Structure for Third Year B. Tech. (Electrical)from Academic Year 2020 - 21

Choice Based Credit System

Semester- I

Sr. No	Code	Subject	Contact Period (Hrs.)			Credits	Continuous Evaluation in terms of Marks						
			L	T	P		Class Test I	Class test II	TA	ESE	TW	Practical & Viva-voce	Total
1		Select any one subject from HSS list from institute website	2	-	-	2	15	15	10	60	-	-	100
2	EE3001	Renewable Energy Technology	3	-	-	3	15	15	10	60	-	-	100
3	EE3002	Electrical Machines-II	3	1	-	4	15	15	10	60	-	-	100
4	EE3003	Digital Electronics	3	-	-	3	15	15	10	60	-	-	100
5	EE3004	Power System II	3	-	-	3	15	15	10	60	-	-	100
6	EE3005	Control Systems	3	-	-	3	15	15	10	60	-	-	100
7		Select any one course from list mandatory courses	3	-	-	0	-	-	-	-	-	-	-
8	EE3006	Lab- Electrical Machines-II	-	-	2	1	-	-	-	-	25	25	50
9	EE3007	Lab- Digital Electronics	-	-	2	1	-	-	-	-	25	25	50
10	EE3008	Lab- Power System II	-	-	2	1	-	-	-	-	25	-	25
11	EE3009	Lab-Control Systems	-	-	2	1	-	-	-	-	25	-	25
		A] Total of Semester I	**20**	**1**	**8**	**22**	**90**	**90**	**60**	**360**	**100**	**50**	**750**

Semester- II

Sr. No	Code	Subject	Contact Period (Hrs.)			Credits	Continuous Evaluation in terms of Marks						
			L	T	P		Class Test I	Class test II	TA	ESE	TW	Practical & Viva-voce	Total
1		*Open Elective I	3	-	-	3	15	15	10	60	-	-	100
2	EE3010	Switchgear and Protection	3	-	-	3	15	15	10	60	-	-	100
3	EE3011	Microprocessor and Microcontroller	3	-	-	3	15	15	10	60	-	-	100
4	EE3012	Power Electronics	3	-	-	3	15	15	10	60	-	-	100
5	EE3013	Advanced Control Systems	3	1	-	4	15	15	10	60	-	-	100
6	EE3014	Advanced Power System	3	-	-	3	15	15	10	60	-	-	100
7	EE3015	Lab- Switchgear and Protection	-	-	2	1	-	-	-	-	25	25	50
8	EE3016	Lab-Microprocessors and Microcontroller	-	-	2	1	-	-	-	-	25	25	50
9	EE3017	Lab-Power Electronics	-	-	2	1	-	-	-	-	25	25	50
	#	Internship/Industrial Training	-	-	-	-	-	-	-	-	-	-	-
		B] Total of Semester II	**18**	**1**	**6**	**22**	**90**	**90**	**60**	**360**	**75**	**75**	**750**
		Total of Semesters (A+B)	**38**	**2**	**14**	**44**	**180**	**180**	**120**	**720**	**175**	**125**	**1500**

L-Lectures, T-Tutorials, P-Practicals, TA-Teacher Assessment, ESE-End-Semester Examination

External Examiner may be appointed from the same university

***Select any one course from the list of open elective course from Institute website.**

 # Internship/Industrial Training: The student has to undergo internship/industrial training of minimum one month after fourth and/or sixth semester with minimum of two weeks in one attempt. The student has to give presentation on the same in subsequent semester

EE3001: Renewable Energy Technology			
Teaching Scheme		**Examination Scheme**	
Lectures	:03 Hrs/Week	Class Test I	: 15 Marks
Tutorial	:0	Class Test II	: 15 Marks
Total Credits	:03	Teachers Assessment	: 10 Marks
		End- Semester Exam	: 60 Marks

Pre-Requisites: Engineering Physics, Electrical Machines, Power Systems

Course Description:

In this curriculum, students will be explored to renewable Energy Technologies such as Wind energy, Solar energy. They will be introduced to concepts of fuel cells and biomass energy.

Course Objectives:

The objectives of the course are to learn

1. Different types of energy sources
2. Various solar PV technologies and its characteristics
3. Various solar thermal technologies and its characteristics
4. Wind energy technologies and its operations
5. Grid integration of wind energy systems and its associated issues.

Course Outcomes: After completing the course, students will be able to

CO1	Describe different types of energy sources
CO2	Explain various solar PV technologies and its characteristics and solve numerical on it.
CO3	Describe various solar thermal technologies and its uses in various applications
CO4	Explain and analyze wind energy technologies and its operations
CO5	Explain and analyze grid integration of wind energy systems and its associated issues

Detailed Syllabus:

UNIT-I	**Basics of Energy:** Energy and power, Hubert peak, Energy Scenario in India, Environmental impact of fossil fuels, Different types of energy sources- solar, wind, tidal, geothermal, wave energy, Introduction to fuel cells and Biomass
UNIT-II	**Solar PV Technology:** Amorphous mono-crystalline, poly-crystalline, V-1 characteristics, Shading impact, PV module, Array, Maximum Power Point Tracking, Grid connected and standalone systems
UNIT-III	**Solar Thermal Technology**: Solar spectrum, solar Geometry, Sun Earth angles, Solar radiation at given locations, Flat plate collector, Parabolic trough, Central receiver, parabolic dish, Fresnel, solar pond, solar still
UNIT-IV	**Wind Energy Technology:** History of wind power, types of wind turbines, power in the wind, Betz limit, Tip speed ratio, Stall and pitch control, wind speed statistics, probability distribution, wind generator topologies, voltage and reactive power control, power quality standard for wind turbines

UNIT-V	**Grid Integration of Wind Energy:** Wind farms, real and reactive power regulation, voltage and frequency operating limits, wind farm behaviour during grid disturbances, power system interconnection, Economic aspects

Text and Reference Books:

1. Thomas Ackermann, Editor, "Wind Power in Power Systems", John Willy and sons ltd., 2005, ISBN 0- 470-85508-8.
2. Gilbert M. Masters, "Renewable and Efficient Electric Power Systems", John Willy and sons, 2004, ISBN0-471-28060-7.
3. S.P. Sukhatme, "Solar Energy", Tata McGrew Hill, Second edition, 1996, ISBN0-07-462453-9.
4. ChetanSingh Solanki, "Solar Photovoltaics", fundamental, technologies and applications, PHI- second edition, 2011.
5. Siegfried Heier, "Grid integration of wind energy conversion systems" John Willy and sons ltd. 2006.
6. Mullic and G.N. Tiwari, "Renewable Energy Applications", Pearson Publications.
7. John A. Duffie, William A. Beckman, "Solar Engineering of Thermal Processes", Wiley Inter Science Publication, 1991

Teacher's Assessment: Teacher"s Assessment is based on one of the following.

1) Assignments
2) Models/Presentations
3) Multiple choice questions test
4) Quiz

Mapping of Course Outcomes with Program Outcomes:

Course outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15
CO1	3						2	2	2	2		2	1		
CO2	3	2	2	1	2	1	2	2	2	2		2	3		
CO3	3	2	2		2	1	2	2	2	2		2	3		
CO4	3	2	2	2	2	1	2	2	2	2		2	3		
CO5	3	2	2	2	2	1	2	2	2	2		2	3		

1- LOW 2- MEDIUM 3- HIGH

Teacher's Assessment: Teacher's Assessment is based on one of the following.

