ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. FOURTH YEAR SEM A (4 YDC)
EE42005: DIGITAL SIGNAL PROCESSING

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
						THEORY		PRACTICAL		TOTAL MARKS
T	P	TU	T	P	TU	CW	END SEM	SW	END SEM	
3	-	-	3	-	-	30	70	-	-	100

PRE- REQUISITE: Basic knowledge of Network Theory, Control System and Signal & Systems.

COURSE OBJECTIVES:

1. Identification of the signals and systems.
2. How to apply the principles of discrete-time signal analysis to perform various signal operations.
3. Which principles of z-transforms to finite difference equations are applicable.
4. How the principles of Fourier transforms help to describe the frequency characteristics of discrete-time signals and systems.
5. Necessity principles of signal analysis to filtering.

COURSE OUTCOMES:

After completing this course, the student will be able to:

EE42005(T).1: Knowledge about various kinds of signals, their properties and significance.

EE42005(T).2: Ability to process the signals in time and frequency domain.

EE42005(T).3: Evaluation of System functions and frequency response by using Z-Transforms.

EE42005(T).4: Capability to design Digital FIR filters using window techniques, Fourier methods and frequency sampling techniques.

EE42005(T).5: Ability to design Digital filters from Analog filters using various techniques.

EE42005(T).6: Development of Fast Fourier Transform (FFT) algorithms for faster realization of signals and systems.

COURSE CONTENTS:

THEORY:

UNIT: 1 Discrete-Time Signals and Systems - Discrete-time signals: sequences and systems, linear time-invariant systems and their properties, Difference equations, Frequency-domain representation of discrete-time signals and systems, Representation of sequences by Fourier transforms and respective properties. Sampling of Continuous-Time Signals and z-Transform - Frequency-domain representation of sampling, Reconstruction of a band-limited signal from its samples, Discrete-time processing of continues-time signals, Continuous-time processing of discrete-time signals.
UNIT: 2 z-transform - The z-transform and its properties, Properties of the region of convergence for the z-transform, Inverse z-transform, Inverse z-transform using contour integration, Complex convolution theorem, Parseval's relation, Unilateral z-transform. Transform Analysis of Linear Time-Invariant Systems - Frequency response of LTIV systems, Systems functions frequency response for rational system functions, Relationship between magnitude and phase, All-pass systems, Minimum-phase systems.
UNIT: 3 Structures of Discrete-Time Systems - Signal representation of linear constant coefficient difference equations, Basic structures of IIR systems, Transposed forms, Basic network structures for FIR systems.
UNIT: 4 Filter Design Techniques - Design of discrete-time IIR filters from continuous-time filters, Frequency transformations of low-pass IIR filters, Computer-aided design for discrete-time IIR filters, Design of FIR filters by windowing, Kaiser Window.
UNIT: 5 Discrete Fourier Transform and its Computation - Discrete Fourier series and its properties, sampling the Fourier transform Fourier representation of finite-duration sequences: Discrete Fourier Transform, Properties of DFT, Linear convolution using the discrete Fourier transform. Computation of Discrete Fourier Transform Efficient computation of the DFT, Goertzel algorithm, Decimation-in-time algorithm, Decimation-infrequency FFT algorithms, Implementation of the DFT using convolution.

ASSESMENT:

A. Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.
B. The end-term theory examination weightage is 70%.

TEXT BOOKS RECOMMENDED:

1. Proakis, "Digital Signal Processing", Prentice-Hall of India edition 2012.
2. Alan V. Oppenheim & Ronald W. Schafer, "Discrete-Time Signal Processing", second edition, Prentice-Hall, 2007.
3. Vallavaraj and Salivahanan, "Digital Signal Processing", Tata McGraw Hill, 2007.

REFERENCES BOOKS:

1. S.K Mitra, "Digital Signal Processing", fourth edition Tata McGraw Hill, 2011.
2. Schaum's Outlines, "Digital Signal Processing", Tata McGraw Hill 1999.
3. L. R. Rabiner & B. Gold, "Theory and Application of Digital Signal Processing", Prentice-Hall Englewood Cliffs, NJ, 1975.

CO-PO MAPPING:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	2	-	-	-	-	-	-	-	-	-	-
CO2	-	-	-	2	-	-	-	-	-	-	-	-
CO3	-	2	3	2	-	-	-	-	-	-	-	-
CO4	-	2	3	-	-	-	-	-	-	-	-	-
CO5	-	2	3	2	-	-	-	-	-	-	-	-
CO6	1	2	3	2	-	-	-	-	-	-	-	-
Average	1	2	3	2	-	-	-	-	-	-	-	-

ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. FOURTH YEAR SEM A (4 YDC)
IP42006: INDUSTRIAL ENGINEERING AND MANAGEMENT

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
						THEORY		PRACTICAL		TOTAL MARKS
T	P	TU	T	P	TU	CW	END SEM	SW	END SEM	
3	-	-	3	-	-	30	70	-	-	100

PRE- REQUISITE: NIL

COURSE OBJECTIVES:
This course aims to develop the productivity improvement skills among students with the applications of methods and tools of Industrial Engineering and Management.

COURSE OUTCOMES:
IP42006(T)1: To understand and apply the concepts of work study for productivity improvement.
IP42006(T)2: To comprehend the basic fundamentals of management and organization.
IP42006(T)3: To grasp and apply the concepts of personnel management and identify the problemsassociated with human resource.
IP42006(T)4: To identify and solve the problems related to quality management and apply thequantitative decision making in managerial decision making.

