Faculty of Engineering

DEPARTMENT OF ELECTRICAL ENGINEERING

Scheme and Syllabi

of

M.E. (ELECTRICAL ENGG.)

(Full-Time)

Power Electronic Systems

(With effect from the Academic Year 2015-2016)

August 2015

OsmaniaUniversity

Hyderabad - 500 007

SCHEME OF INSTRUCTION & EXAMINATION

M.E. (Electrical) 4 Semesters (Full Time)

S.No.	Course Title	Scheme of Instruction		Contact Hrs/wk	Scheme of Examination		Credits
		L/T	P		CIE	SEE	
Semester - I							
1.	Core	3	--	3	30	70	3
2.	Core	3	--	3	30	70	3
3.	Core / Elective	3	--	3	30	70	3
4.	Core / Elective	3	--	3	30	70	3
5.	Elective	3	--	3	30	70	3
6.	Elective	3	--	3	30	70	3
7.	Laboratory - I	--	3	3	50	--	2
8.	Seminar - I	--	3	3	50	--	2
	Total	**18**	6	**24**	**280**	**420**	**22**
Semester - II							
1.	Core	3	--	3	30	70	3
2.	Core	3	--	3	30	70	3
3.	Core / Elective	3	--	3	30	70	3
4.	Core / Elective	3	--	3	30	70	3
5.	Elective	3	--	3	30	70	3
6.	Elective	3	--	3	30	70	3
7.	Laboratory - II	--	3	3	50	--	2
8.	Seminar - II	--	3	3	50	--	2
	Total	**18**	6	**24**	**280**	**420**	**22**
Semester - III							
1.	(Dissertation + Dissertation Seminar)*	--	4	4	**100****		**8**
Semester – IV							
1.	Dissertation	--	6	6		**200**	**16**

CIE: Continuous Internal Evaluation; SEE: Semester End Evaluation

Note*: Six Core subjects, Six Elective subjects, Two Laboratory Courses and Two Seminars should normally be completed by the end of semester II*

** One Dissertation seminar presentation.*

*** 50 marks to be awarded by Supervisor and 50 marks to be awarded by viva-voice committee comprising Supervisor and two internal faculty members*

M. E. (Power Electronic Systems)

Course Code	Course Title	Contact Hrs/wk	Scheme of Examination		Credits
			CIE	SEE	
Core Subjects					
EE3301	Power Electronic Converters	3	30	70	3
EE3302	Industrial Controllers	3	30	70	3
EE3303	Industrial Electronic Systems	3	30	70	3
EE3304	Power Electronic Converters for Renewable Energy	3	30	70	3
EE3305	Advanced Topics in Power Electronics	3	30	70	3
EE3306	Static Control of Electric Drives	3	30	70	3
Elective Subjects					
EE3102	Machine Modeling and Analysis	3	30	70	3
EE3111	Special Electrical Machines	3	30	70	3
EE3112	Microcontroller Applications to Power Electronics	3	30	70	3
EE3113	Neural Networks and Fuzzy Logic	3	30	70	3
EE3212	Power Quality Engineering	3	30	70	3
Elective Subjects (Common to IDC, PS & PES)					
EE3001	Power Electronic Applications to Power Systems	3	30	70	3
EE3002	Renewable Energy Sources	3	30	70	3
EE3003	Electric and Hybrid Electrical Vehicles	3	30	70	3
EE3004	Modern Control Theory	3	30	70	3
EE3005	Reliability Engineering	3	30	70	3
EE3006	Optimization Methods	3	30	70	3
EE3007	Advanced Microprocessors	3	30	70	3
EE3008	Artificial Intelligence & Expert Systems	3	30	70	3
EE3009	Programmable Logic Controllers	3	30	70	3
EE3010	Digital Signal Processing	3	30	70	3
EE3011	Digital Circuits & Logic Design	3	30	70	3
ME2001	Engineering Research Methodology	3	30	70	3
Departmental Requirements					
EE3331	Power Electronic Systems Lab I	2	50	-	2
EE3332	Power Electronic Systems Lab II	2	50	-	2
EE3333	Seminar I	2	50	-	2
EE3334	Seminar II	2	50	-	2
EE3335	Project Seminar	4	100	-	8
EE3336	Dissertation	6	-	200	16
		36	**660**	**1040**	**68**

EE3301 # Power Electronic Converters (Core-IDC & PES)

Instruction	:	3 Periods / Week
Duration of Univ. Examination	:	3 Hours
SEE	:	70 Marks
CIE	:	30Marks

UNIT-I

Power semiconductor switches- Diodes, Bipolar Power Transistors, Power MOSFETS, IGBTS, Analysis of power semiconductor switched circuits with R, L, RL, RC loads, D.C motor load, battery charging circuit.

UNIT-II

Rectifiers - Uncontrolled Rectifier, Rectifier circuits-Single-phase & Three-Phase circuits, Controlled Rectifiers- Single-phase & Three-Phase controlled Rectifier circuits.

UNIT-III

DC-DC Linear Regulators, DC-DC Switched mode Converters- Buck, Boost, Buck-Boost, Cuk, Flyback, Forward, Push-Pull, Half & Full-bridge .

UNIT-IV

DC-AC Switched Mode Converters-Single phase and Three phase inverters, Voltage source and Current source inverters, Pulse modulation techniques, sinusoidal pulse-Width Modulation, Space vector Modulation, advanced PWM techniques, V/F control of induction motor drives.

UNIT V

AC to AC power conversion using voltage regulators, cyclo-converters and Matrix converters.

Suggested Reading:

1. Ned Mohan, Undeland and Robbin, 'Power Electronics: converters, Application anddesign', John Wiley and Sons.Inc, Newyork, 2006.
2. Rashid M.H., 'Power Electronics-Circuits, Devices and Applications' Prentice HallIndia, New Delhi, 2009.
3. L. Umanand, 'Power Electronics Essentials &Applications', Wiley publishing Company, 1st Edition,2014

EE3302

Industrial Controllers
(Core PES & Elective IDC)

Instruction	:	3 Periods / Week
Duration of Univ. Examination	:	3 Hours
SEE	:	70 Marks
CIE	:	30Marks

Unit-I

8051 Micro controller: Architecture, memory organization, timing and control, parallel ports, timer/counters, serial port and interrupts. Addressing modes and instruction set of 8051 micro controller and its usage.

Unit-II

TMSLF2407 DSP Controller: Introduction, brief introduction to peripherals, types of physical memory, software tools. **C2XX DSP CPU and instruction set:**C2xx DSP Core and code generation, mapping external devices to the C2xx DSP core and the pheripherals, memory, Addressing modes, assemblyprogramming using C2xx DSP instruction set.