1. Assignments
2. Models/ Presentations
3. Multiple choice questions test
4. Quiz

EE3002 : Electrical Machines-II	
Teaching Scheme Lectures : 03 Hrs./Week Tutorial : 01 Total Credits : 04	**Examination Scheme** Class Test I : 15 Marks Class Test II : 15 Marks Teachers' Assessment : 10 Marks End -Semester Exam : 60 Marks

Pre-Requisites: EE 143 -Basics of Electrical Engineering,
GE 151- Engineering Mathematics-II

Course Description:

EE 3002: Electrical Machines-I is a one-semester course compulsory to all second year engineering students of the Engineering Department Course is aimed to introduce fundamentals of A.C. machines to undergraduate students. The goal of this course is to understand and apply basic principle of induction motor, synchronous motor and alternator with their applications.

Course Objectives:

The objectives of the course are to learn

1. The principles A.C. machines.
2. Fundamental concepts of induction motor, synchronous motor and alternator.
3. The details of construction, operation, Characteristics and applications induction motor, synchronous motor and alternator
4. Basic knowledge to develop practical skills

Course Outcomes: After completing the course, students will able to

CO1.	Understand fundamental principles, performance and applications of three phase and single phase induction motor
CO2	Understand fundamental principles, performance and applications of synchronous motor and Alternator
CO3	To solve engineering problems of induction motor, synchronous motor and alternator
CO4	To find regulation of synchronous alternator by various methods
CO5	To understand the parallel operation and synchronization of synchronous alternator.

Detailed Syllabus:

UNIT-I	**Three Phase Induction Motors:** Construction, Types, Rotating magnetic field, Principle of operation, Torque equation, Torque slip characteristics, Losses & efficiency ,Phasor diagram & equivalent circuit, No load test, Block rotor test, Circle diagram, Speed control & Starting of Induction Motors, EFFECT of Harmonics on I.M. Introduction to Double Cage Induction Motor, Induction Generator and Starters used in industries Construction,
UNIT-II	**Single Phase Induction Motors:** Double field revolving theory, Equivalent circuit, Torque-slip characteristics, Starting methods & types.
UNIT-III	**Synchronous Motor:** Principle of operation, Phasor diagram, Methods of starting, Operation at constant power & fixed excitation, Equivalent circuit, Power developed, Effect of excitation, Hunting and methods of suppression, Effect of harmonics, Synchronous condenser
UNIT-IV	**Synchronous Generator Part -I:** Construction, Types, Applications, Winding factors, EMF equation, Armature reaction, Phasor diagram, Load characteristics, Voltage regulation by

	synchronous impedance method, MMF method, Zero power factor method, Two reaction theory, Slip test.
UNIT-V	**Synchronous Generator Part -II:** Parallel operation of Synchronous Generators, Methods of synchronization, Synchronization power Synchronizing torque, Operation of Synchronous Generator on infinite bus bar, Effect of load on synchronization power, Effect of unequal voltage, Effect of change in excitation & steam supply, Operating charts for large generators, Short circuit ratio & its importance, Power angle Characteristics, Efficiency & losses

Text Books:

1. A. E. Fitzgerald & C. Kingsley & S. D. Umans, "Electric Machinery", Tata McGraw Hill, New Delhi, 5th Edition.
2. I. J.Nagrath& D. P. Kothari, "Electric Machines", Tata McGraw Hill, New Delhi, 2nd Edition.
3.Dr. P. S. Bhimbra, Electric Machinery, 5th edition, Khanna Publishers, Delhi.
4.J.B.Gupta, "Theory and Performance of Electrical Machines" S.K.Kataria & Sons. 14th Edition Delhi.

Reference Books:

1Syed A. Nasar, "Electric Machines & Power Systems", Volume I, Tata McGraw Hill, New
2 Alexander S. Langsdorf, " Theory of Alternating current Machines" Second Edition, Tata McGraw Hill, New Delhi
3George Mcphersion ,"An Introduction to Electrical Machines and Transformers", John Wiley & Sons, NY
4.A. F. Puchstein, T.C. Lloyd, A.G. Conrad, "Alternating current machines", John Wiley and Sons, New York 1954

Mapping Of Course Outcome with Program Outcomes:

Corse outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15
CO1	3													3	
CO2	3	1	1		1				1	1		1	1	3	
CO3	3	1	1									1	1	3	
CO4	3	1	1									1	1	3	
CO5	3	1	1									1	1	3	

1- LOW 2- MEDIUM 3- HIGH

Teaching Strategies:

The teaching strategy is planed through the lectures, tutorials and team based home works. Exercises are assigned weekly to stimulate the students to actively use and revise the learned concepts which also help the students to express their way of solving the problems fluently in written form. Most critical concepts and mistakes are emphasized.

Teacher's Assessment: Teacher's Assessment is based on one of the /or combination of the few of the following.

1) Home Assignments
2) Power point presentation
3) Develop working models
4) Surprise written Test with multiple choice questions
5) Quiz

E**E3003: Digital Electronics**			
Teaching Scheme		**Examination Scheme**	
Lectures	: 3 Hrs./Week	Class Test 1	: 15 Marks
Total Credits	: 3	Class Test 2	: 15 Marks
		Teachers' Assessment	: 10 Marks
		End -Semester Exam	: 60 Marks

Pre-Requisites:

EE 2003 Analog Electronics

Course Description:

Digital Electronics is a one-semester course compulsory to all third year engineering students of the department.

Course Objectives:

The objectives of the course are to-

1. Provide the knowledge to understand common forms of number representation, logic gates and families, binary codes and Boolean algebra and to enable student to understand the logical operation of simple digital circuits
2. Enable student to construct combinational logic circuits
3. Construct and implement counter circuits using flip-flops
4. Construct and implement logic circuits multiplexers and demultiplexers
5. Discuss A/D converters and D/A converters

Course Outcomes:

After completion of this course students will be able to

CO1. Explain number systems, binary codes, logical operations, logic families and Boolean Algebra
CO2. Describe different techniques for simplifying Boolean functions and to construct combinational logic circuits and also to perform lab work
CO3. Describe different types of flip-flops and counters and to construct mod n counter circuits
CO4. Describe different types of operating modes of shift registers and to construct logic circuits using multiplexer and demultiplexer.
CO5. Discuss different types of A/D converters and D/A converters

Detailed Syllabus:

UNIT-I	**Fundamentals of Digital Electronics:** Number systems - binary, octal and hexadecimal number systems, Their conversions and arithmetic, 1's and 2's complements, Weighed and non-weighted codes, BCD codes, Excess-3 code, Gray code, Error correcting and detecting codes, Review of logic gates and logic families such as RTL, DTL, TTL, Schottky TTL, ECL, MOS, CMOS, IIL etc, Boolean algebra.

UNIT-II	**Combinational Logic Circuits:** Introduction to Karnaugh map, Minterms and Maxterms representation of logical functions, Sum of product and product of sum form minimization, Redundant terms, Quine- Mcklusky method for minimization, Design of combinational logic circuits, Design of half adder and subtractor, Design of full adder and subtractor, Binary parallel adder &subtractor, IC 7483, excess-3 adder, BCD to seven segment decoder, IC 7447.
UNIT-III	**Flip-Flops:** R-S, D, J-K, T, Master slave flip-flops, Their conversion, Different flip-flop ICs. Counters: Different types of counters, Design of divide by N asynchronous and synchronous counters, Design of BCD, Decade, Up-down counter, Ring and shift counters, Various counter ICs.
UNIT-IV	**Shift Registers:** Data-in and data-out modes, SISO, SIPO, PISO and PIPO modes, Left shift and right shift register, Universal shift register, IC 7495. Multiplexer, Cascading of multiplexer, Demultiplexer, Cascading of demultiplexer, various multiplexer and demultiplexer ICs.
UNIT-V	**D/A And A/D Converters:** Digital to Analog converter (DAC)-weighted register method, R-2R ladder method, Analog to Digital Converter (ADC)- Parallel comparator method, Counter method, Successive approximation method, Counting A/D converter, Dual Slope A/D converter, A/D converter using voltage to frequency and voltage to time conversion.