COURSE CONTENTS:
Theory:

Unit-1. Productivity, Method Study- Fundamentals, Procedure, Principles of Motion Economy and Therbligs. Work Measurement techniques, Time Study- Fundamentals, Procedure, Equipments, Rating, Allowances and Time standards.
Unit-2. Principles and Functions of Management, Organization- Principles, Types and Structures, Formal and Informal Organization, Span of Control, Delegation, Centralization and Decentralization.
Unit-3. Personnel Management Functions, Communication, Motivation and Leadership Theories, Recruitment, Selection, Training, Performance appraisal, Job Evaluation, and Wage Incentive Schemes.
Unit-4. Quality Control, Economics of Quality Control, Quality Assurance and TQM Fundamentals, Process Capability Studies, Control Charts for Variables and Attributes, Acceptance Sampling Plans and Economics of Acceptance Sampling.
Unit-5. Quantitative Techniques for Decision Making: Introduction to Operations Research, Models, Linear Programming, Transportation and Assignment Models and Applications, Network Techniques and applications.

COURSE ASSESSMENT:
Students will be assessed as following:

Theory paper:
End Semester Exam: 70% weightage, **Continuous assessment: 30% weightage (**Two midterm tests: 67% weightage,assignment: 16.5% weightage, regularity 16.5% weightage)

BOOKS & REFERENCES RECOMMENDED :

1. Mahajan M.Industrial Engg. and Production Management, Dhanpat Rai, New Delhi.
2. International Labour Organisation (I. L.O.), Work Study, Geneva.
3. Terry and Franklin, Principles of Management, Irwin.
4. Barnes R.M., Time and Motion Study, Wiley, New York.
5. Grant E.L., Statistical Quality Control. McGraw-Hill, New York.
6. Vohra ND, Quantitative Techniques in Management, TMH, New Delhi.

ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. FOURTH YEAR SEM A (4 YDC)
EE 42009: POWER SYSTEM-II

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
						THEORY		PRACTICAL		TOTAL MARKS
T	P	TU	T	P	TU	CW	END SEM	SW	END SEM	
3	2	-	3	1	-	30	70	40	60	200

PRE- REQUISITE: Basic knowledge of Power System.

COURSE OBJECTIVES:

1. To learn the concepts and formulation of power flow analysis.
2. To develop the knowledge of power system stability involving multi-machine systems.
3. To make aware about the fundamentals of speed governing system and the concept of control areas.

COURSE OUTCOMES:

After completing this course, the students will able to:

EE 42009(T).1: Perform steady state power flow analysis of power system networks using load flow methods.
EE 42009(T).2: Analysis of steady state stability of single and multi-machine system.
EE 42009(T).3: Ability to build mathematical model of Automatic Generation and voltage control in modern power system.
EE 42009(T).4: To impart the knowledge about distribution power system & design a radial and loop type distribution feeders. Also calculate the voltage drop and power loss in a distribution system.
EE 42009(T).5: Acquire in-depth knowledge of various circuits for generating high voltages for testing various apparatus and their measurement method.

COURSE CONTENTS:

THEORY :

UNIT: 1
Load flow studies - Formation of Y Bus matrix, load flow equations, G.S method and N-R method of load flow solution, FDLF, Economic operation of power system - Economic dispatch, Emission Dispatch, line loss, ITL, economic dispatch using Lagrangian multiplier method.

UNIT: 2 Power System Stability - Definition, classification of power system stability dynamics of synchronous machine, swing equation, equal area criterion, and solution of swing equation using step by step method
UNIT: 3 Automatic Generation Control: conventional scenario- basic generator loops, fundamental of speed governing system, Governor droop characteristics, speed regulation, load sharing by parallel generating units, block diagram of isolated power system, steady state analysis, concept of control area, AGC of two area interconnected power system, Automatic generation control in restructured power system, traditional versus restructured scenario.
UNIT: 4 Introduction to the electrical distribution system, components of distribution (substation, busbar layout & feeder configuration) nature of loads and its allocation techniques, distribution load flow techniques.
UNIT: 5 Generation and measurement of HV- study of Cockcroft Walton circuit, Vande- Graff generator, cascaded transformers, Marx circuit and impulse generators, sphere gap arrangement, voltage divider, impulse testing of transformer. Insulation Coordination - Principles of insulation coordination, BIL protective devices - surge diverters i.e. lightning arresters, ground wires, surge absorber.

ASSESMENT:

A. Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.
B. The end-term theory examination weightage is 70%.

TEXT BOOKS:

1. John, J. Grainger & W. D. Stevenson, Jr., "Power System Analysis", Tata McGraw-Hill Edition 2003.
2. C. L. Wadhwa, "High Voltage Engineering", third edition, New Age International, 2012.

REFERENCE BOOKS:

1. I.J.Nagrath and D.P.Kothari, "Modern Power System Analysis", fourth edition, Tata McGraw Hill, 2011.
2. O. L. Elgerd, "Electric Energy System Theory", McGraw-Hill New York, 1971.
3. M. S. Naidu, V. Kamaraju, "High Voltage Engineering", fifth edition, Tata McGraw-Hill Education, 2013.
4. Hadi Saadat, "Power System Analysis", Tata McGraw Hill Edition 2002.
5. A. J. Wood, B. F. Wollenberg, "Power generation, operation and control", Second Edition, John Wiley, 1996.