Unit III

GPIO functionality: Pin multiplexing (MUX) and GPIO Overview, multiplexing and GPIO control registers.**Interrupts on the TMS320LF2407:** Introduction, Interrupt Hierarchy and its Control Registers.

Unit IV

ADC: Overview,Operation and programming modes. **Event managers**: Overview, Interrupts, Timers, Compare Units, Capture units and QEP circuitry PWMSignal Generation with Event Managers.

Unit-V

Programmable Logic Controller (PLC) Basics: Definitions and history of PLCs – Advantages and disadvantage of PLC – overall PLC Systems, CPUs and Programmer/ Monitors – Programming procedures – programming equipment – Programming formats Ladder diagrams, Basic PLC programming and Basic PLC functions: Programming on / off inputs to produce on / off outputs, PLC programming examples.

Suggested Reading:

1. Kenneth J.Ayala, *The Micro Controllers - Architecture, Programming & Applications*, Penram International Publishing (India).
2. Hamid A Toliyat, DSP based Electromechanical Motion Control, Steven Campbell 2004, CRC Press.
3. John W. Webb and Roland A. Reis, *Programmable Logic Controllers*, Prentice Hall India Ltd., Fifth edition, 2003.

EE3303 **Industrial Electronic Systems (Core PES)**

Instruction	:	3 Periods / Week
Duration of Univ. Examination	:	3 Hours
SEE	:	70 Marks
CIE	:	30Marks

UNIT I

Power Supplies:UPS- Offline, Online & Hybrid types of UPS, Parallel redundancy, Dual redundancy, AC Power conditioner- power supply noise-servo system – servo controlled voltage stabilizer- AC generator voltage regulator– Constant voltage transformer SMPS -Fly back, feed forward, Push pull and Bridge types.

UNIT II

Automatic Welding System: Physical Description of a wheel welding system - Sequence of operations – Sequence initiation –Interval triggering and gating circuit - Interval stepping circuit –Interval time counter –Heat -cool counter –Weld power circuit.

UNIT III

Closed loop Industrial Systems: Thermistor control of quench oil temperature Proportional mode pressure control system Strip tension controller – Edge guide control for a strip recorder –Control of relative humidity in a textile moisturizing process. Closed loop industrial systems warehouse humidity controller.

UNIT IV

High Frequency Heating: Merits of Induction Heating–Applications of Induction Heating–High Frequency Power Source for Induction Heating–Principle of Dielectric Heating–Theory of Dielectric Heating–Dielectric Properties of a few typical materials–Electrodes used in Dielectric Heating–Method of Coupling of Electrodes to the R.F. Generator–Thermal Losses in Dielectric Heating–Applications of Dielectric Heating.

UNIT V

Reactive Compensation in Electric Arc Furnace: The arc Furnace an Electrical Load – Flicker and Principles of its compensation Thyristor controlled compensators –Saturable Reactor Compensator.

Suggested Reading:

1. Maloney Timothy. J, *IndustrialSolidState Electronics*, Prentice Hall International, 1986.
2. Krishna Kant, *Computer Based Industrial Control*, Prentice Hall of India, 1997.
3. G.K. Mithal, Dr. Maneesha Gupta, Industrial and Power Electronics, Khanna Publishers, 2007.
4. M.D Singh &Kanchandani.K.B., *Power Electronics*, Tata McGraw Hill.,1998.
5. P.C Sen, *Modern Power Electronics*, S.Chand& Co.

EE3304 Power Electronic Converters for Renewable Energy (Elective IDC& Core PES)

Instruction	:	3 Periods / Week
Duration of Univ. Examination	:	3 Hours
SEE	:	70 Marks
CIE	:	30Marks

UNIT I

Introduction to renewable sources: world energy scenario, Wind, solar, hydro, geothermal, availability and power extraction.
Introduction to solar energy: Photovoltaic effect, basics of power generation, P-V &I-V characteristics, effect of insolation, temperature, diurnal variation, shading, Modules, connections, ratings, Power extraction (MPP) tracking and MPPT schemes;standalone systems, grid interface, storage, AC-DC loads.

UNIT II

DC-DC converters for solar PV:buck/boost/buck-boost /flyback /forward/cuk, bidirectional converters, Interleaved and multi-input converters.

UNIT III

Grid connected Inverters: 1ph, 3ph inverters with & w/o x'mer, Heric, H6, Multilevel Neutral point clamp, Modular multilevel, CSI; Control schemes: unipolar, bipolar, PLL and synchronization, power balancing / bypass, Parallel power processing; Grid connection issues: leakage current, Islanding, harmonics, active/reactive power feeding, unbalance.

UNIT IV

Introduction to wind energy: P-V, I-V characteristic, wind power system: turbine-generator-inverter, mechanical control, ratings; Power extraction (MPP) and MPPT schemes. Generators for wind: DC generator with DC to AC converters; Induction generator with & w/o converter.

UNIT V

Synchronous generator with back to back controlled/ uncontrolled converter; Doubly fed induction generator with rotor side converter topologies; permanent magnet based generators. Battery: Types, charging discharging. Introduction to AC and DC microgrids.

Suggested Reading:

[1] SudiptaChakraborty, Marcelo G. Simes, and William E. Kramer. Power Electronics for Renewable and Distributed Energy Systems: A Sourcebook of Topologies, Control and Integration. Springer Science & Business, 2013.

[2] Nicola Femia, Giovanni Petrone, Giovanni Spagnuolo, Massimo Vitelli, Power Electronics and control for maximum Energy Harvesting in Photovoltaic Systems,CRC Press,2013.
[3] Chetan Singh Solanki, Solar Photovoltaics: fundamentals, Technologies and Applications, Prentice Hall of India, 2011.
[4] N. Mohan, T.M. Undeland& W.P. Robbins, Power Electronics: Converter, Applications & Design, John Wiley & Sons, 1989
[5] Muhammad H. Rashid, Power Electronics: Circuits, Devices, and Applications, Pearson Education India, 2004
[6] E. Guba, P. Sanchis, A. Ursa, J. Lpez, and L. Marroyo, Ground currents in single-phase transformerless photovoltaic systems, Progress in Photovoltaics: Research and Applications, vol. 15, no. 7, 2007.
[7] Remus Teodorescu, Marco Liserre, Pedro Rodriguez, Grid Converters for Photovoltaic and Wind Power Systems, John Wiley and Sons, Ltd., 2011.
[8] Ali Keyhani, Design of Smart Power Grid Renewable Energy Systems, Wiley-IEEE Press, 2011.