Text Books:

R. P. Jain, "Modern Digital Electronics", Tata McGraw Hill Publications.
Gothman, "Digital Electronics", Prentice Hall Publications.

Reference Books:

Malvino and Leach, "Digital Principles and Applications", McGraw Hill Publications
Anand Kumar, "Fundamentals of Digital Circuits", Prentice-Hall India

Mapping Of Course Outcome with Program Outcomes:

Course outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15
CO1	3	2	1		1					1				1	3
CO2	3	2			1			1		1	1			1	3
CO3	3	2	1		1			1		1	1			1	3
CO4	3	2	1		1			1		1	1			1	3
CO5	3				1					1				1	3

1. Low 2. Medium 3. High

Teaching Strategies:
The teaching strategy is planed through the lectures, tutorials, NPTEL lectures and home Assignments

Teacher's Assessment:
Teachers' Assessment mark is based on attendance of the student and any one of the following components. However, the course co-ordinator has to announce assessment components at the beginning of the course.

1. Multiple Choice Question Test
2. PPT presentation
3. Quiz
4. Surprise test
5. Design and fabrication of working model
6. Home assignments

EE3004: Power System II	
Teaching Scheme	**Examination Scheme**
Lectures: : 03 Hrs./Week	Class Test I : 15 Marks
Total Credits : 03	Class Test II : 15 Marks
	Teachers Assessment : 10 Marks
	End Semester Exam : 60 Marks

Pre-Requisites: EE 2010 - Power Systems I

Course Description: Electrical Power Systems is growing at a faster pace. An Electrical Engineer should be able to solve the power system network under normal & abnormal conditions. This course is aimed to cover from the fundamentals of Power Systems such as line constants, performance of transmission lines to the analysis part such as symmetrical & unsymmetrical fault analysis & different power flow methods.

Course Objectives:

The objectives of the course are to

1. Provide the knowledge to understand line constants.
2. Analyse sending end voltage, receiving end voltage, transmission efficiency and regulation in case of transmission line.
3. Develop and solve the positive, negative and zero sequence network for a given system.
4. Formulate the power flow problems using load flow methods.
5. Recognise the common cause of faults in power system.

Course Outcomes :

After completing the course, students will able to:

CO1	Demonstrate line constants for various conductor configurations of transmission line.
CO2	Make the use of ABCD Constants to find Efficiency and regulation of transmission line
CO3	Develop and solve the positive, negative and zero sequence network for a given system
CO4	Explain and solve load flow problem for a given system
CO5	Estimate Fault currents under different fault conditions

Detailed Syllabus:

UNIT- I	**Line Constants:** Resistance of line; influence of skin effect on resistance and proximity effect; inductance of single phase two wire line, flux linkage of one conductor of one group, inductance of composite conductor line; G.M.R. and G.M.D.; inductance of three phase line with equilateral spacing, unsymmetrical spacing, effect of transposition, inductance of three phase double circuit line, capacitance of transmission line, capacitance of a three-Phase transposed Line, effect of earth on capacitance.
UNIT- II	**Performance Of Transmission Lines:** Representation and performance of short, medium line- nominal T and nominal π method; long transmission line–rigorous solution, evaluation of ABCD constants interpretation of long line equations, equivalent T and π representation, Ferranti effect, power flow through transmission line.

UNIT- III	**Representation Of Power System Components:** Power in single-phase a. c. circuit. Complex power, complex power balance, power factor correction, complex power flow, balanced three phase circuits, balanced three phase power, one line diagram, impedance and reactance diagrams of a power system, per unit system, per unit representation of transformers, synchronous machines, representation of loads
UNIT- IV	**Load Flow Studies:** Introduction, network model formulation, formation of Y-bus by singular transformation, Load flow problem, Iterative methods of load flow such as Gauss, Gauss-Seidel, Newton-Raphson method.
UNIT- V	**Symmetrical & Unsymmetrical Fault Analysis:** Fundamentals of symmetrical components, sequence impedance and sequence networks of star connected loads, transmission lines, synchronous machines and transformer, sequence networks of a loaded generator, single line to ground (L-G), Line to line (L-L), double line to ground (L-L-G) faults, unbalanced fault analysis of above faults using bus impedance matrix, bus voltages and line currents during faults.

Text and Reference Books:

C. L. Wadhawa , "Electrical Power System", John Wiley & Sons
Hadi Saadat, " Power System Analysis", Tata McGraw-Hill
I. J. Nagrath & D. P. Kothari, "Modern Power System Analysis", Tata McGraw-Hill
W.D. Stevenson and J.J. Grainger, "Power System Analysis", McGraw-Hill
W.D. Stevenson, "Elements of Power System Analysis", McGraw-Hill
W.D. Stagg & A.H. El-Abiad, "Computer Methods in Power System Analysis", McGraw-Hill
Elgerd O. I., "Electrical Energy System Theory", McGraw-Hill

Mapping Of Course Outcome with Program Outcomes:

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	P O7	PO 8	PO 9	PO 10	PO 11	PO 12	PS 13	PS 14	PS 15
CO1	3	2		1	1				1	1		1	3		
CO2	3	2		1	1				1	1		1	3		
CO3	3	2		1	1				1	1		1	3		
CO4	3	2		1	1				1	1		1	3		
CO5	3	2		1	1				1	1		1	3		

1 – Low 2 – Medium 3 – High

Teacher's Assessment: Teachers Assessment of 10 marks is based on attendance of the student and any one / or combination of few of following. However, the course co-ordinator has to announce assessment components at the beginning of the course. Presentation on latest topics/Real life problems related with the subject

1. Problems based on GATE questions
2. Simulations problems
3. Quiz
4. Surprise test

Teaching Strategies:

The teaching strategy is planed through the lectures, tutorials and team based home Assignments.

EE 3005 Control Systems			
Teaching Scheme		**Examination Scheme**	
Lectures	: 3 Hrs./Week	Test I	: 15 Marks
Tutorial	: Nil	Test II	: 15 Marks
Total Credits	: 3	Teachers Assessment	: 10 Marks
		End Semester Exam	: 60 Marks

Course Description: This is the course in Electrical Engineering which introduces the basic concepts of transfer function, signal flow graph, block diagram reduction & basic control system components and specify control System performance in Frequency domain and time domain analysis.