CO-PO MAPPING:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	-	3	-	-	-	-	-	-	1
CO2	3	3	3	-	3	1	-	-	-	-	-	1
CO3	3	3	-	-	-	-	-	-	-	-	-	1
CO4	3	3	3	-	3	-	-	-	-	-	-	1
CO5	3	3	3	-	3	1	-	-	-	-	-	1
Average	**3**	**3**	**3**	**-**	**3**	**1**	**-**	**-**	**-**	**-**	**-**	**1**

LABORATORY:

OBJECTIVES:

- To get familiar with the MATLAB.
- Understand the concept of admittance matrix and run the load flow by using of different load flow techniques.
- To understand the MATLAB code of different load flow techniques.
- Understand the MATLAB Simulink block diagram for an isolated power system and obtain frequency and power response

LABORATORY OUTCOMES:

CO1: Assemble and examine High voltage, impulse voltage generation and measurement of performance

CO2: Formulate the bus admittance matrix through MATLAB.

CO3: Perform various load flow techniques through MATLAB.

CO4: Stability analysis of single machine connected to infinite bus system.

CO5: Perform load frequency dynamics of single area and two area power system.

LABORATORY INSTRUCTIONS:

S. No.	LIST OF EXPERIMENT
1	To perform H-V test on different insulating materials and observe effect of thickness.
2	To study sphere gap arrangement for measurement of breakdown voltage of air.
3	Introduction of MATLAB, Basic commands and operations.
4	MATLAB program for formulation of YBUS given power system.

5	MATLAB program for power flow solution by Gauss-Siedel method.
6	MATLAB program for power flow solution by Newton- Raphson method
7	Load – frequency dynamics of single area power systems.
8	Load – frequency dynamics of two area power systems
9	Stability analysis single machine connected to infinite bus system.

ASSESMENT:

A. Continuous evaluation of laboratory journals with a weightage of 30%. It includes lab attendance as well as experiments performed in the lab.
B. The end-term practical examination weightage is 70%.

CO-PO MAPPING:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	1	-	-	-	3	-	1
CO2	3	3	-	-	3	-	-	-	-	3	-	-
CO3	3	3	-	-	3	-	-	-	-	3	-	-
CO4	-	3	-	-	3	-	-	-	-	3	-	-
CO5	-	3	-	-	3	-	-	-	-	3	-	-
Average	3	3	-	-	3	1	-	-	-	3	-	1

ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. FOURTH YEAR SEM A (4 YDC)
EE 42010: FAULTS AND SYSTEM PROTECTIONS

HOURS PER WEEK			CREDITS			MAXIMUMMARKS				
T	P	TU	T	P	TU	THEORY		PRACTICAL		TOTAL MARKS
						CW	END SEM	SW	END SEM	200
3	2	-	3	1	-	30	70	40	60	

PRE- REQUISITE: Basic knowledge of power system, electrical machines.

COURSE OBJECTIVES:

1. To familiarize the students with various faults occurs in a power system, their analysis andmathematical calculation.
2. To realize the concept of arc initialization and arc extinction theories in circuit breakers.
3. To provide basic concepts of protective devices such as circuit breaker and relays, theirworking principle, construction, characteristics and design parameters.
4. Acquaint students to utilize these devices in protection of various machines such as motor,generator and transformer.

COURSE OUTCOMES: after completing the course, students will be able to

EE42010 (T).1: Develop per unit representation of power system components with computational analysis of symmetrical and unsymmetrical faults**.**

EE42010 (T).2: Comprehend arc initialization and interruption techniques with realizing construction, working principle and interpreting ratings of various circuit breakers**.**

EE42010 (T).3: Assess need of protective relaying and analyze characteristics of comparators and other protective schemes**.**

EE42010 (T).4: Explore working principle, characteristics and design parameters for different types of relays and their applications**.**

EE42010 (T).5: Apply and implement various relays for protection from faults in rotating machines, transformers and bus bar.

COURSE CONTENTS:

THEORY:

UNIT: 1 Fault Studies: Per unit system of computation. PU reactance diagram symmetrical fault analysis by classical and z-bus algorithm. Symmetrical components, sequence impedance and networks. Unsymmetrical fault analysis.
UNIT: 2 Principles of circuit breaking; arc characterization , arc interruption theories, circuit breaking ratings, RRRV calculations, factors affecting re-striking voltage. Resistance switching, capacitive current breaking, current chopping. Types of circuit breakers, SF_6 and vacuum circuit breakers.
UNIT: 3 Protective relaying, General philosophy of protection, Zones of protection. Method of discrimination by location and type of fault,comparator. Duality between amplitude and phase comparator. Static comparators, characteristics of amplitude and phase comparator on complex planes. Distance relay characteristics, carrier current protection.
UNIT: 4 Electromagnetic relays, IDMT relay, Directional over current relay, Differential relay, Percentage biased differential relay. Thermal over current relay, Impedance relay, provision for single phasing.
UNIT: 5 Apparatus Protection: Generator protection, Merz price protection, stator and rotor fault protection. Transformer differential protection. Prevention of relay against magnetic inrush of harmonic current. Motor and bus bar protection.