EE3305 Advanced Topics in Power Electronics (Core PES)

Instruction	:	3 Periods / Week
Duration of Univ. Examination	:	3 Hours
SEE	:	70 Marks
CIE	:	30Marks

Unit-I

Introduction to switches - Advanced Silicon devices - Silicon HV thyristors, MCT, BRT &EST. SiC devices - diodes, thyristors, JFETs & IGBTs. Gallium nitrate devices - Diodes, MOSFETs.

Unit -II

Pulse Width Modulated Rectifiers: Properties of ideal rectifier, realization of near ideal rectifier, control of the current waveform, single phase and three-phase converter systems incorporating ideal rectifiers and design examples. Non-linear phenomena in switched mode power converters: Bifurcation and Chaos.

Unit-III

Control of DC-DC converters- State space modeling of Buck, Boost, Buck-Boost, Cuk Fly back, Forward, Push-Pull, Half & Full-bridge converters. Closed loop voltage regulations using state feedback controllers**.**

Soft-switching DC - DC Converters: zero-voltage-switching converters, zero-current switching converters, Multi-resonant converters and Load resonant converters.

Unit-IV

Advance converter topologies - Multi level converters - Cascaded H-Bridge, Diode clamped, NPC, Flying capacitor. Modular Multi-level converters(MMC), Multi-Input DC-DC Converters, Multi pulse PWM current source converters, Interleaved converters, Z-Source converters.

Unit-V

Control Design Techniques for Power Electronic Systems- Modeling of systems, Digital Controller Design, Optimal and Robust controller Design.

Suggested Reading:

1. Andrzej M Trzynadlowski, 'Introduction to Modern Power Electronics, John Wiley and sons. Inc, New York, 1998

2. L. Umanand, 'Power Electronics Essentials &Applications', Wiley publishing Company, 1st Edition, 2014

3 B. JayantBalinga, 'Advanced High Voltage Power Device Concepts', Springer New York 2011. ISBN 978-1-4614-0268-8

4. BIN Wu, ' High Power Converters and AC Drives', IEEE press Wiley Interscience, a John wiley& sons Incpublication 2006

EE3306 # Static Control of Electric Drives (Core PES)

Instruction	:	3 Periods / Week
Duration of Univ. Examination	:	3 Hours
SEE	:	70 Marks
CIE	:	30Marks

UNIT I

DC Motor Control: Operation of Single phase and Three phase Full converter and Semi converter fed dc motors, Speed torque characteristics, Performance characteristics, Dual converter drives, Analysis of four quadrant chopper fed dc drive, Dynamic & Regenerative braking, Closed loop control of phase control and chopper dc drive.

UNIT II

Scalar Control: Stator voltage control, Static rotor resistance control, Slip power recovery schemes, Closed loop control, VSI & CSI fed Induction motor drives, Analysis of stepped and PWM waveform, Harmonic equivalent circuit and motor performance.

UNIT III

Vector Control: DC drive analogy, Equivalent circuit and Principle of Vector control, Direct vector control – Flux & Torque processor using Terminal voltages and Induced emf, Indirect vector control – Flow chart and Implementation.

UNIT IV

Principle of Sensor less vector control: Principle of Space vector Pulse width modulation & control, Direct torque and Flux control - Torque expression with Stator and Rotor fluxes - Control strategy of DTC.

UNIT V

Brushless D.C Motor: Unipolar and Bipolar Brushless D.C motors, Applications, Stepper Motors — Variable reluctance and Permanent magnet stepper motors — Characteristcs& Drive circuits, Switched reluctance motor.

Suggested Reading:

1. R.Krishnan, *Electric Motor Drives*, Prentice Hall of India Pvt. Ltd., New Delhi, 2002.
2. G.K.Dubey, *Fundamentals of Electrical Drives*, Narosa Publishing House, New Delhi, 1999.
3. W.Shepard, L.N.Hulley and D.T.W.Liang, *Power Electronics and Motor Control*, Cambridge University Press, 1995.
4. B.K.Bose, *Modern Power Electronics and A.C. Drives*, Prentice Hall, 2002.

EE3102 # Machine Modeling and Analysis (Core– IDC& Elective -PES)

Instruction	:	3 Periods / Week
Duration of Univ. Examination	:	3 Hours
SEE	:	70 Marks
CIE	:	30Marks

UNIT I

Basic Principles for Electric Machine Analysis: Magnetically coupled circuits, Electromechanical energy conversion, Basic Two pole DC Machine – primitive 2 axis machine – Voltage and Current relationship – Torque equation.

Theory of DC Machines: Mathematical model of separately excited DC Motor, DC Series Motor, DC shunt motor and D.C. Compound Motor in state variable form – Transfer function of the motor.

UNIT II

Reference Frame Theory: Equations of transformation - Change of variables, Stationary circuit variables Transformed to the Arbitrary Reference Frame, Commonly used reference frames, Transformation between reference frames, Transformation of a balanced set, Balanced steady state phasor Relationships, Balanced steady state equations, Variables observed from various frames.

UNIT III

Theory of Symmetrical Induction Machines: Voltage and torque equations in machine variables, Equations of transformation for Rotor circuits, Voltage and torque equations in arbitrary reference frame variables, Analysis of steady state operation-state-space model of induction machine in'd-q' variables, Free Acceleration Characteristics, Dynamic Performance-during sudden changes in load- during a 3 phase fault at the machine terminals.

UNIT IV

Theory of Synchronous Machines: Voltage and Torque equations in machine variables, Stator Voltage equations in Arbitrary Reference Frame Variables, Voltage Equations in Rotor Reference Frame Variables: park's Equations, Torque Equations in Substitute Variables, Analysis of steady state operation, Dynamic performance - During sudden changes in Input Torque - During a 3 phase fault at the machine terminals.

UNIT V

Linearized Machine Equations: Introduction, Machine equations to be linealized-Induction machine, Synchronous machine.Linearized machine equatiuons-Induction machines, Synchronous machines.Small-displacement stability-Eigan values, Eigan values of typical Induction machines and synchronous machines.

Suggested Reading:

1. Paul C. Krause, Oleg Wasynczuk, Scott D.Sudhoff, "*Analysis of Electric Machinery and drive systems*" John Wiley and Sons, 2nd Edition, 2006
2. C.V. Jones, *"Unified Theory of Electrical Machines"*Butterworths Publishers.

3. P.S. Bhimbra,"*Generalized Theory of Electrical Machines"*, Khanna publishers, 2002.
4. J. Meisel, "*Principles of Electromechanical Energy Conversion" McGraw Hill, 1966.*

EE3111 # Special Electrical Machines
(Elective to IDC & PES)

Instruction	:	3 Periods / Week
Duration of Univ. Examination	:	3 Hours
SEE	:	70 Marks
CIE	:	30Marks

UNIT -I
Stepper Motors
Constructional features, Principle of operation, Variable Reluctance (VR) stepping motor-Single Stack, Multi-Stack, Permanent Magnet Step motor, Hybrid Step Motor, Torque Equation Open Loop Drive, Open loop and closed loop control of Step Motor, Applications.

