CHAITANYA BHARATHI INSTITUTE OF TECHNOLOGY
SCHEME OF INSTRUCTIONS- Dept. of EEE

III YEAR (2015-16 Academic year)

I SEMESTER

THEORY						
S.No	**Code**	**Subject**	**L**	**T**	**P**	**Credits**
1	EE 311	Power Systems – II	4	0	0	3
2	EE 312	Electrical Machinery – II	4	1	0	3
3	EE 313	Linear Control Systems	4	1	0	3
4	EE 314	Power Electronics	4	1	0	3
5	EE 315	Linear Integrated Circuits	4	0	0	3
6	CE 444	Human Values and Professional Ethics	2*	0	0	0
PRACTICALS						
7	EE 316	Electrical Machinery – I Lab	0	0	3	2
8	EE 317	Control Systems Lab	0	0	3	2
9	EE 318	Linear Integrated Circuits Lab	0	0	3	2
		TOTAL	**22**	**03**	**09**	**21**

*21 Periods per semester

II Semester

THEORY						
S.No	**Code**	**Subject**	**L**	**T**	**P**	**Credits**
1	EE 321	Electrical Machinery - III	4	1	0	3
2	EE 322	Switch Gear & Protection	4	0	0	3
3	EE 323	Microprocessor & Microcontrollers	4	0	0	3
4	EE 324	Digital Signal Processing	4	1	0	3
5	EE 351 EE 352 EE 353 EE 354	Elective – I 1. Electrical Engineering Materials 2. Optimization Techniques 3. Advanced Control System 4. Renewable Energy Systems	4	0	0	3
PRACTICALS						
6	EE 325	Power Electronics Lab	0	0	3	2
7	EE 326	Microprocessor & Microcontrollers Lab	0	0	3	2
8	EE 327	Electrical Machinery – II Lab	0	0	3	2
9	EE 328	Mini Project *	0	0	0	1
10		Industry Visit *	0	0	0	Grade
		TOTAL	**20**	**02**	**09**	**22**

* Only internal evaluation

SEM-I

EE 311 POWER SYSTEMS - II

Instruction	4 Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessional	25 Marks
Credits	3

Course Objectives

1. To understand Inductance and capacitance calculations for different line configurations
2. To understand per unit system representation in power systems.
3. To Understand the importance of transmission line representation in terms of short, medium and long lines in finding performance of lines
4. Understand the importance of symmetrical and un-symmetrical faults in power systems.

Course Outcomes: The student will be able to

1. Acquire knowledge in calculation of inductance and capacitance of lines
2. Acquire knowledge to represent the power system data in per unit and consider appropriate line models for specific study.
3. Acquire knowledge to find the performance of given line
4. Acquire knowledge to study different types of faults, and its relevance in relay settings.

UNIT-I

Line Parameter Calculations: Calculating Inductance & Capacitance of Transmission Lines, single phase and three phase symmetrical composite conductors, GMD, GMR, Transposition of conductors, Bundled conductors, effect of earth capacitance.

UNIT-II

Modeling of Transmission Lines: Short, medium, long lines, Line calculations, Tuned Lines, Surge impedance loading.

Corona: Causes, Disruptive and Visual Critical Voltages, Power loss, minimization of Corona effects.

UNIT-III

Per Unit System of Representation: Use of per unit quantities in power systems, Advantages of per unit system.

Symmetrical Faults: Short Circuit Currents, Reactance of Synchronous Machines, fault Calculations, Short circuit capacity of a bus.

UNIT-IV

Unsymmetrical Faults: Symmetrical components of unsymmetrical Phasors, Power in terms of symmetrical components, sequence impedance and sequence networks. Sequence networks of unloaded generators, Sequence impedances of circuit elements, Single line to ground, line-to-line and double line to ground faults on unloaded generator, Unsymmetrical faults of power systems.

UNIT-V

Transients in Power Systems: Causes of over voltages. Travelling Wave Theory, Wave equation, Reflection and refraction Coefficients, Junction of Cable and overhead lines, Junction of three lines of different natural impedances, Bewley Lattice diagram.

Text Books

1. C.L. Wadhwa, Electrical Power Systems, Wiley Eastern Ltd., 4dtEdition, 2006
2. I.J. Nagrath & D.P.Kothari Modern Power Systems Analysis, TMH Edition, 2003.

Suggested Reading

1. John J. Grainger William D.Stevenson Jr. Power System Analysis, Tata McGraw Hill Edn. 2003
2.A.Chakrabarti, M.L.Soni, P. V.Gupta, U.S.Bhatnagar, A Text book on Power System, Dhanpat Rai & Co (P) Ltd -1999.

EE 312 **ELECTRICAL MACHINERY-II**

Instruction	4L+1T Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessional	25 Marks
Credits	3

Course Objectives:

1. To study the principles of tap changing, tests and auto-transformer.
2. To understand different types of three phase induction motors.
3. To discuss about speed control and starting methods of three phase induction motors.
4.To analyze unbalanced operation of three phase induction motors and three phase transformers.
5. To familiarize the construction details, principle of operation, prediction of performance of single phase induction motors.

Course Outcomes: The student will be able to:

1. Apply basic principles of tap changing and auto-transformer.
2. Acquire knowledge about operation and performance analysis of three phase induction motors.
3. Obtain the concepts of speed control and starting methods of three phase induction motors.
4. Analyze unbalanced operation of three phase induction motors and three phase transformers.
5. Acquire the concept of single phase induction motors.

UNIT-I

Transformers: Cooling arrangement in Transformers. Testing of Transformers, Routine Tests and Special tests, Measurement of Voltage ratio and check for voltage vector relationship. Measurement of Insulation resistance. Maintenance of Transformers. Tap changer on transformers, No-load tap changer, On-load tap changer. Third harmonic voltages and tertiary winding in three phase transformers, Auto Transformer, Comparison with two winding transformers, Conversion of two winding transformer to auto transformer.

UNIT-II

Three-phase Induction Motor: Constructional features, Rotating Magnetic field theory, Principle of operation of squirrel cage and slip ring motors, Vector Diagram, Equivalent circuit, Expression for torque, Starting torque, Maximum torque, Slip/Torque characteristics, Performance characteristics, Equivalent circuits from test, Current loci circle diagram, Predetermination of characteristics of Induction Motors.

UNIT-III

Starting methods of Induction motors: Modes of operation, torque and power limits of Induction motors, Speed control methods, Resistance Control, Voltage control, pole changing, Cascading, variable frequency control, Slip power recovery schemes Kramer drive. Scherbius drive, Double cage Induction motors, Induction generator, Doubly fed Induction Generator.

UNIT-IV

Unbalanced Operation: Voltage Unbalance, Unbalanced Operation of 3-phase Induction Motor, Per Phase Equivalent Circuits, Single Phasing, Unbalanced Operation of 3-Phase Transformers, Single-phase load on Three-phase transformers Single Phasing in 3-phase transformers- Delta /Star and Star/Delta transformers.