ASSESMENT:

A. Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.

B. The end-term theory examination weightage is 70%.

TEXT BOOKS RECOMMENDED:

1. B. Ravindranath and M. Chander, "Power System Protection and Switchgear", firstedition, New Age International, 2005.
2. D. P. Kothari, I. J. Nagrath, "Modern Power System Analysis", fourth edition, TataMcGraw Hill 2011.

REFERENCES BOOKS:

1. S. P. Patra, S. K. Basu, S. Choudhary, "Power System Protection", Oxford and IBHPublishing Co, 1983.
2. J. J. Grainger, W.D. Stevenson, "Power System Analysis", Tata McGraw Hill, 2003.
3. Ashfaq Husain, "Electrical Power Systems", Fourth Edition, Cbs publication, 1994.

CO-PO MAPPING:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	2	-	-	-	-	-	-	-	-
CO2	2	2	2	2	1	-	-	-	-	-	-	-
CO3	2	2	2	2	1	-	-	-	-	-	-	-
CO4	-	2	-	2	-	-	-	-	-	-	-	-
CO5	-	2	2	2	-	-	-	-	-	-	-	-
Average	2	2	2	2	1	-	-	-	-	-	-	-

LABORATORY:

OBJECTIVES:

1. To familiar the students with practical approach to examine different faults in powersystem.
2. To provide knowledge on components and constructional features of relays and theirapplications.
3. To foster the students with various protective devices installed in power system.
4. To develop communication skill through laboratory note book with written descriptionsof procedure, result and analysis.
5. To compare theoretical prediction with experimental results of sequence reactance ofvarious machines.

LABORATORY OUTCOMES:

EE42010 (P).1: Experimentally determine the sequence reactance of synchronous machinesand transformer.

EE42010(P).2: Identify different components and constructional features ofelectromagnetic relays and apprehend their functions.

EE42010 (P).3: Conduct secondary injection test on various protective relays and find theirparameters.

EE42010 (P).4: Demonstrate operation and working of protective devices used in powersystem.

EE42010 (P).5: Analyze symmetrical and unsymmetrical faults in single phase and threephase transmission system.

LABORATORY EXPERIMENT:

S. No.	LIST OF EXPERIMENTS
1	To determine the positive and negative sequence reactance of an alternator.
2	To determine the negative sequence reactance by sub transientreactance method.
3	To determine the zero sequence reactance of an alternator by direct measurement method.
4	To determine the zero sequence reactance of an alternator by fault method.
5	To determine the zero sequence reactance of a transformer.
6	To calculate the plug setting multiplier and time setting multiplier and operating characteristics of an inverse definite minimum time (I.D.M.T.) relay.
7	To demonstrate operation and working of different types of drop out fuses.
8	To analyze the Single Line to Ground fault (L-G) of a three phase transmission line.
9	To analyze the Line to Line and Double Line to Ground fault of a three phase transmission line.
10	To analyze the symmetrical L-L-L & L-L-L-G fault of a three phase transmission line.
11	To demonstrate the under voltage and over voltage relay.
12	To calculate the plug setting multiplier and time setting multiplier and operating characteristics of differential relay.
13	To demonstrate operation and working of Air Break Switches. a) Vertical Mounting b) Horizontal Mounting

ASSESMENT:

A. Continuous evaluation of laboratory journals with a weightage of 30%. It includes labattendance as well as experiments performed in the lab.
B. The end-term practical examination weightage is 70%.

CO-PO MAPPING:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	2	2	3	1	-	-	-	-	-	-	1
CO2	2	2	2	3	1	-	-	-	2	3	-	-
CO3	2	2	2	3	1	-	-	-	2	3	-	3
CO4	2	2	2	3	1	-	-	-	2	-	-	-
CO5	2	2	2	3	1	-	-	-	-	3	-	-
Average	2	2	2	3	1	-	-	-	2	3	-	2

ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. FOURTH YEAR SEM A (4 YDC)
ELECTIVE-III
EE 42251: ADVANCED ELECTRICAL MACHINES AND DRIVES

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
						THEORY		PRACTICAL		TOTAL MARKS
T	P	TU	T	P	TU	CW	END SEM	SW	END SEM	
3	-	-	3	-	-	30	70	-	-	100

PRE-REQUISITE: Power Electronics, Electrical Machines, Control System, Basic Electrical Drives.

COURSE OBJECTIVES:

1. To impart the knowledge about fundamentals of Electric drives and control, operational strategies and to discuss Review of Electrical Drive Concepts.

2. To develop the knowledge of PMSM drives, PMBLDCM drive, switched reluctance motor drives and stepper motor drives, their controlling strategies, operation and analysis.

3. To expose students to the operation, application and basic types and control of power conversion systems employed in special electric machine drives to cater to industrial, domestic and other needs.

COURSE OUTCOMES:

At the end of the course, student must be able to,

EE42251.(T).1: Describe the structure of Electric Drive systems and their role in various applications.
EE42251.(T).2: Acquire the knowledge of selection of drives as per practical operational industrial requirement.
EE42251.(T).3: Apply their knowledge to prepare modelling, control schemes, operation and analysis as per different types of motors used in industries.
EE42251.(T).4: Use the basic principles of power electronics and concepts of control system in drives to synthesize the voltages in special motor drives and their speed and torque control.