UNIT -II
Switched Reluctance Motors
Constructional features, Principle of Operation, Torque equation, Torque-speed characteristics, Power Converter for SR Motor-Asymmetrical converter, DC Split converter, Control of SRM, Rotor Position sensors, Current Controllers, Applications.

UNIT-III
Permanent Magnet Synchronous Motor
Permanent magnets and their characteristics, Machine Configurations-SPM, SIPM, IPM and Interior PM with circumferential, Sensorless control, Applications.

UNIT -IV
Brushless DC Motor
Construction, Principle of Drive operation with inverter, Torque speed Characteristics, Closed loop control, Sensorless control, Applications.

UNIT-V
Linear Induction Motors and Linear Synchronous Motors
Linear induction motor, Construction details, LIM Equivalent Circuit, Steps in design of LIM, Linear Synchronous Motor: Principle and Types of LSM, LSM Control, Applications.

Suggested Reading:

1. R.Krishnan, *Electric Motor Drives*, Pearson , 2007
2. B.K.Bose, *Modern Power Electronics and AC Drives*, PHI, 2005
3. Venkataratnam, *Special electrical Machines*, University Press, 2008
4. E.G.Janardanan, *Special Electrical Machines*, PHI, 2014
5 T.J.E.Miller, *Brushless Permanent Magnet and Reluctance Motor Drive*, Clarendon Press, Oxford, 1989

EE3112 Microcontroller Applications to Power Electronics (Elective to IDC & PES)

Instruction	:	3 Periods / Week
Duration of Univ. Examination	:	3 Hours
SEE	:	70 Marks
CIE	:	30Marks

UNIT-I

Review of microcontrollers and digital signal processors, architecture,peripheral modules.; Typical processors for control implementation: memory organization, CPU details, addressing modes, interrupt structure, hardware multiplier, pipelining.; Fixed- and floating-point data representations , Assemblers, linkers and loaders. Binary file formats for processor executable files. Typical structure of timer-interrupt driven programs.;

UNIT-II

Implementing digital processor based control systems for power electronics: Reference frame transformations, PLL implementations, machine models, harmonic and reactive power compensation, space vector PWM.;Numerical integration methods.; Multitasking concepts for power electronics implementations: The need for multitasking, various multitasking methods.

UNIT-III

Use of microcontrollers for pulse generation in power converters - Overview of Zero-Crossing Detectors - typical firing/gate-drive circuits –firing / gate pulses for typical single phaseand three-phase power converters - PIC16F876 Micro-controller – device overview –pin diagrams.

UNIT-IV

PIC16F876 micro-controller memory organization – Special Function Registers - I/O ports –Timers – Capture/ Compare/ PWM modules (CCP).
Analog to Digital Converter module – Instruction set - instruction description - introductionto PIC microcontroller programming- oscillator selection-reset - interrupts -watch dogtimer.

UNIT-V

Introduction to MPLAB IDE and PICSTART plus – Device Programming using MPLAB andPICSTART plus – generation of firing / gating pulses for typical power converters.Example of DSP system A to D signal conversion - DSP Support tools-code composer studio - compiler, assembler and linker

Suggested Reading:

1. PIC16F87X Datasheet 28/40 – pin 8 bit CMOS flash Microcontrollers, Microchip technology
Inc., 2001. and MPLAB IDE Quick start guide, Microchip technology Inc., 2007.
2. John B. Peatman, 'Design with PIC Microcontrollers', Prentice Hall, 2003.
3. MykePredko, 'Programming and customizing the PIC Microcontroller' Tata McGraw-Hill,
3rd Edition, 2008.
4. K Ogata, "Discrete-Time Control Systems", second edition, Pearson Education Asia.
5. N. Mohan, "Power Electronics", third edition, John Wiley and Sons.

EE3113 # Neural Networks and Fuzzy Logic (Elective to IDC & PES)

Instruction	:	3 Periods / Week
Duration of Univ. Examination	:	3 Hours
SEE	:	70 Marks
CIE	:	30Marks

UNIT-I

Neural and Fuzzy Intelligence: Fuzziness as multi-valence - Bivalent paradoxes as fuzzy midpoints, Sets as points in cubes - Subset hood and probability, The dynamical system approach to machine intelligence, Brain as a dynamical system – Neural networks as trainable dynamical system, Intelligent behavior as adaptive model free estimation, Generalization and creativity - Learning as change-Rules vs. principles - Symbolic vs. numeric processing, Structured numerical estimators

UNIT-II

Neural Network Theory: Neurons as functions - Signal monotonicity Biological activities and signals, Neuron fields - Neuronal dynamic systems - Common signal, functions - Pulse coded signal functions, Additional neuron dynamics - Additive neural feedback - Additive activation models Bivalent BAM theorem, Hopfield model

UNIT-III

Synaptic Dynamics: Unsupervised learning - Learning laws, Signal Hebbian learning- Competitive learning, Differential Hebbian learning - Supervised learning, The perceptrons – LMS algorithm, Back propagation algorithm - AVQ algorithm, Global stability of feed back neural networks.\

UNIT-IV

Fuzzy Logic: Fuzzy sets and systems-Geometry of fuzzy sets, Fuzzy entropy theorem- Entropy subset - Hood theorem, Fuzzy& neural function estimators-FAM system Architecture, Uncertainty and estimation - Types of uncertainty - Measure offuzziness -Classical measures of uncertainty, Measures ofdissonance - Confusion and non-specificity. Fuzzy logic structure, Knowledge base defuzzification, Fuzzy logic in control-Pattern recognition–Planning diagnosis

UNIT-V

Fuzzy Logic and ANN Applications: Fuzzy logic application to Induction motor speed control, Flux programming efficiency improvement of induction motor drive, pulsating torque compensation. Neural Network applied to Space Vector PWM, Vector controlled drive feedback signal estimation, model identification and adaptive drive control. Neuro-Fuzzy systems, ANN based Fuzzy inference system (ANFIS)

Suggested Reading

1. Bart Kusko, *Neural Networks and Fuzzy System* - Prentice Hall of India, 1994.
2. B. Yegnanarayana, *Artificial Neural Networks*, PHI Learning 1994.
3. B.K. Bose, Modern Power electronics and AC drives , Prentice Hall PTR, 2002.
4. Timothy J. Ross, *Fuzzy Logic with Engineering Applications*, Wiley

EE3212 # Power Quality Engineering (Elective)

Instruction	:	3 Periods / Week
Duration of Univ. Examination	:	3 Hours
SEE	:	70 Marks
CIE	:	30 Marks

UNIT I

Introduction: Power Quality (PQ),PQ problems , Sags, Swells, Transients, Harmonics, Interruptions, Flicker ,Voltage fluctuations, Notch.Transient Overvoltages – Sources of Transient Overvoltages.