UNIT-V

Single Phase motors: Single phase motors, Theory and operation of single phase motors, Shaded pole, Split phase and capacitor motors, Compensated and uncompensated series and repulsion motors. Linear Induction motors.

Text Books:

1. P.S. Bhimbra Electrical machinery, Khanna Publications, 7th edition, 2003.
2. Nagrath I.J & Kothari D.P, Electrical Machines, Tata McGraw Hill Publications, Sigma series, 2006.
3. H.Cotton, Advanced Electrical Technology, Wheeler & Co,7th edition, CBS publishers,2005.
4. Theory and performance of electrical machines by J.B Gupta ,S.K. Kataria & Sons,14th edition,2014.

Suggested Reading:

1. Juha Pyrho¨ nen, Tapani Jokinen and Valeria Hrabovcova, Design of rotating electricalmachines, John Wiley & Sons, Ltd. 2008.
2. Fitzgerald, Kingsley, Umans, Electric Machinery, Tata Mc-Graw Hill Publications, 6th edition, 2002.
3. Electrical machines by Ashfaq husain, Danpatrai and sons, 3nd edition, 2012

EE 313 LINEAR CONTROL SYSTEMS

Instruction	4L + 1T Periods per week
Duration of Semester Examination	3Hours
Semester Examination	75Marks
Sessional	25Marks
Credits	3

Course Objectives:

1. To understand different types of linear control systems and their mathematical modeling.
2. To study Stability analysis, both in time and frequency domains
3. To study the concepts of State space representation of Linear Time invariant systems (LTI)

Course Outcomes: The student will be able to:

1. Build different mathematical models for any LTI physical /electrical systems
2. Acquire the concepts of stability analysis in time and frequency domains , which is essential to analyze any system performance.
3. Apply the concepts of state space controls
4. Design conventional controllers and compensators used for closed loop performance.

UNIT I

Introduction: Concepts of control systems- Open loop and closed loop control systems and their differences, Different examples of control systems, Classification of control systems, Feedback Characteristics, Effects of feedback. Mathematical models, Differential equations, Impulse Response and transfer functions, Translational and Rotational mechanical systems, Analogous systems.

UNIT –II

Transfer Function Representation: Two Phase Serve motor characteristics, Transfer Function of DC and AC Servo motor, Potentiometers, Synchro transmitter and Receiver, Tacho generator, Stepper Motor characteristics, Block diagram algebra, signal flow graphs and problems.

UNIT –III

Time Response Analysis: Standard test signals, Time response of first/second order systems, Transient response of second order system for step input. Time domain specifications, Types of systems, static error coefficients, Routh-Hurwitz criterion of stability, Root locus technique, Typical systems analyzed by root locus technique, Effect of location of roots on system response, PID Controllers.

UNIT IV

Frequency Response Analysis: Introduction, Frequency domain specifications for a second order system, Bode plots, Stability Analysis from Bode plots. Polar plots, Nyquist criterion for stability. Compensation techniques, Lag, Lead, Lead-Lag Controllers design in frequency domain.

UNIT V

State Space Representation: Concept of state, state variable, state models of linear time invariant systems, Derivation for state models from transfer functions and differential equations, State transition matrix-solution of state equations by time domain method. Obsevability and Controllability, Introduction to discrete control systems.

TEXT BOOKS:

1. I.J.Nagrath, M.Gopal, Control System Engineering, New Age International (P) Limited Publishers, 5th Edition, 2008.
2. B.C. Kuo, Automatic Control Systems, John wiley and son's Publishers, 9th edition, 2009
3. K.Ogata, Modern Control Systems, 5th Edition.PHI publication, 2010.
4. A. Anand Kumar, Control Systems, 2nd Edition, PHI publications, 2014.

Suggested Reading:

1. M.Gopal, Control Systems Principles and Design- Tata McGraw Hill, 2nd Edition, 2003.
2. N.C Jagan-control Systems, 2nd Edition, BS Publications, 2008
3. N. Nise, Control Systems Engineering, 6th edition, Willey Publications, 2011.
4. Linear Control System analysis and design with MATLAB, Taylor & Francis D'Azzo- Control Systems, 2009

EE 314 **POWER ELECTRONICS**

Instruction	4L+1T Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessional	25 Marks
Credits	3

Course Objective:

1. To introduce the characteristics of various power semiconductor switches and their applications.
2. To make acquainted with the operating principles of AC-DC, DC-DC, AC-AC and DC-AC converters, methods of voltage control and converters applications.

Course Outcomes: The student will be able to:

1. Analyze basic operation of various power semiconductor devices and to compare their characteristics.
2. Design protection circuit and control circuits for SCR.
3. Analyze the operation principles of different AC-DC, DC-DC, AC-AC, and DC-AC converters.
4. Identify different topologies of converters.

UNIT-I

Power Diodes and Transistors: Power diode, characteristics, Recovery characteristics, Types of power diodes, General purpose diodes, Fast recovery diodes, their applications. Bipolar Junction Transistors(BJT), Power MOSFETs, IGBTs-Basic structure and working, Steady state and switching characteristics, Comparison of BJT, MOSFET and IGBT, Their applications.

UNIT-II

Silicon Controlled Rectifier (SCR): SCR-Static characteristics, Two transistor analogy, Protection of SCRs, Dynamic characteristics, Series and parallel operation of SCRs, SCR trigger circuits-R, RC and UJT triggering circuits, Commutation methods of SCR.

UNIT-III

Principles of phase controlled converters: Study of Single-phase and three-phase half wave and full wave controlled rectifiers with R, RL, RLE loads, significance of freewheeling diode, Effect of source inductance, Dual converters - circulating and non circulating current modes.

UNIT-IV

DC-DC Converters: Principles of Step-down, Step-up, Step UP/Down choppers, Time ratio control and current limit control, Types of choppers Type- A, B, C, D and E, Introduction to Buck, Boost and Buck-Boost regulators.

AC-AC Converters:

Principle of operation of Single phase Cyclo-converters and their applications. Single-phase AC Voltage Controllers with R and RL loads.

UNIT-V

Inverters: Principle of operation of Single-phase Inverters, Voltage control methods, Single pulse width modulation, Multiple pulse width modulation, Sinusoidal pulse width modulation, Comparison of Voltage Source Inverters and Current Source Inverters, Three-phase bridge Inverters, 180^0 & 120^0 modes of operation.

Text Books:

1. Singh.M.D and Khanchandani.K.B,Power Electronics, Tata McGraw Hill, 2nd Edition, 2006.
2. Rashid.M.H. Power Electronics Circuits Devices and Applications. Prentice Hall of India, 2003
3. Bimbra.P.S, Power Electronics, Third Edition, Khanna Publishers, 2013

Suggested Reading:

1. Mohan, Undeland , Robbins, Power Electronics, John Wiley, 1996.
2. P.C.Sen, Power Electronics, Tata Mc-Graw Hill, 1st Edition, 2001.