Pre-Requisites:
GE252 -Engineering Mathematics-IV
EE244 - Network Analysis

Course Objectives:
The objectives of the course are to give exposure of
1. Transfer function of linear time invariant systems
2. Operation of basic control system components
3. Performance of system in Time domain
4. Performance of system in Frequency domain
5. Operation of various industrial controllers

Course Outcomes:
After completing the course, students will able to:

CO1	Compute transfer function of linear time invariant systems
CO2	Describe operation of various control system components
CO3	Analyze and evaluate linear systems in time domain
CO4	Analyze and evaluate of linear time invariant systems in frequency domain
CO5	Explain various industrial controllers

Detailed Syllabus:

UNIT- I	**Transfer Functions And Block Diagrams:** Basic components and classifications of general control systems, Physical –non physical, Linear, Nonlinear, Continuous-on off, Analog-digital, Open loop and closed-loop systems, Mathematical models of physical systems, Electrical analogy of non-electrical systems, Force-current and force voltages analogies, Definition of transfer function, Block diagram representation of physical systems, Block diagram reduction techniques, Signal flow graphs and Mason's gain formula, Transfer function of electrical, Mechanical and electromechanical systems.
UNIT- II	**Control System Components:** Error detectors: Potentiometers, Synchros and gyros, Optical rotary encoders, DC and AC servomotors, AC and DC tacho-generators.
UNIT- III	**Time-Domain Analysis:** Standard test signals, Type and order of a system, Steady state error and definition of error time constant, Dynamic-error-coefficients, Transient response of second order systems, Time-domain specifications. Stability Concepts:

	Nature of system response from the location of roots in the s-plane of characteristic equation, Absolute and relative stability, Routh-Hurwitz criterion and its applications in special cases. Root Locus: Definition of root-locus, Rules for plotting root-loci, Root contours, Stability analysis using root locus, effect of addition of poles and zeros, Root locus for systems with transportation lag, Computer aided root locus.
UNIT- IV	**Frequency-Domain Analysis:** Frequency-domain specifications, Correlation between time-and frequency-domain responses, Polar plot, Bode plot, Determination of gain- and phase- margin from Bode plot, Effect of gain variation and addition of poles and zeros on Bode plot, Determinations of transfer function from the given Bode plot, Bode plot for all-pass and minimum –phase systems, Computer aided Bode plot, Nyquist stability criterion, Determination of absolute and relative stability by the application of Nyquist Criterion, Effect of addition of poles & zeros on the shape of the Nyquist plot, Stability of linear control systems with time delay.
UNIT- V	**Industrial Controllers:** PD, PI, PID controllers, tuning methods, pneumatic and hydraulic controllers, ISE, IATE.

Text Books:

1. I. J. Nagrath & M. Gopal, "Control System Engineering" New Age International.
2. Xavier," Control system Engineering", Chand Publication.
3. Norman Nice," Control System Engineering", John Wiley and Sons.

Reference Books:

1. Katsuhiko Ogata, " Modern Control Engineering", Prentice Hall.
2. Benjamin Kuo, "Automatic Control System", Prentice Hall.
3. John J. D'Azzo, C.H. Houpis, "Linear Control System Analysis and Design", McGraw Hill.

Mapping of Course Outcome with Program Outcomes:

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	P O7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15
CO1	3	3	1	1	1	2	1	1	1	1	1	2		1	1
CO2	3	2	-		1	2		1	1	1	2	2		1	1
CO3	3	3	1	1	2	2	1	1	1	1	1	2		1	1
CO4	3	3	1	1	2	1		1		1	1	2		1	1
CO5	3	3	1	1	2	2	1	1	1	1	2	2		1	1

1 – Low 2 – Medium 3 – High

Teacher's Assessment: Teachers Assessment of 10 marks is based on anyone / or combination of few of following,

1. Mini Project/ Model Assessment
2. Finding solutions of various problems on control systems using MATLAB
3. PPT Presentation on various applications of control systems in Industries etc
4. MCQ

EE3006: Lab- Electrical Machines-II	
Teaching Scheme Practical: 2 Hrs./Week Credit:01	**Examination Scheme** Term Work : 25 Marks Practical Examination & Viva Voce :25 Marks

Course Objectives:

On completion of this course the student shall be able to

1. To prepare the students to have a basic knowledge of induction motor
2. To prepare the students to have a basic knowledge of synchronous machines

Course Outcomes:

At the end of the course student will have ability to

CO1	Demonstrate the use of various starters for three phase induction motors
CO2	Determine the equivalent circuit parameters of Induction motor using no load and block rotor test
CO3	Demonstrate the characteristics of 3 phase induction motor by circle diagram and load test
CO4	Interpret the regulationof three phase Synchronous Generator and the plot V and inverted V curves of synchronous motor
CO5	Interpret and write the experimental reports.

List of Experiments:

Term work shall consist of record of minimum eight experiments performed from the following list.

Sr. No.	Details
1	Effect of variation of applied voltage on the performance of Induction motor
2	Perform No load test and block rotor test on 3-phase Induction motor & Plot Circle diagram of 3-phase Induction motor
2	Determine of equivalent circuit parameters of single phase Induction Motors
3	Determine parameters of equivalent circuit of 3-phase Induction motor
4	Speed Control of slip ring 3-phase Induction motor using cascade connection
5	Perform Load Test on three phase Induction motor
6	To plot torque-slip characteristics of three phase Induction motor
7	Perform Load Test on three phase Induction motor
8	Determine regulation of a three phase Synchronous Generator by synchronous impedance method
9	Determine regulation of a three phase Synchronous Generator by MMF method
10	Determine regulation of a three phase Synchronous Generator by ZPF method
11	Determine regulation of a three phase Synchronous Generator by direct loading
12	Determine direct and quadrature axis synchronous reactance by using slip test
13	Plot V and inverted V curves of synchronous motor
14	Study of induction motor starters
15	Study of ISI- standards for Energy efficient motors
16	Synchronizing of alternators: Lamp Methods and use of synchroscope

Term Work:

The term work will consist of submitting a file for minimum eight experiments with neatly written records of the study, circuit diagrams, observations, and graphs with results. any another experiment can be added by course coordinator except above list of experimentThe term work will be assessed by the course coordinator

Practical Examination:
The Practical Examination will comprise of performing the experiment and viva voce on the syllabus
The practical will be assessed by two examiners, one will be the course coordinator and other will be examiner appointed by DSB.

Course Outcome:
Mapping Of Course Outcome with Program Outcomes:

Course outcome	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO 10	PO 11	PO 12	PSO 13	PSO 14	PSO 15
CO1	2					1			2	2		2		2	
CO2	2	2				1			2	2		2		2	
CO3	2	2				1			2	2		2		2	
CO4	2	2				1			2	2		2		2	
CO5	2	2				1			2	2		2		2	

1 – LOW 2 – MEDIUM 3 – HIGH

EE 3007: Lab Digital Electronics	
Teaching Scheme Practical :2Hrs./Week Total Credits : 01	**Examination Scheme** Term Work : 25Marks Practical Examination & Viva Voce: 25 Marks

Course Objectives:

The objectives of the course are to-

1. To expose the students to a variety of practical circuits using various digital ICs.
2. To provide hand-on experience in designing and implementing digital/logic circuits.

Course Outcomes:

After completion of this course students will be able to

CO1. To verify truth-table of various logic gates, Boolean algebra
CO2. Design and implement basic combinational and sequential logic circuits.
CO3. Develop technical writing skills
CO4. Acquire teamwork skills for working effectively in groups

List of the Experiments:

The student shall perform minimum eight experiments of the following:

Sr. No.	Name of the Experiments
1	To verify truth table and identify IC numbers of basic logic
2	To build basic logic gates using universal gates
3	Verification of De Morgan's theorems
4	Design and implementation of **any two** combinational logic circuits based on examples such as to find majority of one's, to find numbers exactly divisible by 3 or 4 etc.
5	To design arithmetic circuits such as half and full adder, half and full subtractor
6	To verify truth table of different flip-flop ICs
7	Design of mod-2, mod-5, mod-7/mod- 8/mod-9, mod-10 and reverse mod-10 counter using IC 7490
8	Design of mod n synchronous counter
9	Study of multiplexer and function realization using data selector ICs
10	Study of De-multiplexer and function realization using data selector ICs
11	Study of A/D converters (any one type)
12	Study of D/A converters (any one type)

Term Work:
The term work shall consist of submitting a file for minimum eight experiments performed with neatly written records of the study, circuit diagrams, observations, and graphs with results.
The term work will be assessed by the course coordinator

Practical Examination:
The Practical Examination shall comprise of performing the experiment and viva voce on syllabus
The practical will be assessed by two examiners, one will be internal examiner and other will be external examiner

Mapping Of Course Outcome with Program Outcomes:

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	P 12	PO 13	PO 14	PO 15
CO1	3		1			1			2	1		1			3
CO2	3		1			1			2	1		1			3
CO3	3		1			1			2	1	1	1			3
CO4	3		1			1			2	1	1	1			3

1 – Low 2 – Medium 3 - High

EE3008: Lab- Power System II	
Teaching Scheme Practical : 2Hrs./Week Total Credits : 01	**Examination Scheme** Term Work : 25Marks

Course Objectives:

The objectives of the course are to-

1. Learn the power system software's such as MATLAB /MIPOWER/PSCAD
2. Acquire the skills of programming/modeling power system components.