Wiring and Grounding: Resources, Definitions, Reasons for Grounding, Typical wiring and grounding problems, Solutions to wiring and grounding problems.

UNIT II

Voltage Sag Analysis: Voltage sag characteristics - Methodology for computation of voltage sag magnitude and occurrence — Accuracy of sag analysis — Duration & frequency of sags — Faults behind transformers — Effect of pre-fault voltage — Simple examples — Voltage dip problems, fast assessment methods for voltage sags in distribution systems.

UNIT III

PQ Consideration in Industrial Power Systems: Adjustable speed drive (ASD) systems and applications — Sources of power system harmonics — Mitigation of harmonics — Characterization of voltage sags experienced by three-phase ASD systems — Types of sags and phase angle jumps — Effects of momentary voltage dips on the operation of induction and synchronous motors .

UNIT IV

Harmonics: Harmonic distortion, Voltage versus current distortion, Harmonics versus Transients, Harmonic Indices, Harmonic sources from commercial loads, Harmonic sources from industrial loads, Locating Harmonic sources, System response characteristics, Effects of Harmonic distortion, Inter harmonics, Devices for controlling harmonic distortion.

UNIT V

Power quality monitoring – Monitoring considerations, Historical Perspective of PQ Measuring Instruments, PQ measurement equipment, Assessment of PQ measurement data, Application of intelligent systems, PQ monitoring standards

Suggested Reading:

1. Math H.J. Bollen, *Understanding Power Quality Problems*, IEEE Press, 1999.
2. Roger C.Dugan,MarkF.McGranaghan, Surya Santoso,H.WayneBeaty, *Electrical Power Systems Quality*, Second Edition,Tata McGraw-Hill Edition.
3. C.Sankaran, *Power Quality*, CRC Press, 2002.

(Common Electives for IDC, PS & PES)

EE3001 Power Electronic Applications to Power Systems

Instruction	:	3 Periods / Week
Duration of Univ. Examination	:	3 Hours
SEE	:	70 Marks
CIE	:	30Marks

UNIT - I

Facts concepts: Reactive power control in electrical power transmission, principles of conventional reactive power compensators. Introduction to FACTS, flow of power in AC parallel paths, meshed systems, basic types of FACTS controllers, definitions of FACTS controllers, brief description of FACTS controllers.

UNIT - II

Static shunt and series compensators:

Shunt compensation - objectives of shunt compensation, methods of controllable VAR generation, static VAR compensators - SVC, STATCOM, SVC and STATCOM comparison. Series compensation - objectives of series compensation, thyristor switched series capacitors (TCSC), static series synchronous compensator (SSSC), power angle characteristics, and basic operating control schemes.

UNIT -III

Combined compensators: Unified power flow controller (UPFC) - Introduction, operating principle, independent real and reactive power flow controller and control structure. Interline power flow controller (IPFC), Introduction to Active power filtering, Concepts relating to Reactive power compensation and harmonic current compensation using Active power filters.

UNIT IV

Hvdc transmission: HVDC Transmission system: Introduction, comparison of AC and DC systems, applications of DC transmission, types of DClinks, Layout of HVDC Converter station and various equipments. HVDC Converters, analysis of bridge converters with and without overlap, inverter operation, equivalent circuit representation of rectifier and inverter configurations

UNIT V

Control of HVDC system: Principles of control, desired features of control, converter control characteristics, power reversal, Ignition angle control, current and extinction angle control. Harmonics-introduction, generation, ac filters and dc filters. Introduction to multiterminal DC systems and applications, comparison of series and parallel MTDC systems.

Suggested Reading:

1. Song, Y.H. and Allan T. Johns, 'Flexible AC Transmission Systems (FACTS)', Institution of Electrical Engineers Press, London, 1999.
2. Hingorani ,L.Gyugyi, 'Concepts and Technology of Flexible AC Transmission System', IEEE Press New York, 2000 ISBN –078033 4588.
3. Padiyar, K.R., 'HVDC transmission systems', Wiley Eastern Ltd., 2010.
4. Mohan Mathur R. and Rajiv K.Varma , 'Thyristor - based FACTS controllers for Electrical
transmission systems', IEEE press, Wiley Inter science , 2002.
5. Padiyar K.R., 'FACTS controllers for Transmission and Distribution systems' New Age International Publishers, 1st Edition, 2007.
6. Enrique Acha, Claudio R.Fuerte-Esqivel, Hugo Ambriz-Perez, Cesar Angeles-Camacho 'FACTS –Modeling and simulation in Power Networks' John Wiley & Sons, 2002.

EE3002 Renewable Energy Sources

Instruction	:	3 Periods / Week
Duration of Univ. Examination	:	3 Hours
SEE	:	70 Marks
CIE	:	30Marks

UNIT I

Review of Conventional and Non-Conventional energy sources - Need for non-conventional energy sources Types of Non- conventional energy sources - Fuel Cells - Principle of operation with special reference to H2 °2 Cell - Classification and Block diagram of fuel cell systems - Ion exchange membrane cell - Molten carbonate cells - Solid oxide electrolyte cells - Regenerative system- Regenerative Fuel Cell - Advantages and disadvantages of Fuel Cells — Polarization - Conversion efficiency and Applications of Fuel Cells.

UNIT II

Solar energy - Solar radiation and its measurements - Solar Energy collectors -Solar Energy storage systems - Solar Pond - Application of Solar Pond - Applications of solar energy.

UNIT III

Wind energy- Principles of wind energy conversion systems - Nature of wind - Power in the Wind-Basic components of WECS -Classification of WECS -Site selection considerations -Advantages and disadvantages of WECS -Wind energy collectors - Wind electric generating and control systems - Applications of Wind energy - Environmental aspects.

UNIT IV

Energy from the Oceans - Ocean Thermal Electric Conversion (OTEC) methods - Principles of tidal power generation -Advantages and limitations of tidal power generation -Ocean waves - Wave energy conversion devices -Advantages and disadvantages of wave energy - Geo-thermal Energy - Types of Geo-thermal Energy Systems - Applications of Geo-thermal Energy.

UNIT V

Energy from Biomass - Biomass conversion technologies / processes - Photosynthesis - Photosynthetic efficiency - Biogas generation - Selection of site for Biogas plant - Classification of Biogas plants - Details of commonly used Biogas plants in India - Advantages and disadvantages of Biogas generation -Thermal gasification of biomass -Biomass gasifiers.