COURSE CONTENTS:

SYLLABUS
UNIT: 1 Review of Electrical Drives: Dynamics of electrical drives, Control of electrical drives, Selection of motor power rating, classes of motor duty, DC motor drives, Induction motor drives, synchronous motor drives.
UNIT: 2 Permanent Magnet Synchronous Motor (PMSM) Drives: Introduction, Synchronous Machines with PMs, Vector control of PM Synchronous motor (PMSM), Control strategies, Flux weakening operation, Speed controller Design, Sensor-less control, Parameter Sensitivity.
UNIT: 3 PM Brushless DC Motor (PMBLDCM) drives: Analogy with DC motor, Modelling of PM Brushless DC Motor, PMBDLCM drive scheme, Commutation-torque ripple, Phase advancing, Normalized system equation, Half wave PMBLDCM Drives, Sensor-less Control of PMBDLCM Drives, torque smoothing, Parameter sensitivity of the PMBLDCM Drives.
UNIT: 4 Switched Reluctance Motor Drives: Operation and Control requirements, Selection of pole, phase and windings, Static Torque production, Converter circuit, Modes of operation.
UNIT: 5 Stepper motor Drives: Important features, torque versus stepping rate characteristics, drive circuits for stepper motors.

ASSESMENT:

A. Continuous evaluation through two mid-term tests with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.

B. The end-term theory examination weightage is 70%.

TEXT BOOKS:

1. G. K. Dubey, “Fundamentals of Electrical Drives”, second edition Alpha Science International ltd.,2002

2. J. M. D. Murphy, “Thyristor control of A.C. motors”, Pergamon Press, 1973.

3. B. K. Bose, “Modern Power Electronics and AC Drives”, Prentice-Hall 2007.

4. W. Leonhard, “Control of Electric Drives”, third edition, Springer, 2001.

REFERENCE BOOKS:

1. R. Krishnan, "Electric motor Drives modelling, analysis and control", PHI Learning Pvt. Ltd, 2011.
2. V Subrahmanyam, "Electric Drives Concepts and Applications", Tata McGraw Hill Publishing Company Ltd, 1996.
3. S. K. Pillai, "A First Course on Electrical Drives", New Age International Pvt. Ltd, 2004.

CO-PO MAPPING:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	-	-	-	-
CO2	3	3	1	1	-	-	-	-	-	-	-	-
CO3	3	3	1	1	-	-	-	-	-	-	-	-
CO4	3	3	1	1	-	-	-	-	-	-	-	-
Average	**3**	**3**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. FOURTH YEAR SEM A (4 YDC)
ELECTIVE-III
EE 42252: POWER QUALITY

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
						THEORY		PRACTICAL		TOTAL MARKS
T	P	TU	T	P	TU	CW	END SEM	SW	END SEM	
3	-	-	3	-	-	30	70	-	-	100

PRE- REQUISITE: Basic knowledge of Power System, Power Electronics.

COURSE OBJECTIVES:

1. To know different terms of power quality.
2. To develop the knowledge about the effect of non-linear loads and disturbances on sensitive loads.
3. To know the standards and classification of power quality disturbances.
4. To study the causes, effects and mitigation of voltage sag, interruption and over voltages.
5. To develop the brief concepts of harmonic and mitigation techniques.
6. To study the power quality monitoring method, equipment and develop the ability to analyze the measured data.

COURSE OUTCOMES:
After completing this course students will able to:

EE 42252 (T).1: Define various power quality terms.
EE 42252 (T).2: Analyze current and voltage related power quality issues and their remedies.
EE 42252 (T).3: Illustrate the various mitigation methods of various power quality problems.

EE 42252 (T).4: Assess the severity and solution to harmonics, a power quality problems in distribution system.

EE 42252 (T).5: Demonstrate the concept of power quality conditioners to suppress power system disturbances.

EE 42252 (T).6: Examine various aspects of power quality measurements and analysis.

COURSE CONTENTS:
THEORY:

Unit	Syllabus
1.	Introduction to electrical power quality: definition of power quality, terms used in power quality, power quality issue, electric power quality standards.
2.	Power frequency disturbance: common power frequency disturbances, voltage sag & interruptions, isolation transformer, voltage regulator, static UPS systems.
3.	Electrical transients: types and causes of transients, atmospheric causes, switching on or off, interruption of fault circuits, capacitor switching transients, motor start transients, power factor correction.
4.	Harmonics: definition of harmonics, causes of voltage and current harmonics, individual and total harmonics distortion, effects of harmonics on power system devices, guidelines for harmonic voltage and current limitation, harmonic current mitigation techniques.
5.	Power quality monitoring and conditioning: monitoring considerations, power quality measurement equipment, power quality monitoring standards, shunt and series compensators, custom power devices, DSTATCOM, DVR, and UPQC.

COURSE ASSESSMENT:

A. Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes attendance as well as assignments on the course topics.
B. The end-term theory examination weightage is 70%.

TEXT BOOKS RECOMMENDED:

1. R. C. Dugan, M. F. McGranaghan, Surya Santoso, H. W. Beaty "Electrical Power Systems Quality", Tata McGraw Hill Education Pvt. Ltd., 2013.
2. C. Sankaran, "Power Quality", CRC Press.

REFERENCES BOOKS:

1. G. T. Heydt, "Electric Power Quality", Stars in a Circle Publications, 1994.
2. A. Ghosh, G. Ledwich, "Power quality enhancement using custom power devices", Kluwer Academic Press, 2002.