Course Outcomes:

After completion of this course students will be able to:

CO1. Simulate and analyze power system studies by MATLAB /MIPOWER/PSCAD
CO2. Develop the Y-bus matrix
CO3. Identify fault current under the symmetrical and unsymmetrical faults conditions
CO4. Perform load flow and interpret the results.

List of the Experiments:

The student shall perform minimum eight experiments of the following using MATLAB/ MIPOWER/PSCAD

Sr.No.	Name of the Experiments
1	Simulation of the effect of line parameters on performance of transmission line.
2	Formulation of Y-bus matrix using computer program.
3	Computer aided solution of power flow problem by Gauss Siedal.
4	Computer aided solution of power flow problem by Newton-Raphson method.
5	Computer aided solution of power flow problem fast decoupled method.
6	Simulation and analysis for a symmetrical three phase fault
7	Simulation and analysis of unsymmetrical LL Fault.
8	Simulation and analysis of unsymmetrical LG fault.
9	Simulation and analysis of unsymmetrical LLG fault.
10	Visit to HV/EHV substation, power generating station.

Term Work:

The term work shall consist of submitting a file for minimum eight experiments performed with neatly written records of the study, programs & observations with results.

The term work will be assessed by the course coordinator.

Mapping Of Course Outcome with Program Outcomes:

Course outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 13	PSO 14	PSO 15
CO1	3				3				2	2		1	2		
CO2	3				3				2	2		1	2		
CO3	3				3				2	2		1	2		
CO4	3				3				2	2		1	2		

1 – Low 2 – Medium 3 – High

EE3009: Lab Control Systems	
Teaching Scheme Practical : 2 hrs/Week Tutorial : Nil Total Credits : 01	**Examination Scheme** Term Work : 25marks

Laboratory Course Outcomes:
As an outcome of completing the Laboratory course, students will able to:

CO1	Differentiate various control systems
CO2	Describe various control system components
CO3	Analyze performance of linear second order system in Time domain
CO4	Analyze and evaluate performance of linear second order system in Frequency domain
CO5	Explain operation of industrial controllers

List of Experiments:
Term-work shall consist of minimum eight experiments from the following:

Sr. No.	Details
1	Perform an experiment to study potentiometers as an error detectors.
2	Perform an experiment to study synchros as an error detector.
3	Perform an experiment to study time domain analysis of a second order system.
4	Computer aided plotting of root-locus.
5	Computer aided plotting of Nyquist- and Bode- plots.
6	Perform an experiment to study a continuous- time and/or digital position control system.
7	Perform an experiment to study regulator system.
8	Perform an experiment to study computer aided design of a linear control system.
9	Perform an experiment to study torque speed characteristic of AC servo motor.
10	To study the performance characteristics of a DC speed motor control system.
11	To study the time response of a variety of simulated linear systems and to correlate the studies with theoretical results.

Mapping Of Course Outcome with Program Outcomes:

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15
CO1	3	1			2	1		1		1		1		1	1
CO2	3	2		1	3	1	1	1	1	1		1		1	1
CO3	3	2		1	3	1	1	1	1	1		1		1	1
CO4	3	1		1	2	1		1	1	1		1		1	1
CO5	3			1	3	1	1	1	1	1		1		1	1

1 -Low 2 – Medium 3 - High

EE 3010: Switchgear and Protection	
Teaching Scheme Lectures : 3 Hrs/Week Tutorial : Nil Total Credits : 3	**Examination Scheme** Class Test I : 15 Marks Class Test II : 15 Marks Teachers' Assessment : 10 Marks End -Semester Exam : 60 Marks

Prerequisites:
EE 2010: Power System –I
EE 3004: Power System –II

Course description:
This is a one-semester course compulsory to all third year Electrical Engineering students. It is the fundamental course related to Power System Engineering.

Course Objective:

The objectives of the course are to introduce & explain

1. The philosophy & technology of protection
2. Construction & working of circuit breakers & fuses
3. Different protection schemes of generators & transformers
4. Different protection schemes of transmission lines & bus bars
5. Modern trends in protection

Course Outcomes:

After completing the course, students will be able to:

CO1	Explain basics of fault clearing process
CO2	Explain arc Interruption phenomenon and working of various circuit breakers & their applications
CO3	Apply differential protection schemes to transformers & generators
CO4	Identify protection schemes to transmission lines & bus bars against different faults
CO5	Explain fundamentals of static & numerical relaying

Detailed Syllabus:

Unit 1	**Introduction** Importance of protection in power systems, Fault clearing process , Desirable qualities of protective relaying, Definitions of terms used in relaying, Protective zones , Primary & back up protection
Unit 2	**Principle of Circuit Interruption** Arc phenomenon, A.C. & D.C. circuit breaking, Arc interruption theories, Transient recovery voltage, Re-striking voltage, Factors affecting TRV, Rate of rise of restriking voltage, Resistance switching, Damping of TRV, Current chopping, Capacitive current

	breaking, Auto reclosing **Circuit Breakers** Construction, Working principle, Application & comparison of different types of circuit Breakers such as Air Break, Air blast, Minimum Oil Circuit breaker, SF6 & Vacuum Circuit breakers, H.V.D.C. Circuit breakers. Different contactors, Rewirable & H.R.C. fuses MCB's, ELCB's , Introduction to Gas Insulated Substations
Unit 3	**Protection of Transformers and Generators** **Transformer protection**: Percentage differential protection, magnetic inrush current phenomenon, percentage differential relay with harmonic restraint, restricted earth fault protection, incipient faults, Buchholz relay, protection against over fluxing. **Generator protection**: Stator phase and ground fault protection, protection against unbalanced loading, loss of excitation, loss of prime mover and over speeding.
Unit 4	**Transmission lines & Bus bar protection** Introduction to distance relaying, zones of protection, setting and coordination of distance relays, pilot protection with distance relays, Protection against lightning, insulation co-ordination, Bus bar protection: Different bus bar arrangements, differential protection of bus bar, high impedance differential relay
Unit 5	**Basics of Static & Numerical relaying** Comparison of static and electro-mechanical relays, two input amplitude and phase comparators and their duality, Numerical relaying fundamentals, sampling theorem, anti-aliasing filters, least square method for estimation of phasors, Fourier algorithms, Fourier analysis and discrete Fourier transform, estimation of phasors from discrete Fourier transform, Applications for implantation of various numerical relays

Text and Reference Books

1. C. Russul Mason, "Art & Science of Protective Relaying ", John Wiley & Sons
2. Sunil S. Rao, "Switchgear Protection & Power Systems", Khanna Publishers, Fifth edition
3. Y. G. Paithankar & S. R. Bhide , "Fundamentals of Power Systems Protection", Prentice Hall of India
4. Madhav Rao, "Solid state protective relaying", Tata McGraw Hill
5. M. S. Naidu," Gas Insulated Substations"- IK International Publishing House.1

Mapping of Course outcome with Program Outcomes:

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	P O7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15
CO1	3	2	1	1		1	1	2	1	2		2	3	1	1
CO2	3	2	1	1		1	1	2	1	2		2	3		
CO3	3	2	1	1		1	1	2	1	2		2	3		
CO4	3	2	1	1		1	1	2	1	2		2	3		
CO5	3	2	1	1		1	1	2	1	2		2	3	2	2

1 - Low 2 – Medium 3 – High

Teacher's Assessment: Teachers Assessment of 10 marks is based on **attendance** of the student and one of the / or combination of few of following. However, the course co-ordinator has to announce assessment components at the beginning of the course.