Suggested Reading:

1. Rai G.D, *Non-Conventional Sources of Energy,* Khandala Publishers, New Delhi, 1999.
2. M.M.El-Wakil, *Power Plant Technology.* McGraw Hill, 1984.

EE3003 Electric and Hybrid Electrical Vehicles

Instruction	:	3 Periods / Week
Duration of Univ. Examination	:	3 Hours
SEE	:	70 Marks
CIE	:	30Marks

Unit I

Introduction to Electric Vehicles: Sustainable Transportation - EV System - EV Advantages - Vehicle Mechanics - Performance of EVs - Electric Vehicle drivetrain - EV Transmission Configurations and components-Tractive Effort in Normal Driving - Energy Consumption - EV Market - Types of Electric Vehicle in Use Today - Electric Vehicles for the Future.

Unit II

Electric Vehicle Modelling - Consideration of Rolling Resistance - Transmission Efficiency - Consideration of Vehicle Mass - Tractive Effort - Modelling Vehicle Acceleration - Modelling Electric Vehicle Range -Aerodynamic Considerations - Ideal GearboxSteady State Model - EV Motor Sizing - General Issues in Design.

Unit III

Introduction to electric vehicle batteries - electric vehicle battery efficiency - electric vehicle battery capacity - electric vehicle battery charging - electric vehicle battery fast charging - electric vehicle battery discharging - electric vehicle battery performance – testing.

Unit IV

Hybrid Electric Vehicles - HEV Fundamentals -Architectures of HEVs- Interdisciplinary Nature of HEVs - State of the Art of HEVs - Advantages and Disadvantages - Challenges and Key Technology of HEVs - Concept of Hybridization of the Automobile-Plug-in Hybrid Electric Vehicles - Design and Control Principles of Plug-In Hybrid Electric Vehicles - Fuel Cell Hybrid Electric Drive Train Design - HEV Applications for Military Vehicles.

Unit V

Advanced topics - Battery Charger Topologies, ChargingPower Levels, and Infrastructure for Plug-InElectric and Hybrid Vehicles - The Impact of Plug-in Hybrid Electric Vehicles onDistribution Networks – Sizing Ultracapacitorsfor Hybrid Electric Vehicles.

Suggested Reading:

1. Modern Electric, Hybrid Electric and Fuel Cell Vehicles – Fundamentals, Theory and Design – MehrdadEhsani, UiminGao and Ali Emadi - Second Edition - CRC Press, 2010.
2. Electric Vehicle Technology Explained - James Larminie, John Lowry - John Wiley & Sons Ltd, - 2003.

3. Electric Vehicle Battery Systems - SandeepDhameja – Newnes - New Delhi – 2002.
4. Hybrid electric Vehicles Principles and applications With practical perspectives -Chris Mi, Dearborn - M. AbulMasrur, David WenzhongGao - A John Wiley & Sons, Ltd., - 2011.
5. Electric & Hybrid Vehicles – Design Fundamentals -IqbalHussain, SecondEdition, CRC Press, 2011.
6. Research Papers:
   i) The Impact of Plug-in Hybrid Electric Vehicles on Distribution Networks: a Review and Outlook - Robert C. Green II, Lingfeng Wang and MansoorAlam - 2010 IEEE.
   ii) Sizing Ultracapacitors For Hybrid Electric Vehicles - H. Douglas P Pillay -2005 IEEE.
   iii) Review of Battery Charger Topologies, Charging Power Levels, and Infrastructure for Plug-In Electric and Hybrid Vehicles - Murat Yilmaz, and Philip T. Krein, - IEEE transactions on power electronics, vol. 28, no. 5, may 2013.

EE 3004 # Modern Control Theory

Instruction	:	3 Periods / Week
Duration of Univ. Examination	:	3 Hours
SEE	:	70 Marks
CIE	:	30Marks

UNIT I

Review of state variable representation of systems - Controllability and Observability –Model control of single input – single output systems (SISO), Controllable and Observable companion forms – Effect of state feedback on Controllability and Observability, Pole placement by state feedback.

UNIT II

Classification of Non-linearities: Phenomenon exhibited by the nonlinearities – Limit cycles – Jump resonance ,Sub-harmonic oscillations – Phase plane analysis – Singular points – Construction of phase plane trajectories – Isocline method – Delta method – Measurement of time on phase plane trajectories.

UNIT III

Concept and definition of stability - Lyapunov stability - Lyapunov's first and second methods - Stability of linear time invariant systems by Lyapunov's second method - Generation of Lyapunov functions- Variable gradient method - Krasooviski's method.

UNIT IV

Formulation of optimal control problems - Calculus of variations – Fundamental concepts –Functionals – Variation of functionals – Fundamental theorem of calculus of variations - Boundary conditions – Constrained minimization – Dynamic programming – Hamilton Principle of optimality, Jacobi Bellman equation – Potryagins minimum principle.

UNIT V

Introduction to adaptive control, types of adaptive control systems. Design of model reference adaptive control systems using M/T rule and Lyapunov stability theorem.

Suggested Reading:

1. I.J Nagarath , M.Gopal *Control Systems Engineering*, fifth edition , New Age International Publishers, 1984 Wiley Eastern Ltd.
2. Ogata K, *Modern Control Engineering*, Prentice Hall, 1997.
3. Donald E Kirk, optimal control thery An introduction
   Karl J AstromBjronwihenmark, *Adaptive control* second edition – Pearson education.

EE3005 Reliability Engineering

Instruction	:	3 Periods / Week
Duration of Univ. Examination	:	3 Hours
SEE	:	70 Marks
CIE	:	30Marks

UNIT I

Discrete and Continuous Random Variables - Binomial, Poisson, Normal, Lognormal, Exponential and Weibull distributions - Causes of failure - Failure rate and Failure density - Reliability and MTTF.

UNIT II

Maintainability and Availability - MTBF and MTTR - Reliability block diagram - Series and parallel systems -Redundancy - Standby system with and without imperfect switching device - r out of n configuration.

UNIT III

Morkov models - Reliability models of single unit, Two unit, Load shared and Standby systems - Reliability and availability models of the above systems with repair. Frequency of failures - State transition matrices and solutions - Accelerated life testing.

UNIT IV

Chi-square distribution - Confidence limits for Exponential and Normal distributions - Applications of Weibull distribution and ML estimates - Goodness of fit test - Preventive maintenance - Reliability and MTTF - Imperfect maintenance - Age replacement policy.

