-Latch
- **Flip- Flop :** To implement JK Flip-Flop and SR Flip Flop using Discrete Gates

References

1. *T.D. Kuryachan & Shyam Mohan S,"Electronics Lab Manual, Vol.I", Ayodhya publications*

CORE LAB 5 : FUNDAMENTALS OF MICROPROCESSOR

- Addition – 8 bit, 16 bit
- Subtraction – 8 bit, 16 bit
- Multiplication
- Array addition (multibyte)
- Logical operators – AND, OR NOT
- Decimal to ASCII and ASCII to Decimal
- Decimal to Hexa and Hexa to Decimal
- Ascending Order
- Descending Order
- Up/down Counter
- Block data transfer
- Rotating display – Flashing display
- Interfacing with LED's
- Square wave Generators
- Interfacing with ADC

Allied 1 : Electrical Instruments and Measurements

Unit – 1

DC Network Theorems: Electric Circuits and Network Theorems-Kirchhoff's Laws-Determination of Voltage Sign-Assumed Direction of Current-Maxwell's Loop Current Method-Source Conversion-Ideal Constant-Voltage -Current Source-Superposition Theorem-Thevenin Theorem-Delta/Star Transformation-Star Delta Transformation--Millman's Theorem- Maximum Power Transfer Theorem-Power Transfer Efficiency

Work, Power and Energy. : Effect of Electric Current-Joule's Law of Electric Heating-Thermal Efficiency-S-I.Units-Calculation of Kilo-watt Power of a Hydroelectric Station

Unit – 2

Electrical Instruments and Measurements: Absolute and Secondary Instruments-Electrical Principles of Operation-Essentials of Indicating Instruments-Deflecting Torque-Controlling Torque-Damping Torque-Moving-iron Ammeters and Voltmeters- Extension of Range by Shunts and Multipliers-Moving-coil Instruments-Permanent Magnet Type Instruments-Voltmeter Sensitivity-Multi-range Voltmeter-Electrodynamic or Dynamometer Type Instruments-Hot-wire Instruments- Magnification of the Expansion-Thermocouple Ammeter-Megger-Induction type Voltmeters and Ammeters--Electrostatic -Attracted-disc Type Voltmeter-Quardant Type Voltmeter-Kelvin's Multicellular -Ammeters-Dynamometer Wattmeter-Energy Meters-Electrolytic Meter-Motor Meters- Quantity or Ampere-hour Meters-Ampere-hour Mercury Motor Meter-Induction Type Single-phase Watt hour Meter-Ballistic & Vibration Galvanometer-Vibrating-reed, Electrodynamic, Moving iron Frequency Meter-Electrodynamic, Nalder-Lipman

Potentiometer-Transformers:-: instrument Ratio and Phase-angle Errors-Current--Potential Transformers

Unit – 3

A C Fundamentals - Generation of Alternating Voltages and Currents & Equations - Time-Period-Frequency-Amplitude-Different Forms of E.M.F. Equation-Phase-Phase Difference-Root Mean Square (R.M.S.)Value-Mid-ordinate Method-Analytical Method-R.M.S. Value of a Complex Wave-Average Value-Form Factor- -Representation of Alternating Quantities-A.C. Through Resistance, Inductance and Capacitance

Unit - 4

Series A.C. Circuits: A.C. through Resistance and Inductance-Power Factor-Active and Reactive Components of Circuit Current-I-Active, Reactive and Apparent Power-Q-factor of a Coil-Power in an Iron-cored Chocking Coil—Resonance in *R-L-C* Circuits-Graphical Representation of Resonance-Resonance Curve--Q-Factor of a Resonant Series Circuit-Circuit Current at Frequencies Other than Resonant Frequencies

Parallel A.C. Circuits: Solving Parallel Circuits-Vector or Phasor Method-Admittance Method-Complex or Phasor Algebra-Series-Parallel Circuits-Series Equivalent of a Parallel Circuit-Parallel Equivalent of a Series Circuit-Bandwidth of a Parallel Resonant Circuit

Unit – 5

A.C. Network Analysis: Kirchhoffs Laws-Mesh Analysis-Nodal Analysis-Superposition Theorem-Thevenin's Theorem-Reciprocity Theorem-Norton's Theorem-Maximum Power Transfer Theorem-Mailman’s Theorem

A.C. Filter Networks :-Different Types of Filters-Octaves and Decades of frequency-Decible System-Value of 1 dB-Low-Pass RC Filter-Other Types of Low-Pass Filters-