EE 315 LINEAR INTEGRATED CIRCUITS

Instruction	4 Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessional	25 Marks
Credits	3

Course Objectives:

1. To study the characteristics of operational amplifiers, stability, basic applications such as integrator, differentiator etc.,
2. To study the different applications of operational amplifiers in voltage limiter, Schmitt trigger, instrumentation circuits.
3. To study the concepts of waveform generation, sine, square, triangular using op-amps.
4. To study the operation of 555 timer as a monostable and an astable multivibrator.
5. To study different types of voltage regulator, Filters and their characteristics.

Course Outcomes: The student will be able to:

1. Understand the basic characteristics of op-amps and their significance.
2. Analyze a typical op-amp equivalent circuit by calculating its voltage gain and input resistance.
3. Define stability for a amplifier circuit.
4. Analyze an instrumentation amplifier circuit and discuss its applications.
5. Analyze higher order filter circuits and explain their significance.
6. Analyze and design voltage regulators (Fixed voltage and adjustable voltage).

UNIT-I

Operational Amplifiers Characteristics: open loop voltage gain, output impedance, input impedance, common mode rejection ratio, Offset balancing techniques, Slew rate, Frequency response, Stability, frequency compensation of Op-amp.

Basic OP-Amp Applications: inverter summer, analog integrator, differentiator, current to voltage converter, voltage to current converter, voltage follower, ac amplifier.

UNIT-II

OP-Amp Applications: Voltage limiter, clipper & clamper, precision rectifier, full wave and half wave, peak detector, comparator, zero crossing detector, Schmitt trigger, monostable, astable, bistable multiplier, divider, difference amplifier instrumentation amplifier circuits using Op-amps.

UNIT-III

Waveform Generation using Op-Amps: Sine, Square, Triangular and Quadrature oscillators, voltage controlled oscillator / multi vibrator, voltage to frequency converter, 555 timer functional diagram, operation as monostable and astable. phase locked loop, A/D and D/ A converters.

UNIT-IV

Voltage Regulators: Series voltage regulator using Op-amp, shunt regulators using Op-amp, switching regulators using Op-amp, dual voltage regulator, fixed voltage regulators, dual tracking regulators, hybrid regulator, current sensing and current feedback protection.

UNIT-V

Filters: RC active filters, low pass, high band pass, band reject, notch, first order, second order transformation, state variable filter, switched capacitor filter, universal filter, Balanced modulator/ demodulator.

Text Books:

1. D.Roy Choudhury, Linear Integrated Circuits, Shail B.Jain, 3rd Edition, New Age International(P) Ltd., 2007.
2. Malvino Albert Paul, Electronic Principles, 7th Edition, Tata McGraw Hill, 2006
3. Coughlin and Driscoll, Operational Amplifiers and Linear integrated Circuits, 6th Edition, Prentice hall of India 2003.

Suggested Reading:

1. Gayakwad R.A. Op-Amps and Linear Integrated Circuits, 4th Edition, Prentice Hall of India, 2002.
2. David A. Bell, Operational Amplifiers and Linear IC s, PHI, 2003.

CE 444 HUMAN VALUES AND PROFESSIONAL ETHICS

Instructions	: 21 Periods per semester (7*3)
Duration of University Examination	: 2 Hours
University Examination	: 50 Marks
Sessional	: Nil
Credits	: Nil

Course Objectives:

1. To develop the critical ability among students to distinguish between what is of value and what is superficial in life
2. To enable the students understand the values, the need for value adoption and prepare them meet the challenges
3. To enable the students develop the potential to adopt values, develop a good character and personality and lead a happy life
4. To motivate the students practice the values in life and contribute for the society around them and for the development of the institutions /organisation around they are in.
5. To make the students understand the professional ethics and their applications to engineering profession

Course Outcomes

1. Students develop the capability of shaping themselves into outstanding personalities, through a value based life.
2. Students turn themselves into champions of their lives.
3. Students take things positively, convert everything into happiness and contribute for the happiness of others.
4. Students become potential sources for contributing to the development of the society around them and institutions / organisations they work in.
5. Students shape themselves into valuable professionals, follow professional ethics and are able to solve their ethical dilemmas.

UNIT-1 Concepts and Classification of Values –Need and challenges for value Adoption

Definition of Values – Concept of Values – Classification of Values – Hierarchy of Values – Types of Values –Espoused and Applied Values – Value judgement based on Culture – Value judgement based on Tradition – Interdependence of Values

Need for value education – Findings of Commissions and Committees - Corruption and illegal practices – Science and Technology without values- Exploitation of nature – Increasing use of violence and intoxicants – Lack of education in values – Implications of education in values – Vision for a better India

Challenges for Value adoption – Cultural, Social, Religious, Intellectual and Personal challenges

UNIT – 2: Personal Development and Values in Life

Personal Development: Enlightened self-interest – Accountability and responsibility – Desires and weaknesses – Character development – Good relationships, self-restraint, Spirituality and Purity – The quest for Character – Tests of Character – The key to good character

Values in Life: Building an ethical policy – Integrating values in everyday life – Archaic Social Values – Parenting practices – Critical Thinking - Analyzing and Prioritizing values – Practicing Yoga and Meditation

UNIT – 3: Practicing Values for the development of Society

Resentment Management and Self-analysis – Positive Thinking and Emotional Maturity – The importance of Women , Children and Taking care of them – Helping the poor and needy – Fighting against addictions and atrocities – Environmental awareness – Working for the Sustainable development of the society

Values in Education system: Present Scenario- Engineering education –Current trends- Need for quality improvement- Adoption of value education – Principles of Integrity-Institutional Development.

UNIT – 4: Basic Concepts of Professional Ethics

Ethics, Morals and Human life , Types of Ethics, Personal Ethics, Professional ethics, Ethical dilemmas, Indian and Global thoughts on ethics, Profession, Professional and Professionalism, Ethical role of a professional Basic ethical principles, Some basic ethical theories, use of ethical theories.

Science, Religion Ethics, Genders and ethics, Media and ethics, Computer Ethics, Case Studies on Professional Ethics, Exemplary life sketches of prominent Indian personalities

UNIT-5: **Ethics in engineering profession**

Engineering profession-Technology and Society-Engineering as Social Experimentation-Engineering ethics-Ethical obligations of Engineering Professionals-Role of Engineers-Engineers as Managers-Professional responsibilities of Engineers- Engineers Responsibility for Safety- A few Case Studies on Risk management

Conflicts of Interest- Occupational Crimes- Plagiarism-Self plagiarism-Ethics Audit-Consideration for ethics audit-Ethics Standards and Bench Marking

Text Books:

1. Subramanian R., " Professional Ethics " , Oxford University Press , 2013
2. Nagarajan R.S., " A Text Book on Human Values and Professional Ethics " New Age Publications , 2007
3. Dinesh Babu S., " Professional Ethics and Human Values " , Laxmi Publications , 2007

Reference Books:

4. SantoshAjmera and Nanda Kishore Reddy " Ethics , Integrity and Aptitude " ,McGrawhill Education Private Limited , 2014
5. GovindaRajan M., Natarajan S., Senthil Kumar V.S." Professional Ethics and Human Values " Prentice Hall India Private Limited ,2012
6. Course Material for Post Graduate Diploma In "Value Education & Spirituality " Prepared by Annamalai University in Collaboration with Brahma Kumaris , 2010

EE 316 ELECTRICAL MACHINES I LAB

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessional	25 Marks
Credits	2

Course Objectives:

1. To understand the performance & Load characteristics of different types of DC generators & Motors.
2. To understand the procedure to separate core losses in a single phase transformer, perform OC and SC test on transformer and conduct Sumpner's test on two identical transformers.
3. To understand the procedure to estimate the efficiency of DC machine by Hopkinson test.
4. To understand the control procedure and vary speed of DC shunt motor.