CO-PO MAPPING:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	2	-	-	-	-	-	-	-	-	-	-
CO2	3	2	-	-	-	-	-	-	-	-	-	-
CO3	-	-	3	-	-	-	2	-	-	-	-	-
CO4	3	-	3	-	-	-	-	-	-	-	-	-
CO5	-	2	-	-	1	-	-	-	-	-	-	-
CO6	-	-	3	-	-	1	2	-	-	-	-	-
Average	3	2	3	-	1	1	2	-	-	-	-	-

ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. FOURTH YEAR (4 YDC) SEM A
EE42498: MAJOR PROJECT PHASE I

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
						THEORY		PRACTICAL		TOTAL MARKS
T	P	TU	T	P	TU	CW	END SEM	SW	END SEM	
-	8	-	-	4	-	-	-	40	60	100

COURSE OUTCOMES:
After completing the Major Project Phase I, the student will able to:

EE42498 (P).1: Identify problem of a selected area in engineering domain.

EE42498 (P).2: Explore the state of art of the selected problem.

EE42498 (P).3: Formulate the problem and suggest expected outcomes of the solution using software/hardware.

EE42498 (P).4: Integrate the information from multiple sources and demonstrate an application of appropriate societal and professional ethical standards.

EE42498 (P).5: summarize the findings in terms of technical report.

CRITERIA AND RUBRICS

INTERNAL ASSESSMENT

Maximum Marks: 40 Marks
Student will be judged using following criteria and rubrics:

S. No	Criteria	Marks	CO
1	Selection of Problem	5	CO1
2	Literature survey	10	CO2
3	Proposed Design	10	CO1,CO3,CO4
4	Impact on Society	5	CO4
5	Report	10	CO5

EXTERNAL ASSESSMENT:

Maximum Marks: 60 Marks
Student will be judged using following criteria and rubrics:

S. No.	Criteria	Marks	CO
1	Presentation	10	CO1, CO2,CO3
2	Organization of Thesis	20	CO5
3	Learning Outcome	10	CO3
4	Ethical Practise	5	CO4
5	Results	10	CO1,CO2, CO3
6	Confidence	5	CO1, CO4

CO-PO MAPPING:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	3	3	-	-	2	1	3	3	2	-
CO2	3	3	3	3	-	-	2	1	3	3	2	-
CO3	3	3	3	3	3	3	2	1	3	3	2	2
CO4	3	3	3	3	3	3	2	3	3	3	2	2
CO5	3	3	3	3	3	-	2	3	3	3	2	-
Average	3	3	3	3	3	3	2	3	3	3	2	2

ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. FOURTH YEAR SEM A (4 YDC)

EE42481: EVALUTION OF INTERNSHIP-II

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
						THEORY		PRACTICAL		TOTAL MARKS
T	P	TU	T	P	TU	CW	END SEM	SW	END SEM	
-	-	-	-	2	-	-	-	40	60	100

COURSE OUTCOMES:

After completing the Industrial Internship and seminar, student will able to:
EE42481(P).1: Select the industry and construct the company profile in terms of structure, product, services offered with brief history and key achievement.
EE42481(P).2: Asses their strength, weakness, and opportunity in the selected industry.
EE42481(P).3: Apply theoretical knowledge in practical situation by completing the task in given time period.
EE42481(P).4: Apply time management skill to complete the task and prepare draft report of the findings.
EE42481(P).5: Analyze the functioning of industry and suggest the changes for improvement of their services.

CRITERIA AND RUBRICS

INTERNAL ASSESSMENT

Maximum Marks: 40 Marks
Student will be judged using following criteria and rubrics:

S.No.	Criteria	Marks	CO
1	Learning Outcome	10	CO1, CO3, CO4
2	Time line	5	CO4
3	Leadership Developed	10	CO2, CO4
4	Organisation of Report	15	CO4, CO5

EXTERNAL ASSESSMENT

Maximum Marks: 60 Marks
Student will be judged using following criteria and rubrics:

S.No	Criteria	Marks	CO
1	Future Goals	5	CO5
2	Presentation	10	CO3
3	Technical Knowledge	20	CO1, CO2
4	Organisation of Report	20	CO3
5.	Confidence	5	CO4, CO5

CO-PO MAPPING:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	2	-	-	3	-	-	-	-	-	-	-	-
CO2	-	-	-	-	-	-	-	2	3	-	-	-
CO3	3	3	3	3	3	-	-	-	-	-	-	-
CO4	-	-	-	-	3	-	-	-	-	-	3	2
CO5	-	-	-	-	-	1	-	-	3	3	3	-
Average	2.5	3	3	3	3	1	-	2	3	3	3	2

ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. FOURTH YEAR SEM B (4 YDC)
ELECTIVE – IV
EE 42XXX: POWER SYSTEM DYNAMICS AND CONTROL

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
						THEORY		PRACTICAL		TOTAL MARKS
T	P	TU	T	P	TU	CW	END SEM	SW	END SEM	
3	-	-	3	-	-	30	70	-	-	100

PRE- REQUISITE: Basic knowledge of Power System-I and II is required.