Bandpass Filter-R-C Bandstop Filter-The-3 dB Frequencies-Bandstop and Bandpass Resonant Filter Circuits-Series-and Parallel-Parallel-Resonant Bandpass Filter

Introduction to Electrical Energy Generation: Preference for Electricity-Comparison of Sources of Power-Sources for Generation of Electricity--Classifications of Power Transmission- Selecting A.C. Transmission Voltage for a Particular Case - Conventional Sources of Electrical Energy - Non-Conventional Energy Sources

References

1. Electrical Measurements and Measuring Instruments, **U.A.Bakshi, A.V.Bakshi, Technical Publications, 2009**
2. Electrical Instrumentation, **U.A.Bakshi, A.V.Bakshi, Technical Publications, 2009**
3. Fundamentals of Instrumentation, **U.A.Bakshi, A.V.Bakshi, Technical Publications, 2009**
4. **Renewable Energy: Power for a Sustainable Future**, Second Edition Godfrey Boyle, Oxford, United Kingdom, 2012
5. **Alternative Energy Sources,** Michaelides, Efstathios E. (Stathis), Springer, Germany, 2012.

Allied 2 : Renewable Energy Resources and Improved Energy Utilization

Unit – 1

Energy from the Oceans: Prospects of Ocean Thermal Energy Conversion in India Ocean Thermal Electric Conversion (OTEC) -Open cycle OTEC System-The closed or Anderon, OTEC Cycle-Heat Exchangers-Bio-fouling-Site Selection-Energy Utilization-Hybrid Cycle-Energy from Tidal:- Principles, Components, Operation- Estimation of Energy and power in Simple Single Basin Tidal System-Estimation of Energy and power in a Double cycle system-Advantages and Limitation of Tidal Power Generation-Ocean Waves: Merits and demerits of Wave Energy-Energy and power from the waves-Wave-Energy conversion Devices-Small scale Hydroelectric-Nature &Classification of Small Hydro power stations-Components of hydroelectric scheme-Turbines and Generators for small scale Hydro Electric-Protection, control and management of Equipments-Advantages and Limitations of Small scale Hydro Electric-Hybrid Systems

Unit – 2

Chemical Energy Sources: Fuel cells -Classification and -Types - Advantages and Disadvantages-Conversion Efficiency -Types of Electrodes - Work output and EMF
Batteries - Basic Battery Theory, Definitions, Fundamental Characteristics -Different Types of Battery Arrangement - Classification - Advantages of for Bulk Energy Sources

Unit – 3

Hydrogen Energy: Hydrogen Production:-Electrolysis – Thermo chemical Methods – Some Thermo chemical Cyclic Processes- Fossil Fuel Methods - Solar Energy Methods -Hydrogen-Storage – Hydrogen Transportation–Utilization -Hydrogen as an Alternative Fuel for Motor Vehicles-Safety and Management-Hydrogen Technology Development in India

Magneto Hydro Dynamic (MHD) Power Generation: Principles of MHD Power Generation – MHD- Open and Closed-cycle systems-Design Problems and Developments - Advantages - Electrical Conditions: Voltage and Power output of MHD Generator -Gas Conductivity - Materials for MHD Generators-Magnetic Field-Super Conductivity - International Status of MHD Power Generation and its Future prospects

Unit – 4

Thermo Electric Power: Principles of Thermoelectric Power Generation - Thermoelectric Power Generator - Performance Analysis of Thermo-Electric Power Generator - Thermoelectric Materials-Selection of Materials

Thermionic Generation: Thermionic Emission and Work Function-Basic Thermionic Generator-Analysis of Thermionic Generator

Thermo Nuclear Fusion Energy: Nuclear Fusion and Reactions –Plasma Confinement – Magnetic-Confinement Fusion-Inertial-Confinement Fusion – Muon Catalysed Fusion-Characteristics of D-T Reaction – Advantages of Nuclear Fusion-Fusion Hybrid – Cold Fusion

Unit – 5

Energy Storage and Distribution: Energy storage systems – Mechanical Energy Storage - Compressed Air Storage – Energy Storage via Flywheels-Electrical Storage : The Lead Acid Battery – Chemical Storage : - Energy storage via Hydrogen – Ammonia – Reversible Chemical Reactions-Electromagnetic Energy Storage – Thermal Energy Storage :-Biological Storage-Distribution of Energy -Gas Pipelines-Electricity Transmission – Batch Transport-Heat-Chemical Heat Pipe