1. Presentation on latest topics/Real life problems related with the subject
2. Problems based on GATE questions
3. Simulations problems
4. Quiz

EE3011: Microprocessor And Microcontroller			
Teaching Scheme		**Examination Scheme**	
Lectures	: 3 Hrs./Week	Test I	: 15 Marks
Tutorial	: NIL	Test II	: 15 Marks
Total Credits	: 03	Teachers Assessment	: 10 Marks
		End Semester Exam	: 60 Marks

Pre-Requisites:
EE3003 - Digital Electronics

Course Description: The purpose of this course is to teach students the fundamentals of microprocessor and microcontroller systems. The student will be able to incorporate these concepts into their electronic designs for other courses where control can be achieved via a microprocessor/controller implementation.

Course Objectives:
The objectives of the course are to

1. Explain the architecture of microprocessor 8086 and micro controller 8051.
2. Explain the assembly language program for microprocessor 8086.
3. Explain the assembly language program for micro controller 8051.
4. Explain the interfacing of peripheral with microprocessor 8086.
5. Explain the interfacing of peripheral with micro controller 8051.

Course Outcomes:
After completing the course, students will able to:

CO1	Describe and write assembly language programming with 8085 microprocessor
CO2	Compare and describe various data transfer schemes of 8085microprocessor
CO3	Analyze and write assembly language program with 8086 for various applications
CO4	Describe advanced processors and compare multiprocessor systems
CO5	Know 8051 microcontroller and analyze its assembly language programming for various applications

Detailed Syllabus:

UNIT I	**Evolution of Computers:** Intel 8085 Microprocessor Architecture, Addressing modes, Timing diagrams, Classification of Instructions, Instruction Set. Programming 8085: Assembly Language Programs Based on Arithmetic (8/16/32 Bit) Logical, Branch and Machine Control Group of Instructions, Programs for Counting Time Delays, Stack operation, Programs Illustrating the use of Stacks and Subroutines.
UNIT II	**Interrupts And Data Transfer:** Interrupt Structure of 8085, Programs Illustrating the use of Hardware interrupts, Various Hardware and Software Interrupts, Types of data Transfer, Synchronous and Asynchronous Data Transfer, Interrupt Driven Data Transfer, Data Transfer by polling, Parallel Data Transfer.
UNIT III	**Advanced Microprocessors-** Architecture of Typical 16 Bit Microprocessor(Intel 8086), Memory Address Space And Data Organization, Segment Registers And Memory Organization, Addressing Modes,8086

	Configurations, Minimum Mode, Maximum Mode, Comparison of 8086 And 8088, Bus Interface, Interrupts and Interrupt Priority Management. Programming 8086-Instruction Set, Assembly Language Programming, Input/ Output Operations, Interfacing Of Peripheral Devices Like 8255, 8259, LED etc.
UNIT IV	**Multiprocessor System-** Queue Status And Lock Facility Of 8086 Based Multiprocessor System, 8087 Coprocessor, Concept, Architecture, Instruction Set And Programming.
UNIT V	**Microcontrollers-** Introduction, Evolution, Architecture, Comparison With Microprocessor, Selection Of A Microcontroller, MCS 51 Family, 8051 Architecture, I/O Ports And Memory Organization Addressing Modes, Instruction Set, Interrupts, Real World Interfacing. Overview of Atmel Microcontrollers 89CXX.

Text Books:

1. B Ram, "Fundamentals of Microprocessors and Microcomputers", DhanpatRai and Sons, New Delhi, IV Edition.
2. R.A.Gaonkar, "Microprocessor Architecture Programming and Applications with 8085",Penram
3. Badri Ram, "Advanced Microprocessor and interfacing", Tata McGraw Hill, New Delhi.

Reference Books:

Myke Predko, "Programming and customizing the 8051 Microcontroller", Tata McGraw Hill, New Delhi.
Barry B Brey, "The Intel Microprocessor 8086 to Pentium architecture programming and interfacing", Tata McGraw Hill, New Delhi.
M. A. Mazidi & G. M. Mazidi," The 8051 Microcontroller and Embedded System ",Pearson education, 3rd Indian reprint.
Ajay Deshmukh, "Microcontrollers", Tata McGraw Hill, New Delhi.
Embedded Microcontroller Intel Manual
Intel Data Handbook for MCS96 Family
Kenneth Ayala, 8051 Microcontroller, Pen ram international, II edition
Online reference www.microchip.com

Mapping Of Course Outcome With Program Outcomes:

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	P O7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15
CO1	3	3		1	2	1		1		1	1	1		1	1
CO2	3	1			2	1		1		1	1	1	1	1	1
CO3	3	2			2	1	1	1		1	1	1		1	1
CO4	3	3		1	1	1	1	1		1	1	1	1	1	1
CO5	3	3	1	1	2	1	1	1		1	1	1	1	1	1

1 – Low 2 – Medium 3 – High

Teacher's Assessment:

Teachers Assessment of 10 marks is based on one of the / or combination of few of following,

1. Mini projects.
2. PPT presentation.
3. Assignment based on programming of microprocessor for different applications.

EE 3012: Power Electronics			
Teaching Scheme:		**Examination Scheme:**	
Lectures	: 3 Hrs/Week	Class Test I	: 15 Marks
Tutorial	: NIL	Class Test II	: 15 Marks
Total Credits	: 03	Teachers Assessment	: 10 Marks
		End Semester Exam	: 60 Marks

COURSE DESCRIPTION:

The objective of this course is to give exposure to the students of various semiconductor devices of Thyristor family and mainly SCR. It also covers applications of different types of power converters and their control techniques.

Prerequisites:

1. Electronic Devices and Circuits
2. Network Analysis

Course Objectives:

The objective of the course is to give exposure to the students of

1. Power semiconductor devices of Thyristor family
2. Triggering methods, commutation methods and various characteristics of Thyristor
3. Operations and analysis of AC-DC converters and dual converters
4. Operations and analysis of DC-DC converters and their control techniques
5. Operations of DC-AC converters and its various control techniques

Course Outcomes:

After completing the course, students will able to:

CO1	Describe structure, characteristics, and applications of power semiconductor devices
CO2	Describe different triggering methods, commutation methods & various characteristics of Thyristor and solve numerical on it
CO3	Explain and analyze single and three phase AC-DC converters with different types of load and their control techniques
CO4	Explain and analyze types, operation and control techniques of DC-DC converters
CO5	Explain and analyze DC-AC converters and various control techniques

Detailed Syllabus:

Unit 1	**Power Semiconductor Devices:** Structure, Principle of operation, V/I characteristics of power semiconductor devices such as SCR,TRIAC, DIAC, GTO, Power Transistor, Power MOSFET, IGBT
Unit 2	**Performance of Thyristor:** Gate triggering methods, Turn on-Turn off characteristics of SCR, Thyristor gate characteristics, Types of commutation, Ratings, protection, Series & parallel operation
Unit 3	**AC-DC Converters:** Principle & operation of single phase half wave and full wave converters with different types of load, Three phase half and full wave converters, Performance parameters, Use of freewheeling diode, Effect of source inductance, Dual converters