COURSE OBJECTIVES:

1) Develop detail model of synchronous machine for dynamic studies.
2) Analyze synchronous machine model for steady state & transient state
3) Develop models of different excitation systems
4) Extend concept of mathematical modeling for transmission line and loads

COURSE OUTCOMES:

EE 42XXX(T) 1: Implement principles of modelling and analysis of power systems subject to components of Power Systems
EE 42XXX(T) 2: Analyze the model of synchronous machine and Excitation system
EE 42XXX(T) 3: Apply the principles of modelling and for transmission line and load.

COURSE CONTENTS:

THEORY:

UNIT: 1: Modeling of Power System Components: The need for modeling of power system, different models for power system analysis. Transformer modeling, tap-changing & phase-shifting transformer modeling.
UNIT: 2 Synchronous machine modelling: Model for steady-state analysis. The development of model for dynamic studies. The current & flux linkage models using Park's transformation leading to simulation as linear model.
UNIT: 3 Excitation system modelling: Simplified view of excitation control, Excitation configuration, Excitation control systems using dc generator exciter, alternator-rectifier, and alternator-SCR, voltage regulators such as electro-mechanical and solid state.

UNIT: 4

Modeling of Transmission Lines and Loads: Transmission Line Physical Characteristics. Transmission Line Modeling. Load Models - induction machine model. Other Subsystems - HVDC, protection systems.

UNIT: 5

Power system stabilizer: Introduction, control signals, Power System Stabilizer, structure – Stabilizer based on shaft speed signal (delta omega) – Delta P-Omega stabilizer, Frequency based stabilizers, digital stabilizer, designing methods of stabilizer, recent development and trends in PSS. Role of Power system stabilizer in multimachine small signal stability analysis.

ASSESMENT:

A. Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.
B. The end-term theory examination weightage is 70%.

TEXT BOOKS:

1. K. R. Padiyar, Power System Dynamics, Stability & Control, 2nd Edition, B.S. Publications, Hyderabad, 2002.
2. Power System Control and Stability – Vol. – I – Anderson & Foud, IEEE Press, New York.
3. P.Kundur, 'Power System Stability and Control', McGraw Hill Inc., USA, 1994.
4. M.A.Pai and W.Sauer, 'Power System Dynamics and Stability', Pearson Education Asia, India, 2002.

REFERENCE BOOKS:

1. Power System Operation & Control – P.S.R. Murthy.
2. "Electrical Energy System Theory – an introduction" by Olle Elgerd. TMH Publishing Company 2nd Edition, New Delhi.
3. "Power System Analysis" – John J. Granier and W.D. Stevenson Jr, 4th Edition, Mcraw Hill International student edition.
4. R.Ramunujam," Power System Dynamics Analysis and Simulation, PHI Learning Private Limited, New Delhi, 2009.

ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. FOURTH YEAR (4 YDC) SEM B
ELECTIVE-IV

EE 42602: ELECTRIC AND HYBRID VEHICLES

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
						THEORY		PRACTICAL		TOTAL MARKS
T	P	TU	T	P	TU	CW	END SEM	SW	END SEM	100
3	-	-	3	-	-	30	70	-	-	

PRE-REQUISITE: Basic knowledge of motors, energy storage and power electronics, simple mechanical systems, differential equations and control theory.

COURSE OBJECTIVES:

Objective of the course is to enhance the learning domain of the students such that they are able to,

1. Differentiate between the functioning of IC engine based vehicles and electric vehicles.
2. Identify the types of motors and drive trains used in electric cars.
3. Discuss the application of power electric converters used in electric vehicles and the operation of DC/DC converters.
4. Describe the principles of battery operation& Estimate the battery performance.
5. Develop the basic understanding of charging methods of EVs covering: AC charging, DC charging, smart charging, vehicle to-grid technology, ICT for charging.

COURSE OUTCOMES:

At the end of course, the student will be able to,

EE42602(T).1: Differentiate the constructional features of electric vehicles and hybrid electric vehicles. Describe their working & Select the different drive trains and motors based on the application.

EE 42602(T).2: Recognize the various charging schemes for EV's,& elucidate the need of battery management system inelectric vehicles.

EE 42602(T).3: Explain the wireless and on-road charging of EV's, and classify the different communication protocols in electric vehicles.

EE 42602(T).4: Interpret the mathematical model of an electric vehicle and analyze the performance of vehicle on different road conditions.

EE 42602(T).5: Categorize the different control strategies and algorithms for an electric vehicle.

THEORY:

COURSE CONTENT
UNIT: 1 Introduction to electric cars: Comparison different drive-trains: (Internal combustion engine vehicles, Hybrid electric vehicles, Plug in hybrid electric vehicles, Full Electric vehicles, Hydrogen fuel cell vehicles), constructional features, working, motors (dc motor, BLDC, PMSM, Induction motor) and their effect on dynamics.
UNIT: 2 Electrical propulsion system: Various drives based system configurations, mathematical modelling and analysis of the driveline (Power train, chassis & wheels, engine, suspension system)
UNIT: 3 Energy storage (Li-ion): battery losses, battery packs and battery management systems, Charging requirements: DC-DC converters for battery charging, AC charging such as Type 1,2,3 and DC charging and Chademo, Tesla and CCS.
UNIT: 4 Automotive Communication protocols: ICT and communication protocols required to implement EV charging and smart charging, Concept of wireless and on-road charging of EVs, microgrids for EV charging, using renewable energy sources.
UNIT: 5 Control & Performance analysis of an electric vehicle: Control algorithms -classical and modern control methods, observer design, and electric vehicle control using DSP.