Energy Conservation: Economic Concept of Energy – Principles of Energy Conservation and Energy Audit – Energy Conservation Approach / Technologies-Co-Generation-Waste Heat Utilization – Combined Cycle Power Generation-Heat:- Recuperators, Regenerators , pipes – Stirling Engine – Heat Pumps – Energy storage – Renewable Energy Sources/ Devices – Instrumentation and Control

References

1. Renewable Energy: Power for a Sustainable Future, **Second Edition Godfrey Boyle, Oxford, United Kingdom, 2012**
2. **Alternative Energy Sources,** Michaelides, Efstathios E. (Stathis), Springer, Germany, 2012
3. Sustainable Energy Systems and Applications, **Dinçer, İbrahim, Zamfirescu, Calin, Springer, Germany, 2012**

Allied 3 : Basics of Information Technology

Unit – 1

History of Computers-Generation of Computers -Computer Peripherals-Hardware Devices-Input Devices- Output Devices -Processors / CPU-Memory Unit -Storage Devices-Software-System Software-Application Software -Operating System- Need for an Operating System-Types of Operating System- Operating System Techniques -Networking- Windows Operating System- LINUX Operating System-A Brief History of LINUX- LINUX Architecture- Visual Editor

Unit – 2

Personal Productivity Software -Microsoft Word- Microsoft Excel--Microsoft PowerPoint-Microsoft Access

Unit – 3

Elements of Multimedia--Features of Multimedia-Applications of Multimedia - Images - Making Still Images - Vector Graphics Bitmaps and Pixmaps-File Formats and Compressions-Hardware Requirements-Graphics Adaptors-Scanners-Digital Camera – Monitors-What is Sound-How is Sound Recorded-Sound File Formats-Video -1 What are Moving Images-types of Video-analogue Video-Digital Video-Hardware Requirements-Analogue- Digital

Desktop Publishing Basics-What is Desktop Publishing- Desktop Publishing Programs Steps in Desk Top Publishing-The PageMaker-Ventura Publisher--Desktop Publishing- Processor Packages Advantages of Word Processing -Examples of Common Word Processors - Graphics for DTP- What are Graphics- Local Area Networking Technology and Networking Topology- Wide Area Networking Technology and Routing - Routing in a WAN -Protocols and Layering - Need for Protocols-Protocol Suites- Layering of Protocols- Networking Devices

Unit – 4

What is Internet?- Brief History of Internet-Internet Capabilities -how does Internet work? - Hardware Requirements for Internet-Computer-Modem-Software Requirements-PPP Account-Shell Account-TCP/IP -Internet Service Provider-Internet Services- Historic Internet Services- -E-mail -Usenet-FTP-Hot Internet Software -World Wide Web-Internet Addressing- Domain Name System (DNS)

Unit – 5

E-Mail Fundamentals-Web Page Creation /Development Tools-Introduction to HTML-HTML Terminology- HTML Skeleton- Text Tags-Links4- Lists-Tables-Forms- Frames-Images

REFERENCES

"A FIRST COURSE IN COMPUTERS" BY
SANJAY SAXENA

"FUNDAMENTALS OF INFORMATION SYSTEM" BY
RALPH STAIR, GEORGE REYNOLDS.

Allied 4 : MANAGEMENT INFORMATION SYSTEMS

Unit -1

Introduction to MIS: MIS concept – Definition – Role of MIS – Impact of MIS – MIS and the User – Management as a Control system – MIS: a support to Management -Management Effectiveness and MIS – Organization as a system – MIS: organization effectiveness

E-business enterprise: Introduction – Organization of Business in an E-enterprise – E-business – E-commerce – E-communication – E-collaboration

Unit – 2

Strategic Management of Business: The concept of corporate planning – Essentiality of Strategic Planning – Development of Business Strategies – Types of Strategies – Short-range Planning – Tools of Planning – Strategic Analysis of Business

Information Security Challenges in E-Business: Introduction – Security Threats and Vulnerability – Controlling Security Threat and Vulnerability – Management Security Threats and Vulnerability – Disaster Management – MIS and Security Challenges

Unit – 3

Decision Making: Decision-making concepts – Decision-making process – Decision Analysis by Analytical Modeling – Behavioral Concepts in Decision-making – Organizational Decision-making – MIS and Decision-making