UNIT V

Power system reliability - Outage definitions - Morkov model of a generating plant with identical units and un-identical units - Capacity outage probability table – Cumulative frequency -LOLP and LOLE.

Suggested Reading:

1. Charles E. Ebeling, An *Introduction to Reliability and Maintainability Engineering*, McGraw Hill International Edition, 1997.
2. Endrenyi, *Reliability Modelling in Electrical Power Systems* - John Wiley & Sons, 1980.
3. Roy Billington and Ronald N.Allan, *Reliability Evaluation of Engineering Systems*,Plenum Press, NewYork,1992.
4. Roy Billington and Ronald N.Allan, *Reliability Evaluation of Power Systems*, Plenum Press, NewYork, 1996.

EE3006 # Optimization Methods

Instruction	:	3 Periods / Week
Duration of Univ. Examination	:	3 Hours
SEE	:	70 Marks
CIE	:	30Marks

Unit I

Classical Optimization techniques: Introduction to optimization and design optimization, optimum design problem formulation, Single variable optimization- Multivariable optimization with and without constraints – Multi variable optimization with inequality constraints – Solution by Lagrangian multipliers - Kuhn-Tucker conditions.

Unit II

Linear Programming: Formulation and standard form of LP problem, Basic definitions and theorems – Solution of a system of linear simultaneous equations – simplex method and its algorithm – Revised simplex method – Big-M method – Duality in LP and primal dual relations – Dual simplex method.

Unit III

Non Linear Programming: One dimensional minimization methods – Introduction – Elimination methods – Unrestricted search, Exhaustive search, Dichotomous search, Fibonacci methods. Unconstrained optimization techniques- Univariate and Powell's pattern search method, steepest descent method.

Unit IV

Evolutionary computations: Introduction – Genetic algorithms – Terminologies and operations of GA – Advanced operators and techniques in GA – Introduction to particle swarm optimization and Ant colony optimization.

Unit V

Advanced topics in optimization: Fast Multi-swarm Optimization for Dynamic Optimization, Reliability-Based Optimization Using Evolutionary Algorithms, Ant Colony Optimization for Mixed-Variable Optimization Problems, Bacterial Foraging Global Optimization Algorithm.

Suggested Reading:

1. Engineering Optimization, Theory and Practice - Singiresu S. Rao, S. S. Rao – Fourth edition – New Age Internationals – 2009.
2. Introduction to Optimum design, Jasbir S. Arora, - Third Edition – Elsevier – 2013.
3. Optimization methods for Engineers, N.V.S. Raju – PHI – 2014.
4. Introduction to Genetic Algorithms, S.N.Sivanandam, S.N Deepa – Spinger – 2013.
5. Reliability-Based Optimization UsingEvolutionary Algorithms: IEEE transactions on evolutionary computation, vol. 13, no. 5, october 2009.
6. Ant Colony Optimization for Mixed-VariableOptimization Problems: IEEE Transactions on evolutionary computation, vol. 18, no. 4, august 2014.

EE3007 # Advanced Microprocessors

Instruction	:	3 Periods / Week
Duration of Univ. Examination	:	3 Hours
SEE	:	70 Marks
CIE	:	30Marks

UNIT I

Review of Basic I/O Interfaces: Programmable Interval Timer 8253 - Programmable peripheral Interlace 8255 — Programmable Interrupt Controller 8259 Microprocessor 8085 applications.

UNIT II

8086 Architecture: CPU Architecture Machine language instructions - Instruction execution — Timing.

UNIT III

Assembler Language Programming: Incorporating Data Transfer -Branch Arithmetic -Loop -NOP and HLT - Flag manipulation, Logical Shift and Rotate Instructions — Directives and Operators.

UNIT IV

Modular Programming: Linking and Relocation -Stacks - Procedures - Interrupts and Interrupt Routines. Byte and String Manipulation: String instruction - REP Prefix -Text Editor - Table translation.

UNIT V

8087 Numeric Data Processor: NDP -Data types -Processor architecture -Instruction set.

Suggested Reading:

1. Liu, Gibson, *Microcomputer Systems The 8086/8088 Family*, Prentice Hall India, 1986.
2. Ghosh, Sridhar, *0000-8085 introduction to Microprocessors*, Prentice HallIndia, 1991.

EE3008 Artificial Intelligence & Expert Systems

Instruction	:	3 Periods / Week
Duration of Univ. Examination	:	3 Hours
SEE	:	70 Marks
CIE	:	30Marks

UNIT I

Artificial Intelligence: Definition and Study of AI Techniques - Problems and problem space, Al Characteristics — Heuristics - Forward and backward reasoning - Problem trees - Problem graph- Hill climbing - Search method - Problems reduction - Constraint satisfaction means and analysis - Game playing - Minimax algorithms Alphabetic heuristics.

UNIT II

Computer vision: Perception - Early processing - Representation and recognition at senses Guzman's algorithms of spurting objects in a scene - Waltz algorithm.

UNIT III

Natural Language understanding problems - Syntactic analysis - Semantic analysis - Augmented transition networks.

UNIT IV

Knowledge representation (Logic) - Representing facts in logic predicate logic — Resolution — Unification - Question answering - Mathematical theorem providing knowledge representation (structured) - Declarative representation - Semantic nets - Procedural representation.

UNIT V

Learning: Learning as Induction - Failure drive earning - Learning by teaching - Learning through examples (Winston's program) - Skill acquisition.

Suggested Reading:

1. Elarine Rich, *Artificial Intelligence*, McGraw Hill, 1985.
2. K.L.Nilson, *Principles of Artificial Intelligence*, Tiago Pub Company, Palo Alto, C.A, 1980.
3. P.H.Winston, *The Psychology of Computer vision*, McGraw Hill, 1975

EE3009 # Programmable Logic Controllers

Instruction	:	3 Periods / Week
Duration of Univ. Examination	:	3 Hours
SEE	:	70 Marks
CIE	:	30Marks

UNIT I

PLC Basics: Definition and History of PLC - PLC advantages and disadvantages - Over all PLC Systems - CPUs and Programmer Monitors - PLC input and output models - Printing PLC Information- Programming Procedures - Programming Equipment - Programming Formats- Proper Construction of PLC Diagrams - Devices to which PLC input and output modules are connected - Input on/off switching devices - Input analog devices - Output analog on/off devices and output analog devices.

UNIT II

Basic PLC Programming: Programming on/off inputs to produce on/off outputs - PLC input instructions - Outputs - Operational procedures - Contact and coil input/output programming examples - Relation of digital gate logic contact / coil logic - PLC programming and conversion examples - Creating ladder diagrams from process control descriptions - Sequence listings - Large process ladder diagram constructions.