Unit 4	**DC-DC Converters:** Principle of operation of chopper, Types of choppers, Various commutation methods, various control techniques
Unit 5	**DC-AC Converters:** Principle of operation of series and parallel inverters, Single phase centre tapped and bridge inverter with R, RL load, Three phase bridge inverters, PWM techniques-Single, Multiple and Sinusoidal PWM, PWM inverter, Current source inverters

Text and Reference Books:

1. M.H. Rashid, “Power Electronics”, Third Edition, Prentice-Hall of India Pvt. Ltd. 2005
2. Mohan, Undeland, Robbins, "Power Electronics”, Second Edition, John Willey & Sons, 1995
3. B. K. Bose, “Modern Power Electronics and AC Drives”, Prentice-Hall of India Pvt. Ltd. 2006
4. C. W. Lander, “Power Electronics”, Tata McGraw-Hill Publications India 1993
5. P.C. Sen, “Power Electronics", Tata McGraw-Hill Publications India
6. G. K. Dubey, S. R. Doradla, A. Joshi, M. K. Sinha, “Thyristorised Power Controllers", Wiley Eastern Ltd.
   1987
7. M. Ramamoorthy, ”An Introduction to Thyristors & Their Applications”, East-West Press Pvt. Ltd., New
   Delhi

Mapping of Course outcome with Program Outcomes:

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15
CO1	3	2	-		-	2		1	-	-		2		3	
CO2	3	2	-		1	2		1	1	1		2		3	
CO3	3	3	1		1	2		1	1	1		2		3	
CO4	3	3	1		1	2		1	1	1		2		3	
CO5	3	3	1		1	2		1	1	1		2		3	

1 – Low 2 – Medium 3 – High

Teacher’s Assessment:

Teacher assessment will be based on **any ONE** of the following:

1. Multiple Choice Objective Test : 10 Marks
2. Assignments/PPT presentation on allotted topics : 10 Marks
3. Written Test on numerical : 10 Marks
4. Quiz : 10 Marks

EE3013: Advanced Control Systems			
Teaching Scheme		**Examination Scheme**	
Lectures	: 3 Hrs./Week	Test I	: 15 Marks
Tutorial	: 01	Test II	: 15 Marks
Total Credits	: 04	Teachers Assessment	: 10 Marks
		End Semester Exam	: 60 Marks

Pre-Requisites:
EE 3005 - Control Systems
MA2001- Engineering Mathematics III

Course Description: This course is aimed to expose the students to advanced control theory, techniques and practices adopted by the industry. The course introduces the fundamental concepts, principles and application of advanced control system. Analysis and design of control system is also included.

Course Objectives:
The objectives of the course are to
1. Explain Control system design in frequency domain.
2. Introduce Digital control system and estimate stability by using Jury criterion.
3. Explain design of non-linear control system using describing function concepts and phase-plane techniques.
4. Introduce optimal design concept, Intelligent Controllers like Fuzzy logic controller.

Course Outcomes:
After completing the course, students will able to-

CO1	Design the controller using Bode plot
CO2	Analyze and design the control system using state space approach.
CO3	Find the pulse transfer function and check the stability of system using Jury's Stability criteria
CO4	Analyze and design the nonlinear control system using describing functions and phase plane techniques
CO5	Formulate optimal control problem and find the optimal values of the parameters of the system,

Detailed Syllabus:

UNIT I	**Control System Design in Frequency domain:** Design of Lag compensation, Lead compensation, Lag-Lead compensation using Bode plot
UNIT II	**State Variable Analysis And Design:** State space representation of continuous systems solving the time –invariant state equation, State transition matrix, Eigen values and Eigen vectors, Controllability and observability criteria for time invariant systems, Pole placement using state variable feedback, Design of state observers.

UNIT III	**Digital Control Systems:** Introduction to discrete time systems, The Z transform and the inverse Z transform, Pulse transfer function, Stability using Jury criterion, Bilinear transformation.
UNIT IV	**Non Linear Control Systems:** Common physical nonlinearities, construction of phase trajectory, Describing function. Stability of nonlinear control system.
UNIT V	**Introduction to Optimal Control:** Formal statement of optimal control system, performance indices, Optimal control formulation using calculus of variation.

Text Books:

I.J. Nagrath& M Gopal, "Control Systems Engineering", New Age Publishers Fourth Edition.
M. Gopal,"Digital Control Systems", New Age Publishers Fourth Edition.

Reference Books:

1. Benjamin Kuo, "Digital Control system", Oxford.
2. K. Ogata, "Modern Control System"", Prentice Hall.
3. Lee Stoline,"Applied Non –Linear System", Prentice Hall.
4. J. Stephanpoulis,"Chemical Process Control: An Introduction to theory and Practice", Prentice Hall.
6. Norman Nice, "Control System Engineering", New Age Publishers.

Mapping Of Course Outcome with Program Outcomes:

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	P O7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15
CO1	3				3	1						1			3
CO2	3	1			3	1						1			3
CO3	3	2			3	1						1			3
CO4	3	1	1		3	1						1			3
CO5	3	2		2	3	1						1			3

1. LOW 2. MEDIUM 3. HIGH

Teacher's Assessment: Teachers Assessment of 10 marks is based on one of the / or combination of few of following,

1. Assignments
2. MCQ

EE3014:Advanced Power System	
Teaching Scheme Lectures : 03 Hrs/Week Total Credits : 03	Examination Scheme Class Test I : 15 Marks Class Test II : 15 Marks Teachers Assessment : 10 Marks End Semester Exam : 60 Marks

Pre-Requisites: EE 3004 - Power Systems I

Course description:
This Course deals with various Stability conditions of power system, causes for instability and methods of stability enhancement. Various excitation control method, Reactive power compensation and load frequency control is also dealt with.

Course Objectives:

The objectives of the course are to-

1. Explain concepts of power system stability to students.
2. Describe transient stability and methods of analysis.
3. Enumerate excitation systems to student.
4. Introduce the concept of reactive power and voltage control.
5. Explain optimal operation of generating units & grid management.

Course Outcomes:
After completing the course, students will able to-

CO1	Describe stability conditions of power systems.
CO2	Determine transient stability under various fault conditions.
CO3	Employ excitation methods.
CO4	List reactive power and voltage control methods.
CO5	Find the optimum unit commitment for a power system.

Detailed Syllabus:

UNIT I	Power system Stability: Brief review of synchronous machine equations and parameters, concept of steady state, transient and dynamic stability , Modeling of synchronous machine, the stability problem, power angle equation, node elimination techniques ,Steady state stability limit, methods to determine steady state stability limit- Clarke diagram etc., methods of improvement
UNIT II	Transient stability analysis: Swing equation , point by point solution of the swing equation, one machine connected toinfinite bus, critical clearing angle and time; equal area criterion for stability and its application to one machine infinite bus and two finite machines problems, concept of multi-

	machine system; effect of type of fault, grounding, reclosing on transient stability limit , methods of improvement
UNIT III	a] Excitation Systems: Excitation System requirements, Elements of an excitation system Types of excitation systems. b] Improvement of stability: Transient stability enhancement, small signal stability enhancement.
UNIT IV	Control of voltage and reactive power: Necessity, Various Methods, Load Frequency Control: Load frequency problem, speed governing system, automatic voltage control
UNIT V	Optimal system operation**:** System constraints, economic load sharing of units in power stations and in interconnection; incremental fuel cost method, Grid Management

Text and Reference Books:

W.D. Stevenson, "Elements of Power Systems Analysis", McGraw Hill
WadhawaC.L, "Electrical Power System", Wiley Eastern ltd.
I.J. Nagrath and D.P. Kothari, "Modern Power System Analysis", Tata McGraw-Hill
HadiSaadat, " Power System Analysis", Tata McGraw-Hill
O.I. Elgerd, "Electric Energy Systems Theory" , Tata McGraw-Hill
Stevenson W.D. and Grainger J.J., "Power System Analysis", McGraw-Hill
PrabhaKundur , "Power System Stability And Control", Tata McGraw-Hill

Mapping Of Course Outcome with Program Outcomes:

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	P O7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 13	PSO 14	PSO 15
CO1	3	2				1			1	1		1	3		
CO2	3	2				1			1	1		1	3		
CO3	3	2				1			1	1		1	3		
CO4	3	2				1			1	1		1	3		
CO5	3	2				1			1	1		1	3		

1. LOW 2. MEDIUM 3. HIGH

Teacher's Assessment: Teachers Assessment of 10 marks is based on attendance of the student and one of the or combination of few of following. However, the course co-ordinator has to announce assessment components at the beginning of the course.