Information and Knowledge: Information Concepts – Information: a quality product – Classification of Information – Methods of data and Information Collection – Value of Information – General Model of a Human as an Information Processor

Unit – 4

Applications in Manufacturing Sector: Personnel, Financial, Production, Raw Material and Marketing Managements

Applications in Service Sector: Service management System – MIS Application in Service Industry – MIS: Service Industry

Unit – 5

Enterprise Management Systems: Enterprise Management Systems – ERP system – ERP Model and Modules – Benefits of ERP – ERP Product Evaluation – ERP Implementation. Technology of Information Systems: Introduction – Data Processing – Transaction Processing –Application Processing – Information System processing

References

1. **MANAGEMENT INFORMATION SYSTEMS Text and Cases – Waman S Jawadekar**
2. **MANAGEMENT INFORMATION SYSTEMS managing the Digital Firm – Kenneth C Laudon & Jane P. Laudon**, 9th edition, PHI
3. **MANAGEMENT INFORMATION SYSTEMS for the Information Age – Haag, Cummings, McCubbrey,** 4th edition, TMH
4. **MANAGEMENT INFORMATION SYSTEMS a Concise Study – S.A. Kelkar,** 2005, PHI

Skill Based Subject 1 : Transformers & AC Motors

Unit – 1

Transformer: Working Principle , construction—core-type & Shell type Transformers—Ideal Transformer—E.M.F. Equation of Transformer—Voltage Transformation ratio—Transformer with losses but no magnetic leakage—Transformer on No-lead & on load—Transformer with winding Resistance but no Magnetic leakage—Equivalent Resistance—Magnetic leakage—Transformer with Resistance and leakage Reactance—Simplified Diagram—Total Approximate voltage Drop in Transformer—Exact voltage Drop—Equivalent Circuit Transformer tests—Open-Circuit or No-load Test—Separation of Core Losses—Short-circuit of Impedance Test—Regulation of a Transformer—Percentage Resistance, Reactance and Impedance—Kapp Regulation diagram—Sumpner or Back-to-back-Test—Efficiency of a Transformer—Condition for maximum efficiency—Variation of efficiency with power factor—All-day efficiency—Auto –transformer—Convertion of 2-winding transformer into Auto-transformer—parallel operation of Single-phase Transformers

Unit – 2

Three Phase Transformers connections-Star/Star or Y/Y Connection—Delta-Delta of Connection—Wye/Delta of Y/Connection—Delta/Wye or/Y Connection—Open Delta of V-V Connection — Power supplied by V-V Bank-Scott Connection or T-T Connection—3-phase to Two-phase Convertion and vice-versa-Parallel Operation of 3-phase Transformers-Transformers :- Instrument, Current ,Potential

Unit – 3

Induction Motor: Classification of AC Motors—General Principle—Construction—Squirrel –cage Rotor—Phase-Wound Rotor—Production of Rotating Field—Three-phase supply-Slip-frequency of Rotor current—Relation between Torque and Rotor Power Factor—Starting Torque-Effect of change in supply voltage of starting torque—Rotor E.M.F. and Reactance under running conditions—Torque under running condition-Rotor Torque and breakdown torque—Relation between Torque and slip—Effect of change in supply Voltage of Torque and Speed—Effect of change in supply frequency Torque and speed—Full-load Torque and Maximum Torque—Starting Torque and Maximum Torque—Torque/speed curve-plugging of an Induction motor—Induction motor operating as a Generator—Complete Torque/Speed curve of a three-phase machine—Measurement of a slip—Power stages in a induction motor—Torque developed by an induction motor—Torque, mechanical power and Rotor output—-Synchronous watt—variation in Rotor current—Analogy with Mechanical Clutch—Analogy with a D.C Motor— Induction motor :- Sector , Linear,—Magnetic Levitation—Rotor output—Equivalent Circuit of the Rotor—Equivalent circuit of an induction motor—Power balance equation—Maximum power output—Corresponding slip.