Course Outcomes: The student will be able to:

1. Acquire requisite knowledge to evaluate and compare the characteristics and performance aspects of different types DC generators and motors by conducting suitable tests.
2. Acquire knowledge to analyze the single phase transformer by performing the suitable tests.
3. Gain practical knowledge to know different losses and efficiency in DC machine and their dependence on other parameters such as speed, field current etc., and also calculate efficiency at different loads.
4. Gain knowledge to perform speed control of DC shunt motor

List of Experiments:

1. Magnetization characteristics and the speed verses voltage curve of separately and self excited D.C. generator
2. Load characteristics of separately excited and self excited Shunt Generators
3. Load characteristics of DC Compound generator

4. Performance characteristics of Series Motor
5. Swinburne's Test & Performance characteristics of D.C. shunt motor.
6. Performance characteristics of DC Compound motor

7. Separation of iron and friction losses and estimation of parameters in D.C. machines.
8. Speed control of D.C. shunt motor by shunt field control and armature resistance control
9. Separation of core losses in a Single Phase transformer

10. Open circuit and short circuit tests on a Single Phase transformer

11. Sumpner's test on two identical transformers
12. Estimation of efficiency of DC Machine by Hopkinson test.
13. Retardation Test, Dynamic Braking of DC Shunt Motors.

Note: ATLEAST 10 EXPERIMENTS SHOULD BE CONDUCTED IN THE SEMESTER

EE 317 CONTROL SYSTEMS LAB

Instruction	3 Periods per week
Duration of Semester Examination	3 Hours
Semester Examination	50Marks
Sessional	25Marks
Credits	2

Course Objectives:
1. To understand the characteristics of DC, AC Servo Motors and synchro pair.
2. To understand the frequency response of compensating networks.
3. To study the closed loop performance for given plant using
   i) P, PI and PID controllers ii) ON/OFF controller.

Course Outcomes: The student will be able to
1. Obtain DC, AC Servo Motors and Synchro pair characteristics.
2. Design, Analyse and Simulate performance of a given second order plant from frequency and time response point of view.
3. Gain knowledge in visualizing the designing, functioning and simulation of compensators in improving the stability of the system.
4. Acquire knowledge in analyzing the performance of P, PI, PID and ON/OFF controller and to distinguish the merits and de-merits of different types of controllers in closed loop environment.

List of Experiments:

PART A

Any Eight of the following experiments are to be conducted
1. Characteristics of D.C Servo motor.
2. Characteristics of A.C. Servo motor.
3. Characteristics of Synchro Pair.
4. Step response of second order system.
5. Frequency response of compensating networks.
6. Closed loop P, PI and PID Controller for temperature of a given plant.
7. Step response and Frequency response of a given plant.
8. Level Control system.
9. Temperature control system - ON/OFF Control.
10. a) Characteristics of magnetic amplifier.
    b) Step angle measurement for Stepper motor.
11. System simulator.

PART B

Any Two of the following simulation experiments are to be conducted using MATLAB
1. Stability Analysis (Root locus, Bode and Nyquist) for Linear Time Invariant systems.
2. a) Determining the Time Domain specifications for a second order system.
   b) Determining the Frequency Domain specifications for a second order system.
3. State space model for a given classical transfer function and its verification.
4. Compensator design (lag, lead and lag-lead).

EE 318

LINEAR INTEGRATED CIRCUITS LAB

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessional	25 Marks
Credits	2

Course Objectives:

After completing the lab course, the students will be able to

1. Analyze and design various applications of Op-Amp
2. Design and construct waveform generation circuits
3. Design and implement timer and analog and digital circuits using op amps.
4. Design and implement combinational logic circuits using digital IC's
5. Design and implement Active Filters, such as Low pass, High Pass, Band Pass for various cut off frequencies.

Course Outcomes:

The student will be able to:

1. Design and conduct experiments using op-amps, as well as analyze and interpret result.
2. Design basic application circuits using op-amp.
3. Analyze circuits for inverting and non-inverting amplifiers, diff. amps and comparators.
4. Recognize and make use of the DC & AC limitations of OP-AMPS.
5. Understand and implements the working of basic digital circuits.

LIST OF EXPERIMENTS:

PART – A

I. Generation of triangular, sine and square wave using IC's.
2. PLL (Phase locked loop).
3. Design of astable multi-vibrator using 555 timer.
4. Active filters.
5. Instrumentation amplifier-Sample and hold circuit.
6. Design of integrator and differentiator using Op-Amp.
7. Clippers and clampers using Op-Amps.
8. Monostable operation using IC's.
9. Boot-strap sweep circuit using Op-Amp.

PART – B

1. Multiplexer-application for logic realization and parallel to serial Conversions.
2. Synchronous counters. .
3. Asynchronous counters.
4. Half adder, full adder and subtractor and realization of combinational logic.
5. A/D converters.
6. D/ A converters.

Note: At least **SIX experiments** from **PART-A** and **FOUR** from **PART-B** should be conducted in the semester.

SEM-II

EE 321

ELECTRICAL MACHINERY-III

Instruction	4L+1T Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessional	25 Marks
Credits	3

Course Objectives:

1. To study the principles of synchronous machines
2. To understand different types of alternator regulation methods for wound rotor, salient pole types and about their parallel operation.
3. To discuss about synchronous motor performance and its starting methods.
4. Impart knowledge about transient behavior of synchronous machines and their stability
5. To familiarize the construction details, principle of operation, prediction of performance of Electrical special machines

Course Outcomes: The student will be able to:

1. Apply basic principles of synchronous machines
2. Acquire knowledge about operation, regulation and parallel operation of alternators
3. Obtain the concepts of synchronous motor and stability analysis of synchronous machines
4. Acquire the concept of Electrical permanent magnet and special machines.

UNIT-I

Synchronous Machines: Constructional Details, Types of windings, Winding factors, e.m.f. equation, Fractional pitch and fractional slot windings, Suppression of harmonics and tooth ripple, Armature reaction and reactance, Synchronous impedance.

UNIT-II

Synchronous Machine Design: Output equation, Main dimensions, short Circuit Ratio (SCR). Length of air gap calculation, selection of armature slots, design of field system and design of turbo alternators.