UNIT III

Basic PLC Functions: General Characteristics of Registers - Module addressing - Holding registers - Input registers - output registers - PLC timer functions - examples of timer functions. Industrial applications - PLC counter functions.

UNIT IV

Intermediate Functions: PLC Arithmetic functions - PLC additions and subtractions - The PLC repetitive clock - PLC Multiplications, Division and Square Root - PLC trigonometric and log functions - Other PLC arithmetic functions - PLC number comparison functions. PLC basic comparison functions and applications - Numbering systems and number conversion functions - PLC conversion between decimal and BCD-Hexadecimals numbering systems.

UNIT V

Data Handling Functions: The PLC skip and master control relay functions - Jump functions - Jump with non return - Jump with return. PLC data move Systems - The PLC functions and applications. PLC functions working with bits - PLC digital bit functions and applications - PLC sequence functions - PLC matrix functions.

Suggested Reading:

1. John W. Weff, Ronald A. Reis, *Programmable Logic Controllers,* Prentice Hall of India Private Limited, Fifth edition, 2003.

EE3010 # Digital Signal Processing

Instruction	:	3 Periods / Week
Duration of Univ. Examination	:	3 Hours
SEE	:	70 Marks
CIE	:	30Marks

UNIT I

Introduction to Digital Signal Processing: Discrete time signals & sequences - Linear shift Invariant systems - Stability and causality- Linear constant coefficient difference equations - Frequency domain representation of discrete time signals and systems.

UNIT II

Discrete Fourier Series: Properties of Discrete Fourier Series - DFS representation of periodic sequences - Discrete Fourier Transforms- Properties of DFT - Linear convolution of sequences using DFT - Computation of DFT - Fast Fourier Transforms (FFT) - Radix-2 decimation in time and decimation in frequency FFT Algorithms inverse FFT.

UNIT III

Applications of Z-Transforms: Solution of difference equations of digital filters - System function - Stability criterion - Frequency response of stable systems - Realization of digital filters - Direct, Canonic, Cascade & Parallel forms.

UNIT IV

IIR Digital Filters: Analog filter approximations - Butterworth and Chebyshev - Design of IIR Digital filters from analog filters - Bilinear transformation method - Step & Impulse invariance techniques - Spectral Transformations.
FIR Digital Filters: Characteristics of FIR Digital Filters - Frequency response - Design of FIR filters using Window Techniques.

UNIT V

Introduction to digital signal processors: TMS320C5X architecture – CALU, ARAU, PLU, MMR, on chip memory, on chip peripherals, Digital signal processing applications.

Suggested Reading:

1. Proakis&Manolakis, *Digital Signal Processing Principles,* P Pub. 1994.
2. Sahivahanam, Valtavaraj&Gnanapariya, *Digital Sign Processing,* TMGH Pub. 2001.
3. Oppenheim &Sehaffter, *Digital Signal Processing,* PHI Pub.
4. S.K.Mitra, *Digital Signal Processing,* TMH, 1996.

EE3011 Digital Circuits and Logic Design

Instruction	:	3 Periods / Week
Duration of Univ. Examination	:	3 Hours
SEE	:	70 Marks
CIE	:	30Marks

UNIT I

Relay contacts-Analysis and synthesis of contact networks - Symmetric networks - Identification of symmetricfunctions-Combinational circuit design with Programmable Logic Array, Programmable Read-Only Memory and Programmable Array Logic.

UNIT II

Synchronous sequential circuit - Mealy and Moore models - Sequential circuit analysis - Synthesis of synchronous sequential circuits - Incompletely specified circuits.

UNIT III

Simplification of Sequential Circuits - State equivalence- State reduction in completely specified circuits using Inspection, Partitioning and Implication table - State reduction in incompletely specified sequential circuits using Merger diagrams.

UNIT IV

Types of Asynchronous Circuits- Analysis of Pulse-mode asynchronous circuits-Synthesis of pulse-mode asynchronous circuits-Analysis of fundamental-mode circuits-Synthesis of fundamental-mode circuits.

UNIT V

Introduction to Races, Cycles and Hazards - Avoidance of race conditions – Race-free state assignments and sequential logic circuit testing.

Suggested Reading:

1. Z.Kohavi, *Switching and Finite Automata Theory*, Tata McGraw Hill, 48th Reprint 2010.
2. 2. Victor P.Nelson, H.Troy Nagle, Bill D Caroll, J.David Irwin, *Digital Logic Circuit Analysis and Design*, Prentice Hall International, 1996.

ME2001 # Engineering Research Methodology

Instruction	:	3 Periods / Week
Duration of Univ. Examination	:	3 Hours
SEE	:	70 Marks
CIE	:	30Marks

UNIT I

Research Methodology: Objectives and Motivation of research – Types of Research– Research approaches – Significance of Research – Research Methods versus Methodology– Research and scientific method– Importance of research methodology – Research process – Criteria of good research – Problems encountered by Researchers in India – benefits to society in general.

Defining Research problem: Definition of research Problem– Problem formulation – Necessity of Defining the Problem – Techniques involved in defining a problem

UNIT II

Literature survey: Importance of Literature survey– Sources of information – Assessment of Quality of journals and articles – Information through internet.

Literature Review**:** Need of Review – Guidelines for Review – Record of Research Review.

UNIT III

Research Design: Meaning of research Design – Need of research design – Features of a good design– Important concepts relating to Research Design – Different research designs- Basic Principles of experimental designs - Developing a Research plan – Design of experimental set-up – Use of standards and codes

UNIT IV

Exploration of data: Analysis of data– Role of statistics for data analysis – Functions of statistics – Estimation of population parameters – Parametric Vs Non parametric methods – Descriptive statistics- Point of central tendency – Measures of variability – Inferential statistics – estimation – Hypothesis testing – Use of statistical software.

Data Analysis: Deterministic and random data – Uncertainty analysis- Tests for significance – Chi-square test – Student's 't' test – Regression modeling – ANOVA-F test – Time series analysis – Autocorrelation and Autoregressive modeling.

UNIT V

Research Report Writing: Format of research report – Style of writing report – Reference/ Bibliography / Webiliography – Technical paper writing – Journal report writing. Research Proposal Preparation: Writing a research Proposal and research Report – Writing a Research Grant proposal.

Suggested Reading:

1. C.R.Kothari, *Research methodology, Methods & technique,* New age international publishers, 2004.
2. R.Ganesan, *Research Methodology for Engineers* ,MJP Publishers: Chennai,2011.
3. DR.Vijay Upagade and Dr.Aravind Shende; *Research Methodology*; S.Chand& Company Ltd. New Delhi;2004

4. P.Ramdass and A.WilsonAruni; Research and Writing across the disciplines; MJP Publishers; Chennai 2009.