1. Presentation on latest topics/Real life problems related with the subject
2. Problems based on GATE questions
3. Simulations problems
4. Quiz

Teaching Strategies: The teaching strategy is planed through the lectures, tutorials and team based home assignments.

EE3015 : Lab Switchgear and Protection	
Teaching Scheme	**Examination Scheme**
Practical : 2 Hrs/Week	Term Work : 25 Marks
Total Credits : 1	Practical &Viva : 25 Marks

Course Objectives

The objectives of the course are to-

1. Learn fundamentals of relay operation
2. Learn working & application of different switchgears
3. Learn different protection schemes for the protection of power system equipments
4. Learn recent developments in relaying

Course Outcomes:

After completion of this course students will be able to

CO 1. Do the relay settings & plot the characteristics of relay
CO 2. Explain working of circuit breakers
CO 3. Apply different protection schemes
CO 4. Know basics of static and numerical relay

List of the Experiments:

Term work shall consist of minimum eight experiments from the following:

Sr. No.	Name of the Experiments
1	Study & use switchgear testing kit.
2	Plot Characteristics of rewirable HRC fuse.
3	Plot Characteristics of over current relay.
4	Study Distance protection of transmission line.
5	Study Biased & Unbiased differential protection of transformer
6	Study Differential protection of alternator.
7	Study of vacuum circuit breaker.
8	Study of Numerical Relay.
9	Study of Air Circuit Breaker.
10	Study of Bucholz, Relay
11	Study of MCB.
12	Study of static relay.
13	Study of protection of 3-phase Induction Motor against various faults.
14	Simulation of sine and cosine type comparators in MATLAB/Simulink.
15	Visit report on protection schemes in substation.

Term work:

The term work shall consist of submitting a file for minimum eight experiments performed with neatly written records of the study, programs & observations with results.

The term work will be assessed by the course coordinator

Mapping of Course outcome with Program Outcomes:

Course outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15
CO1	3	2	1	2	1	3	2	2	1	2	2	2	3	2	
CO2	3	2	1	2	1	3	2	2	1	2	2	2	3	2	
CO3	3	2	1	2	1	3	2	2	1	2	2	2	3	2	
CO4	3	2	1	2	2	3	2	2	1	2	2	2	3	2	1

1 - Low 2 – Medium 3– High

EE 3016: Lab Microprocessors And Microcontroller	
Teaching Scheme Practical : 2Hrs/Week Tutorial : NIL Total Credits : 01	**Examination Scheme** Term Work : 25 Marks Practical and Viva-Voce : 25 Marks

Laboratory Course Outcomes:

As an outcome of completing the Laboratory course, students will able to:

CO1	Analyze and write, execute assembly language programs on 8085 microprocessor.
CO2	Analyze and write, execute assembly language programs on 8086
CO3	Analyze and write, execute assembly language programs to interface peripherals on 8085 microprocessor
CO4	Analyze and write, execute assembly language programs to interface peripherals on 8086 microprocessor
CO5	Analyze and write, execute assembly language programs and interface peripherals to 8051 microcontroller

List of Experiments:

Term-work shall consist of minimum ten experiments from the following:

Sr. No.	Details
1	Study of 8085 Trainer kit.
2	Execution of simple programs based on data transfer instructions/ on arithmetic and logical instructions
3	Execution of programs based on 16 bit data.
4	Execution of programs using any hardware interrupts of 8085.
5	Execution of programs using SID/SOD.
6	Study of 8086 Microprocessor Kit and Execution of simple programs (Data transfer, arithmetic, logical operations)
7	Interfacing of 8255,8259 to 8086
8	Interfacing of LED, LCD display to 8086
9	Study of 8051 Microcontroller
10	Interfacing of 8255 to 8051.
11	Interfacing of LED, LCD display to 8051
12	Interfacing of stepper motor to 8051
13	Interfacing of ADC/DAC to 8051

Mapping Of Course Outcome With Program Outcomes:

Course Outcome	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO 11	PO 12	PO 13	PO 14	PO 15
CO1	3	3			2	1		1		1		1	1	1	1
CO2	3	2		1	3	1	1	1	1	1		1	1	1	2
CO3	3	2		1	3	1	1	1	1	1		1	1	1	1
CO4	3	1		1	2	1		1	1	1		1	1	2	2
CO5	3			1	3	1	1	1	1	1		1		1	1

1- Low 2 – Medium 3 - High

EE 3017: Lab Power Electronics			
Teaching Scheme		**Examination Scheme**	
Lectures	: 2 Hrs/Week	Term Work	**:** 25 Marks
Tutorial	: NIL	Practical/Oral	: 25 Marks
Total Credits	: 01		

Lab Course Objectives:

The objective of the course is to give exposure and hands on training to the students to

1. Identify various power semiconductor devices and understand the fundamentals & working principles
2. Build and operate various power electronics circuits
3. Carry out performance analysis of various power electronics circuits

Laboratory Course Outcomes:

As an outcome of laboratory course, students will able to:

CO1	Describe and validate fundamentals of power electronics
CO2	Describe and use power electronics circuits
CO3	Analyze the performance of power electronics circuits
CO4	Record the operations and write technical reports
CO5	Work individually and in a team effectively

List of Experiments:

Term work shall consist of minimum eight experiments from the following :
(Software/Hardware based) Perform an experiment/simulate/study

Sr. No.	Details
1	Plot Static V-I Characteristics of SCR, IGBT, MOSFET and measure I_L, I_H, V_{BO}
2	Plot Transient Characteristics of SCR/MOSFET
3	Construct SCR using two transistors.
4	Draw waveforms of load voltages by varying firing angles for R, R-C, UJT Triggering Methods of SCR.
5	Draw waveforms of load voltages using Forced Commutation methods of SCR.
6	Draw waveforms of load voltages for single phase half wave and full wave Converter with R, RL loads.
7	Draw waveforms of load voltages for single phase half and fully controlled converter with R, RL loads.
8	Draw waveforms of load voltages for three phase converter with different types of load.
9	Observe the operation of Series/ parallel Inverters and measure associated voltages
10	Observe the operation of SCR D.C. Choppers and measure output voltage by varying duty ratio
11	Study of D. C. Power Supplies/ A. C. Power Supplies
12	Study of SCR/IGBT based Industrial applications

Mapping of Course outcome with Program Outcomes:

Course Outcome	PO1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PO 13	PO 14	PO 15
CO1	3					1						2		3	
CO2	3		2	2	2	2						2		3	
CO3	3	3	2	2	2	2		2				2		3	
CO4	3					2		2				2		3	
CO5								2	3	3		2		3	

1 – Low 2 – Medium 3 - High