UNIT-III

Synchronous Generator: Voltage Regulation, Phasor diagram of alternator with nonsalient poles, O.C. and S.C characteristics, Synchronous impedance, Ampere turn, ZPF methods for finding regulation, Principle of two reaction theory and its application for the salient pole synchronous machine analysis, Synchronism and parallel operation.

UNIT-IV

Synchronous Motor: Theory of operation, Vector diagram, Variation of current and power factor with excitation, Hunting and its prevention, Current and power diagram Predetermination of performance, Methods of Starting and Synchronizing. Synchronizing Power, Synchronous Condenser.

UNIT-V

Special Machines: Permanent Magnet Motors, Switched Reluctance Motors, Hysteresis Motors, Stepper motor and BLDC motor.

Text Books:

1. P.S. Bhimbra Electrical machinery, Khanna Publications, 7th edition, 2003.
2. Nagrath I.J & Kothari D.P, Electrical Machines,Tata McGraw Hill Publications, Sigma series, 2006
3. H.Cotton, Advanced Electrical Technology, Wheeler & Co,7th edition, CBS publishers,2005.
4. J.B Gupta ,S.K. Kataria & Sons, Theory & performance of electrical machines,14th edition, 2014.

Suggested Reading:

1. Juha Pyrho¨ nen, Tapani Jokinen and Valeria Hrabovcova, Design of rotating electrical machines, John Wiley & Sons, Ltd. 2008
2. Fitzgerald, Kingsley, Umans, Electric Machinery, Tata Mc-Graw Hill Publications, 6th edition, 2002
3. Ashfaq husain, Danpatrai and sons, Electrical machines, 3nd edition, 2012

With effect from the academic year 2015-2016

EE322 **SWITCHGEAR AND PROTECTION**

Instruction	4 Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessional	25 Marks
Credits	3

Course Objectives:

1. To analyze principles of operation of the different types of relays.
2. To comprehend the different principles of protective schemes in power system.
3. To understand the principles of operation of the different types of circuit breakers.
4. To be acquainted with different lightning arrestors and the appropriate circuit for the protection of the various components of power system

Course Outcomes: The student will be able to

1. Know various components used in relays.
2. Design the relay settings of over current and distance relays.
3. Understand arc quenching mechanisms used in different circuit breakers.
4. Comprehend the concept of unit and non-unit protection, and how the various associated parameters affect it.

Unit – I

Protective relays: Need for protection, Backup protection, Zones of protection, Definitions of relay pickup, dropout and reset values, Classification of relays, Operating principles and construction of electromagnetic and induction relays, Over current, Over voltage and Power relays, Directional features, Universal relay torque equation. Over current protection for radial feeders and ring mains, Protection of parallel lines, Relay settings for over Current relays, Earth fault and phase fault protection.

Unit – II

Static phase and Amplitude comparators, Characteristics of Dual input comparators, Distance protection, 3-step Distance relays, Characteristics Distance relays on the RX diagram, Sampling comparator, static over current relay, Microprocessor based over current relaying, Need of numerical relays, Advantages of numerical relays over solid state relays, Fundamentals of numerical relays, Functional block diagram of numerical relay.

Unit – III

Transformer and generator protection, Differential relays, Percentage differential relays, Protection of generator and transformer using percentage differential relays, Split phase, Inter turn protection, Overheating, Loss of excitation, Protection of generators, Protection of transformers against magnetizing inrush, Buchholz relay, Protection of earthing transformers, Generator transformer unit protection.

Unit – IV

Circuit breakers, Need for circuit breakers, Arc Properties, Principles of arc quenching theories, Recovery and Restriking voltages, Definitions in circuit breakers, Rated symmetrical and restricting asymmetrical breaking current, Rated making current, Rated capacity, Voltage and Frequency of circuit breakers, Current chopping, Resistance switching, Derivations of RRRV, Maximum RRRV etc., Circuit breaker calculations, Types of circuit breakers, Oil, Poor oil, Air, Air blast, SF6 and Vacuum circuit breakers, Testing of circuit breakers.

Unit – V

Over voltage protection, Protection of transmission lines against direct lightening strokes, Ground wires, Protection angle, Protection zones, Height of ground wire, Conductor clearances. Conductor heights, Tower footing resistance and its effects, Equipment protection assuming rod gaps, Arcing horns, Different types of lightening arrestors, Their construction, Surge absorbers, Peterson coil, Insulation coordination.

Text Books:

1. C.L. Wadhwa, Electrical Power System, Wiley Eastern Ltd., 2nd Edition, 2013
2. Badriram & Viswakarma, Power System Protection and Switchgear, Tata McGraw Hill, 2011.
3. Sunil S. Rao Switchgear and Protection, Khanna Publications, 2008
4. J.B. Gupta, Switchgear and protection, S.K. Kataria& Sons, 3rd Edition, 2014.

Suggested Reading:

1 B. Ravindranath, M. Chander , Power System Protection and Switchgear, New Age International, 2011.

2 OZA, Power System Protection and Switchgear, Tata McGraw Hill, 2010.

With effect from the academic year 2015-2016

EE 323 MICROPROCESSORS AND MICROCONTROLLERS

Instruction	4 Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessional	25 Marks
Credits	3

Course Objectives:

1. To understand the Fundamentals of 8086 Microprocessors and its Programming.
2. To study the Interfacing of 8086 microprocessors using its various ports.
3. Fundamentals of 8051 Microcontroller, programming and its interfacing.

Course Outcomes: The student will be able to:

1. Understand the internal Architecture of both 8086 processor and 8051 microcontroller
2. Write assembly language programs on his own after gaining through knowledge of Instruction set.
3. Know how to establish communication between the processor/controller and peripheral devices.

UNIT I

Introduction to Microprocessor and 8086 Microprocessor: Fundamentals of a microprocessor and its evolution, Architecture of 8086 Microprocessor- Segmented memory, Addressing modes, Instruction set, Pin diagram, Minimum and Maximum mode operations.

UNIT –II

Programming using 8086 Microprocessor: Assembly language programming (i.e. machine language programming), Assembler directives, simple programs using Assembler directives, strings, procedures, and Macros Timing.

UNIT –III

Interfacing with 8086 Microprocessor: Memory and I/O interfacing, A/D and D/A interfacing, 8255(PPI), Programmable Internal Timer (8253), Keyboard and display interface 8279, interrupts of 8086.

UNIT IV

Introduction to 8051 Microcontroller and its Programming: 8051 Microcontroller and its Architecture, I/O ports, Instruction set, Assembly language programming, connecting External memory.

UNIT V

Interfacing with 8051 Microcontroller, interrupts and special function registers: Interrupts, serial I/O, Timers, Counters, Applications of microcontrollers-Interfacing LEDs, Seven Segment display, Keyboard Interfacing, Induction to PIC Microcontroller.