Computation and Circle Diagrams:-Circle diagram for a Series circuit—Circle diagram of the Approximate equivalent circle—Determination of G0 and B0—No-load test—Blocked Rotor Test—Construction of the circle diagram—Maximum quantities—Starting of induction motors—Direct-switching or Line starting of induction motor—Squirrel-cage motors—Starting of slip-ring motors—starter steps—Crawling—Cogging or magnetic locking—Double squirrel-cage motor—Equivalent circuit—Speed control of induction motor—Three-phase AC Commutator Motors—Scharge Motor—Motor enclosures—Standard type of Squirrel-cage Motors—Class A Motors—Class B motors—Class C Motors—Class D Motors—Class E motors—Class F Motors

Unit – 4

Single-phase motors:-Type of single-phase motors -Single-phase induction motors—Double-field Revoling Theory Making single-phase induction motor self-starting—Equivalent circuit of Single-phase induction motor—without core loss -Equivalent circuit—With core loss-Types of Capacitors—Start motors - Capacitor start-and-run Motors -Shaded pole Single-phase motor - Repulsion type motors-Repulsion motor & principle-Compensated Repulsion motor-Repulsion-start Induction-run Motor-Repulsion-Induction Motor-A.C. Series Motors—Universal Motor & its Speed control-Unexcited Single-phase Synchronous Motors- Reluctance Motor Hysteresis Motor

Alternators:-Basic Principle—Stationary Armature—Details of Construction—Rotor—Damper Windings—Speed and Frequency—Armature windings-Concentric or chain windings—Two-layer winding—Wye and Delta Connections-Short-pitch winding: pitch factor/Chording factor-Distribution or Breadth Factor or winding factor or Spread factor-Equation of Induced E.M.F-Effect of Hormonics on Pitch and Distribution factors—Factors affecting Alternator Size-Alternator on Load—Synchronous Reactance-Voltage Regulation-Ampere-turn Method-General Case—Zero power factor Method or Potier method—Procedural Steps-Power Developed by a Synchronous Generator—Parallel Operation of Alternators-synchronizing of Alternators-Synchronizing Current—Synchronizing Power—Effect of Load on Synchronizing Power-Alternative expression for Synchronizing power-Parallel operation of two Alternators-Effect of Unequal Voltages—Distribution of load—Time-period of Oscillation—Maximum power output

Unit – 5

Synchronous Motor:-Principle of Operation-Method of starting—Motor on load with Constant Excitation—Power flow & Power Developed within a Synchronous Motor—synchronous Motor with Different Excitations—Effect of increased load with constant excitation—Effect of Changing Excitation of Constant load—Different Torque of a Synchronous Motor—Effects of Excitation on Armature Current and power factor—Constant-power lines—Construction of V-Curves—Hunting of Surging or Phase Swinging—Methods of Starting—Procedure for Starting a Synchronous Motor—Comparison Between Synchronous and Induction Motors—Synchronous Motor Applications

Special Machines:-Stepper Motors-Types of Stepper Motors:-Variable Reluctance ,Multi-stack VR ,Permanent-Magnet & Hybrid : **DC Motor :--** Permanent-Magnet, Low-inertia ,Shell-type, Low-inertia ,Printed Circuit (Disc)-Permanent Magnet Synchronous Motor-Sychros:-Types &Applications-Control Differential Transmitter & Receiver-Switched Reluctance Motor-Comparison between VR stepper Motor and SR Motor-The Resolver-Servomotors-DC & AC Servomotors

References

Text Book by B.L Therja

Skill based Subject 2: Heat & Thermodynamics

Unit – 1

Thermodynamic **Process**: Thermal equilibrium-zeroth law-concept of heat and temperature-thermodynamic variables-extensive and intensive parameters-thermodynamic equilibrium- -indicator diagram-work done in quasi static process-work in isothermal-First law of thermodynamics -application of first law to heat capacities

Unit – 2

Second Law Of Thermodynamics - Reversible and irreversible processes, Conditions for reversibility

Unit – 3

Entropy - definition of entropy -Thermodynamic Relations & Functions-Enthalpy

Unit – 4

Quantum statistics**:** Bose Einstein and Fermi Dirac distribution laws (no derivations)-Distribution law to black body radiation-Planck's radiation law-Stefan's law-Wien's displacement law-Specify Heat of solids-Free electrons gas in a metals- Expression for Fermi energy of electron system-electron energy distribution- Dying Stars

Unit – 5

Passive solar heating technology-Pool heating-Concentrator solar technology-Solar cooling and air conditioning -Direct solar power generation -Innovation in passive solar power technology

Reference

1. Thermodynamics and statistical mechanics-Brijlal Subramanium
2. Thermal And stoical Phycis –C.J Babu
3. Physics- Resnick and Halliday
4. Heat and Thermodynamics-Zemansky
5. Heat and Thermodynamics-DS Mathur (V Edn.)
6. Thermodynamics – Y V C Rao – Universities Press
7. Statistical Mechanics – An Elementary Outline – Avijit Lahiri – Universities Press
8. Advanced Physics Second Edition – Keith Gibbs – Cambridge University Press

Skill Based Subject 3 : Solar Energy Fundamentals andModeling Techniques

Unit – 1

Energy and Climate Change: - Energy and Climate- Energy and Society - Energy and Industry - Energy and the Economy - Energy and the Atmospheric Environment - Energy and the Future.