Text Books:

1. A.K.Ray and K.M.Burchandi**,** 'Advanced Microprocessors and peripherals' - Tata McGraw Hill Co., 2006

2. Mohammad Ali Mazidi and Janice Gillespie Mazidi"- The 8051 Microcontroller and Embedded Systems"
using assembly and 'c'—prentice hall of India, 2008

Suggested Reading:

1. Douglas. V.Hall- Microprocessors and Interfacing – Tata McGraw Hill- revised edition,2006.
2. Krishna Kant – Microprocessors and Microcontrollers-Architecture, Programming and System Design 8085, 8086, 8051, 8096, Prentice – Hall India- 2007.
3. Kenneth.J. Ayala – "The 8051 Microcontroller Architecture, Programming and Applications ", Thomson publishers, 2nd edition.

With effect from the academic year 2015-2016

EE 324 **DIGITAL SIGNAL PROCESSING**

Instruction	4 Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessional	25 Marks
Credits	3

Course Objectives:

1. To introduce basic concepts of signals and systems and representation of digital system.
2. To discuss DFT, DTFT, FFT, IFFT and Z transformation for the digital system analysis.
3. To make students familiar about design concepts of FIR and IIR filters.
4. To introduce digital signal processor.

Course Outcomes: The student will be able to:

1. Identify the digital system and find its response.
2. Apply DFT, DTFT, FFT,IFFT and Z transformation to analyze the digital system.
3. Design FIR and IIR filter.
4. Be familiar with architecture and features of TMS 320F/2047 DSP.

UNIT-I

Introduction to Digital Signal Processing: Classification of Signals & Systems. Linear shift invariant systems, stability and causality, Sampling of Continuous signals, Signal Reconstruction, quantizing & encoding, linear constant co-efficient difference equations, properties of discrete system- linearity.

UNIT-II

Fourier Analysis: Distinguishing Fourier transform of discrete singular & discrete Fourier transform, Discrete Fourier series, Phase and amplitude spectra, Properties of Discrete Fourier Transform, Linear Convolution of sequence using DFT, Frequency domain representation of discrete time system DTFT and DFT, Computation of DFT. Fast Fourier transform: Radix-2 decimation in time and decimation in frequency FFT algorithms, Inverse FFT.

UNIT-III

Z- Transform: Application of Z- Transforms for solution of difference equations of digital filters system function, stability criterion, Realization of filters, direct, canonic. Cascade and parallel form, linear phase realization, Introduction to Cosine Transform and Wavelet Transform.

UNIT-IV

IIR Filters: Design of Butterworth Chebyshev filters, IIR. filter design by impulse invariant bilinear transformation, impulse invariance method, step invariance method

UNIT-V

FIR Filters: Characteristics of FIR Digital Filters. Frequency response, comparison of FIR, IIR filters, Window techniques, Design of these filters using Rectangular, Hamming, Bartlet, Kaiser windows, Architecture and features of TMS 320F/2047 and ADSP signal processing chips, Applications of DSP.

Text Books:

1. P. VenkataRamani, M.Bhaskar, "Digital Signal Processo1; Architecture, Programming & Application ", TataMcGrawHill-2004
2. Avatar Singh, S.Srinivasan, "Digital Signal Processing, Thomson Publication, 2004.
3. Lafley," DSP Processing. fundamentals. architecture & features. S.Chand publishers & Co. 2000.
4. Johan G Peoahis, Dimitris G Manolakis, Digital signal processing, 5th eidition, Pearson prentice Hall, 2007

Suggested Reading:

1. Jackson L.B. Digital Filters and Signal Processing. Second edition, Kluwer Academic Publishers, 1989.
2. Oppenheim A V, and Schafer R. W. Digital Signal Processing –Prentice Hall Inc. 1975.
3. Tarun Kumar Rawat Digital Signal Processing first edition Oxford higher education, 2015
4. Anand kumar A, Digital Signal Processing, Second edition PHI learing, 2015.

With effect from the academic year 2015-2016

EE 325 **POWER ELECTRONICS LAB**

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessional	25 Marks
Credits	2

Course Objectives:

1. To obtain and plot the characteristics of different static switches.
2. To design the triggering and commutation circuits for SCR.
3. To observe the effect of freewheeling in converters.
4. To familiarize the conversion principle of AC-DC, DC-DC, DC-AC and AC-AC conversion circuits and their applications.
5. To be acquainted with simulation of different power converters.

Course Outcomes: The student will be able to

1. Analyze the effects of control signals on static switches.
2. Distinguish the characteristics of different controlled switches and their applications.
3. Demonstrate the effects of freewheeling.
4. Acquainted with the conversion principles of AC-DC, DC-DC, DC-AC and AC-AC converters
5. Know how to use the simulation software to design different power electronic circuits.

PART-A

1. S.C.R. Characteristics
2. BJT, MOSFET and IGBT Characteristics
3. Gate triggering circuits for SCR using R, RC and UJT.
4. Single phase step down Cycloconverter with Rand RL loads.
5. A.C voltage controllers with R and RL loads.
6. Study of forced commutation techniques.
7. Two quadrant D.C drive.
8. Single phase fully controlled bridge rectifier with Rand RL loads.
9. Single phase half controlled bridge rectifier with Rand RL loads.
10. Buck and Boost choppers.
11. Study of 1 kVA UPS and SMPS for variable voltage with constant load, Constant voltage with variable load.
12. V/f control of AC drive.
13. Single phase inverter with R and RL Loads.

PART-B

1. Simulation of Single phase Full converter and Semi converter.
2. Simulation of Three phase Full converter and Semi converter.
3. Simulation of Single phase Inverter.
4. Simulation of Three phase Inverter.
5. Simulation of Single phase AC voltage controller.
6. Simulation of Single phase Cycloconverter.
7. Simulation of Single phase Inverter with single, multiple and sinusoidal pulse width modulations.

Note: At least **SEVEN experiments** from **PART-A** and **THREE** from **PART-B** should be conducted in the semester.

With effect from the academic year 2015-2016

EE 326 MICROPROCESSORS & MICROCONTROLLERS LAB

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessional	25 Marks
Credits	2

Course Objectives:

1. To write and execute simple programs using MASM software tool.
2. To get the students acquainted with the processor kit and improve their Programming skills
3. To make the students work with controller and understand how to program and get the desired output in different platforms.

Course Outcomes: The student will be able to:

1. Have command over basic assembly language programming.
2. Get familiarized with different assembly language software tools.
3. Know how a processor/controller will communicate with the External world

List of Experiments

For 8086Microprocessor:

Section 1: Using MASM/TASM (**Any 3 of** the below mentioned Expts. are to be conducted in this Section)

1. Programs for signed/unsigned multiplication and division.
2. Programs for finding average of N 16-bit numbers.
3. Programs for finding the largest number in an array.
4. Programs for code conversion like BCD numbers to 7-Segment.
5. Programs for computing factorial of a positive integer number.

Section 2: Using 8086 Kit(Interfacing) (**Any 2 of** the below mentioned Expts. are to be conducted in this Section)

1. 8255-PPI: Write ALP's to generate triangular, saw-tooth and square waveforms using DAC.
2. 8279-Keyboard Display: Write a small program to display a string of characters.
3. Write an ALP to display some alpha-numeric characters on a seven-segment display module.
4. Traffic Signal Controller.

For 8051 Microcontroller:

Section 3: Using 8051 Kit (**Any 3 of** the below mentioned Expts. are to be conducted in this section)

1. Data Transfer - Block move, Exchange, sorting, Finding largest element in an array.
2. Arithmetic Instructions :Multi byte operations
3. Boolean & Logical Instructions (Bit manipulations)
4. Use of JUMP and CALL instructions.
5. Programs to generate delay and programs using serial port and on chip timer/counter.

Section 4: Program Development using 'c' cross compiler for 8051 (**Any 2 of** the below mentioned Expts. are to be conducted in this section).

1. DAC interfacing for Generation of Sinusoidal Waveform.
2. Stepper motor control(clockwise and anticlockwise directions)
3. Interfacing of Keyboard and 7-segment Display Module.
4. ADC interfacing for temperature monitoring.

Major Equipment required for the LAB:

1. 8086 Microprocessor trainer kit(s) with in-built assembler/disassembler
2. 8051 Microcontroller trainer kit(s)
3. Interfacing Modules for both 8086 and 8051.
4. MASM Software and Kiel/Ride Cross-'c' compiler Software.

EE 327 ELECTRICAL MACHINES II LAB

Instruction	3 Periods per week
Duration of University Examination	3 Hours
University Examination	50 Marks
Sessionals	25 Marks
Credits	2

Course Objectives:

1. To understand thoroughly Scott connection
2. To comprehend principles of regulation of alternator
3. To become familiar in operating the induction motor with various speed control methods.
4. To analyse the performance of three phase induction motor

Course Outcomes: The student will be able to:

1. Identify the suitable technique to be adopted for the analysis three phase transformer.
2. Become familiar with simulation aspects of A.C machines analysis.
3. Know the right A.C machine and its usage for a given load application

List of Experiments:

1. Three phase to Two-phase conversion (Scott connection).
2. Heat run test on Three-phase transformer.
3. No-load test blocked rotor test and load test on 3-phase Induction motor.
4. Speed control of Three-phase Induction motor by any three of the following.
   a. Cascade connection b. Rotor impedance control c. Pole changing
   d. Rotor slip recovery, Kramer drive e. V/f control.
5. Parallel operation of Alternators.
6. Performance characteristics of Single-phase Induction motor.
7. Voltage regulation of Alternator by

a. Synchronous impedance method b. Ampere-turn method. c. Z.P.F. Method.

8. Regulation of Alternator by slip test.
9. Determination of V curves and inverted V curves of synchronous motor.
10. Power angle characteristics of a synchronous motor.
11. Load characteristics of Induction Generator.
12. P.F Improvement of Induction motor using capacitors.

Note: ATLEAST 10 EXPERIMENTS SHOULD BE CONDUCTED IN THE SEMESTER

With effect from the academic year 2015-2016

EE 351 ELECTRICAL ENGINEERING MATERIALS
(Elective -I)

Instruction	4 Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessional	25 Marks
Credits	3

Course Objectives: After the completion of the course the students should be able to:

1. Analyze the mechanical, magnetic and the electrical properties of materials.
2. Select materials for various engineering application.
3. Establish how failures occur in materials and how to prevent them.

Course Outcomes: The student will be able to

1. Classify the given material based on its properties.
2. Select a proper material for a given application.

UNIT I:

Conducting Materials: Electrical conducting Materials, High conductivity materials, Materials of High Resistivity, Materials used for precision work, rheostats; heating devices, Super conductivity, Special types of alloys, Applications & Properties of semiconductors, Silicon wafers, integration techniques, Large and very large scale integration techniques (VLSI).

UNIT II:

Insulating Materials: Classification of Insulting materials, temperature rise, electrical properties of insulating materials used for wires-laminations- machines and their applications, Ceramics, Plastics, DC electrical properties, AC electrical properties, Dielectric properties of insulators, Dielectric materials used for various electrical applications, suitability.

UNIT III:

Magnetic Materials: Magnetic parameters, the three types of magnetic material, measuring magnetic materials, Application of soft magnetic materials, Magnetic recording media, Hard (permanent) magnets, Ferrites, Samarium, Cobalt alloys, Neodymium Iron Boron (Nd Fe B).

UNIT IV:

Optical properties of materials: EM Radiation Spectrum, Optical properties in materials, photo electric emission, Photo conductivity, Lasers, Optical fibres, Fibre cables.

UNIT V:

Materials for direct energy conversion devices: Solar cells, equivalent circuit of a solar cell, fuel cell, MHD generators, storage of hydrogen, thermoelectric generators, Nano applications in Electrical Engineering.

Text Books:

1. G.K Benergy; Electrical and Electronic engineering materials, PHI, 2014
2. Ian P. Jones; materials science for Electrical and Electronic Engineers, Oxford university press, 2008.
3. R. K Sukhla: Electrical Engineering Materials, MC Graw Hill Education, 2013.

Suggested Readings:

1. Dhir: Electronic components & materials, MC Graw Hill education, 2012.
2. TTTI Mardras: Electrical Engineering materials, MC Graw Hill education, 2014.

With effect from the academic year 2015-2016

EE 352

OPTIMIZATION TECHNIQUES
(Elective -I)

Instruction	4 Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessional	25 Marks
Credits	3

Course Objectives:

1. To study about classical optimization techniques which include single variable and multi variable optimization with equality constraints.
2. To study about – linear programming.
3. Top study non linear programming, gradient methods and principles of Dynamic programming.

Course Outcomes:

1. Able to acquire knowledge about optimization techniques, linear programming, Dynamic programming etc. for analyzing actual systems.
2. This theory will give knowledge to formulate problems for applying optimization techniques and familiarize the computational aspects.

UNIT I

Introduction: Classical optimization techniques: Statement of optimization problem, Objective function, Classification of optimization problems, Single-variable & Multi-variable Optimization without constraints. Multi-variable optimization with equality Constraints. Lagrange multiplier method, Multi-variable optimization with inequality constraints, Kuhn- Tucker conditions.

UNIT II

Linear programming: Standard form, Formulation of the LPP, Solution of simultaneous equations by Pivotal condensation, Graphical method, Simplex algorithm, Big M method,

UNIT III

Non-Linear Programming: One dimensional Search method: Fibonacci method, Golden Section method.
Direct Search method: Uni-variate Search and Pattern Search methods,
Gradient method: Steepest Descent, Conjugate Gradient and Quasi- Newton method,

UNIT IV

Dynamic Programming: Multistage design process, Types, Principle of optimality, Computational procedure in Dynamic programming, Examples using Calculus method and Tabular method of solutions.