Atmospheric Environment and Renewable Energy - Weather, Climate, and Climate Change - Atmosphere and Its Natural Composition - Anthropogenic Composition of the Atmosphere - Carbon Dioxide (CO2) -Methane (CH4) - Nitrous Oxide (N2O) - Chlorofluorocarbons (CFCs) - Water Vapor (H2O).- Aerosols.- Energy Dynamics in the Atmosphere -Renewable Energy Alternatives and Climate Change – Energy :-Solar, Wind , Hydropower , Biomass ,Wave , Hydrogen- Energy Units

Unit – 2

Solar Radiation Deterministic Models - The Sun -Electromagnetic (EM) Spectrum - Energy Balance of the Earth-Earth Motion - Solar Radiation -Irradiation Path -Solar Constant &Radiation Calculation –Estimation of Clear-Sky Radiation-Solar Parameters -Earth's Eccentricity - Solar Time - Useful Angles - Solar Geometry - Cartesian and Spherical Coordinate System - Zenith Angle Calculation - Solar Energy Calculations Daily Solar Energy on a Horizontal Surface Solar Energy on an Inclined Surface -Sunrise and Sunset Hour Angles

Unit – 3

Linear Solar Energy Models: Solar Radiation and Daylight Measurement . Instrument Error and Uncertainty Operational Errors - Diffuse-Irradiance Data Measurement Statistical Evaluation of Models Coefficient of Determination ($R2$) -Coefficient of Correlation (r) Mean Bias Error, Mean of Absolute Deviations,-and Root Mean Square Error .- Outlier Analysis Linear Model . Angström Model (AM) -Successive Substitution (SS) -Model Unrestricted Model (UM) - Principal Component Analysis (PCA) Model -Linear Cluster Method (LCM)

Unit – 4

Non-Linear Solar Energy Models Classic Non-Linear Models Simple Power Model (SPM) -Estimation of Model Parameters- Comparison of Different Models Solar Irradiance Polygon Model (SIPM) -Triple Solar Irradiation Model (TSIM) –Triple Drought–Solar Irradiation Model (TDSIM) Fuzzy Logic Model (FLM)-Fuzzy Sets and Logic-Fuzzy Algorithm Application for Solar Radiation –Geno Fuzzy Model (GFM) . Monthly Principal Component Model (MPCM)-Parabolic Monthly Irradiation Model- (PMIM)-Solar Radiation Estimation from -Ambient Air Temperature References

Unit – 5

Spatial Solar Energy Models Spatial Variability -Linear Interpolation.- Geometric Weighting -Function Cumulative Semi variogram(CSV) and Weighting Function -Standard Spatial -Dependence Function (SDF) Regional Estimation .-Cross-Validation Spatial Interpolation . General Application

Solar Radiation Devices and Collectors Solar Energy Alternatives Heat Transfer and Losses. Conduction -Convection Radiation – Collectors- Flat Plate Collectors-Tracking Collectors Focusing (Concentrating)-Collectors Tilted Collectors Solar Pond Collectors - Photo-Optical Collectors -Photovoltaic (PV) Cells Fuel Cells -Hydrogen Storage and Transport –Solar Energy Home -Solar Energy and Desalination Plants - Future Expectations

Reference

Text Book by Zekai Sen

Skill Based Subject 4 - Lab : Photo Voltaic Technology and Solar Energy Lab

- Study of direct and diffused beam solar radiation
- Study of green house effect
- Performance evaluation of solar flat plate collector
- Study the effect of solar flat plate collector in parallel combination
- Performance evaluation of concentrating solar collector
- Performance evaluation of solar cooker
- Performance evaluation air dryer
- Performance evaluation distillation
- Performance evaluation of a solar PV panel
- Performance of PV panel in series and parallel combination
- Charging characteristics of a battery using PV panel
- Effect of tilt angle on solar PV panel
- Effect of shadow on solar PV panel

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