UNIT-V

Metaheuristic Techniques :Introduction to Genetic Algorithms, Encoding, Fitness Fuction, Basic Operators, Section Tournament Selection, Introduction to Particle Swarm Optimization (PSO), ivariations of PSO, Differential Evolution, Function optimization Formulation, DE fundamentals, Application to Economic load dispatch.

Text Books:

1. S.S.Rao, Engineering Optimization Theory and Applications, New Age International, 3rdEdition, 1998.
2.Jasbir S.Arora, Introduction to Optimum Design, McGraw Hill International Edition,1989.

Suggested Reading:

1.Kalyamoy, Deb, Multi objective optimization using evolutionary algorithms, Wiley publications.
2. S. Rajasekharam, G.A. Vijaya Lakshmi, Neural networks, Fuzzy logic and Genetic algorithms – Synthesis and Applications, PHI publications.

With effect from the academic year 2015-2016

EE 353 **ADVANCED CONTROL SYSTEMS**
(Elective -I)

Instruction	4 Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessional	25 Marks
Credits	3

Course Objectives: After the completion of the course the students should be able to:
1. Analyze non-loinear systems using different methods
2. Asses the stability of non-linear systems

Course Outcomes: The student will be able to
1. Compute the given problem of a non-linear system mathematically
2. Formulate the optimal control problem using calculus of variation

UNIT-I

Review of state-space: representation of continuous time systems and their solution, state models for discrete time systems described as difference Equations and transfer functions, Transfer function from State model, State-Transition matrix and solution of state equations for discrete time systems.

UNIT--II

Controllability and Observability: Concepts of Controllability and Observability, Controllability tests for continuous time, discrete-time, time-invariant systems. Observability tests for continuous time, discrete- time, time-invariant systems. And Controllability and Observability modes in State. Jordan's canonical form, Controllable and Observable companion forms for single input single output Systems, pole placement by State feedback.

UNIT-III

Nonlinear systems: Behavior of Nonlinear systems, jump resonance, Sub-harmonic oscillation, Limit cycles, common physical non-linearities, Singular points, phase plane-method, Construction of phase plane trajectories, Isoclines method, Delta method, Computation of time.

UNIT-IV

Stability: Lyapunov's stability criteria, Theorems, Direct method of Lyapunov For linear systems, Non-Linear Systems, Methods of constructing Lyapunov function, Krasovki's Method, Variable gradient method.

UNIT-V

Optimal Control: Formulation of optimal control problem, calculus of variations, Minimization of functional. Formulation of variational calculus using Hamiltonian method.

Text Books:

1. Gopal.M., Modern Control System Theory, Wiley Eastern Limited, 2004.
2. Schulz D.G., Melsa J.L., State Functions Linear Control Systems, McGraw Hill.

Suggested Readings:

1. M. Gopal, Digital Control and State Variable Methods, Tata Mcgraw Hill, 2/e, 2003.
2. Ogata .K "Discrete Time control Systems", 2nd Edition, PHI publications, 1995

With effect from the academic year 2015-2016

EE 354 **RENEWABLE ENERGY SOURCES**
(Elective-1)

Instruction	4 Periods per week
Duration of University Examination	3 Hours
University Examination	75 Marks
Sessional	25 Marks
Credits	3

Course Objectives:

1. To make the students familiar with NCES
2. Familiar with various types of solar applications
3. To recognize the applications of wind energy system.
4. To know about the contemporary knowledge of energy related issues.

Course Outcomes: The student will be able to:

1. Identify the proper NCES for a given situation
2. Design solar PV module for a given load requirement
3. Diagnose the wind mill system.

UNIT-I

Basics of Energy: Energy and Power, Estimation of Energy Bill, Characteristics of energy, Energy parameters, Energy planning, cogeneration, classification of energy, Energy Resources, Alternative energy sources, Energy scenario in Indian context.

UNIT-II

Introduction to Energy Sources :Significance of non-conventional energy sources, solar energy, wind energy, energy from biomass and biogas, ocean energy, wave energy, Tidal energy, Geo thermal energy, fuel cell, MHD.

UNIT-III

Solar photovoltaic technologies: Solar spectrum, extraterrestrial radiation, solar radiation at a given location, Advantages and limitations of solar PV technology, PV Technology, Basics of Technology, The amount of power generated, the rated power and actual power from a module, Generating more power using solar PV, Generating more power using solar PV – Protection of solar cells., Solar PV systems and their components, Solar PV lantern, Stand – alone PV systems, Home lighting and other usage, solar PV water pumping system.

UNIT-IV

Solar thermal technologies: Solar Thermal Energy Systems, Absorption and Radiation, Solar Cooking systems, Principle of Cooking, Cooking by Boiling, speed of cooking, Types of Solar Cooker, Solar Distillation System, Operation of Solar Distillation, Solar Heating Systems (Hot water), Principle of Conversion, Applications, Types of Heating systems, design and costing of solar heating systems., Maintenance.

UNIT-V

Wind Energy: Wind Flow, Motion of wind, vertical wind speed variation, distribution of wind speeds, Power in the wind, conversion of wind power- wind turbine, Worldwide wind Installations, Wind Turbine Sizing and systems design, energy derived from a wind turbine, annual energy production- approximate and accurate, estimation of required wind turbine power rating.

Text Books:

1. Chetan singh solanki: Renewable Energy Technology, PHI, 2009 A practical guide for begineers.
2. B H Khan: Non conventional Enginery & Resources, MC Graw Hill education, 2012.
3. Er. R.K.Rajput: Non-Conventional Energy Sources and Utilization, S.Chand Publishing, 2014.

Suggested Readings:

1. Garg & prakash: Solar Energy" Fundamentals & Applications, MC Graw Hill education 2012.
2. DP Kothari: Singal & Ranjan Renewable Energy Sources & Emerging Technologies, PHI 2014.
3. G.S.Sawhney: Non-Conventional Energy Resources, PHI learning pvt ltd., edition 2012.

With effect from the academic year 2015-2016

EE 328 **MINI PROJECT**

Instruction	21 Periods
Duration of University Examination	3 Hours
University Examination	0 Marks
Sessional	25 Marks
Credits	1

Mini Project is a course that a student has to undergo during his/her academic term, which involves the student to explore in a discipline that belongs to their research interest within their program area. It is a credit based course. The Mini Project shall be carried out during 6th semester along with other lab courses by having regular weekly slots. Students will take mini project batch wise and the batches will be divided as per the guidelines. The topic of mini project should be so selected enabling the students to complete the work in the stipulated time with the available resources in the respective laboratories. The scope of the mini project could be handling part of the consultancy work, maintenance of the existing equipment, development of new experiment setup or can be a prelude to the main project with a specific outcome.

EE 329 **INDUSTRY VISIT**

Least 3 days in semester	3 x 8 =24 hours
Sessional /Examination	*Grade

Students are expected to visit at least two industries during the semester and submit a detailed technical report on the study -visits to the Department. The Department should evaluate the reports through a Committee consisting of Head of the Department and two more faculty members to award the Grades.

*Excellent /Very Good/Good /Satisfactory /Unsatisfactory.