ASSESSMENT:

A. Continuous evaluation through two mid sem test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.
B. The end-term theory examination weightage is 70%.

TEXT BOOKS RECOMMENDED:

1. Ali Emadi, "Handbook of Automotive power Electronics and Motor Drives", CRC Press, 2005.
2. M. Wang, R. Zhang and X. Sheng, "Mobile Electric Vehicle, Online Charging & Discharging" Springer, 2015.

REFERENCES BOOKS:

1. Mehrdad Ehsani, Yimin Gao, Sebastien E. Gay and Ali Emadi, "Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Fundamentals, Theory, and Design," CRC Press, London.
2. N.**Patel**, A.K. **Bhoi**, S. **Padmanaban**, J.B. **Holm-Nielsen**, "Electric Vehicles, Modern Technologies and Trends," Springer, 2021.

CO-PO MAPPING:

CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO10	PO11	PO12
CO1	1	2	3	-	-	-	1	-	-	-	-	-
CO2	1	2	3	2	-	1	1	-	-	-	-	-
CO3	-	-	-	2	1	1	-	-	-	-	-	-
CO4	1	2	3	-	-	-	-	-	-	-	-	-
CO5	-	-	3	2	1	-	-	-	-	-	-	-
Average	1	2	3	2	1	1	1	-	-	-	-	-

ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. FOURTH YEAR (4 YDC) SEM B
EE 42660 : HVDC & FACTS

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
						THEORY		PRACTICAL		TOTAL MARKS
T	P	TU	T	P	TU	CW	END SEM	SW	END SEM	
3	-	-	3	-	-	30	70	-	-	100

PRE- REQUISITE: Basic knowledge of Power system-I, Power system-II & Power Electronics is required

COURSE OBJECTIVES:
Students will be able to

1. Explain the importance of HVDC transmission, also analyse HVDC converters and their control characteristics.
2. Design filters to reduce harmonics in HVDC transmission systems.
3. Explain HVDC light systems and also compare them with classical systems.
4. Model HVDC system for AC-DC power flow.
5. Explain the importance of FACTs controllers, their different types and devices used.
6. Explain the objectives of shunt compensation and the FACTs controller used for shunt compensation.
7. Explain the objectives of series compensation and the FACTs controller used for series compensation.

COURSE OUTCOMES:
At the end of the course, students will develop ability to:

EE42660(T).1: Develop the knowledge of HVDC transmission, HVDC light system, HVDC converters and the applicability and advantages of HVDC transmission over conventional AC transmission.
EE42660(T).2: Formulate and **solve** mathematical problems related to rectifier and inverter control methods and learn about different control schemes as well as starting and stopping of DC links. Also able to model HVDC systems for AC-DC power flow.
EE42660(T).3: Analyze the different harmonics generated by the converters and their variation with the change in firing angles. **Develop** harmonic models and use the knowledge of circuit theory to develop filters.
EE42660(T).4: Develop the understanding of FACTs controller, types of FACTs controller.
EE42660(T).5: Analyze and select various FACTs devices and apply them for solving the problems of the AC transmission system.

EE42660(T).6: Develop mathematical and circuit models of the FACTs devices and use them for series compensation, shunt compensation, controlling the line power flow and enhancing transmission capacity.

COURSE CONTENTS:

THEORY:

UNIT: 1
Introduction to high voltage direct current transmission system, General aspects of HVDC system and comparison with AC transmission, Solid state devices and valves in HVDC system, Converter and inverter circuit operation in HVDC system, Control of HVDC system, Harmonic generation and their elimination.
UNIT: 2
HVDC light system, Multi-pulse voltage source converter based system, Modelling of HVDC system for AC-DC power flow, recent trends in HVDC system.
UNIT: 3
Introduction to Flexible A.C. Transmission Systems, Classification of FACTS Devices, Power electronics devices used in FACTS devices, Objectives of Shunt Compensation, Thyristor Controlled Reactor, operation, Thyristor switched Capacitor, operation, firing schemes, configurations. Static Var Compensator, characteristics and control scheme.
UNIT: 4
Synchronous Condenser for Reactive Power Compensation, Static Compensators (STATCOM), operation, V-I characteristics, STATCOM, control schemes, direct & Indirect Control.
UNIT: 5
Objectives of Series Compensation, thyristor Controlled Series Capacitors, operation, V-I characteristic, TCSC, basic Control schemes, Static Synchronous Series Compensator (SSSC).

ASSESSMENT:

A. Continuous evaluation through two mid-term tests with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.
B. The end-term theory examination weightage is 70%.

TEXT BOOKS:

1. E.W. Kimbark, "Direct Current Transmission System, vol. I", Wiley Inter-science, New York, 1971.
2. T. J. E. Miller, "Reactive Power Control in Electric System", Wiley, 1984.
3. K. R. Padiyar, "HVDC Power Transmission System: Technology and System Interactions," John Wiley 1990.

REFERENCE BOOKS:

1. R. M. Mathur, "Static Compensators for Reactive Power Control", Cantext Publications, Winnipeg, Canada, 1986.
2. C. Adamson and N.G. Hingorani, "High voltage Direct current power transmission", Garraway publication, London, digitized 2006.
3. P.Kundur, "Power System Stability and control" Tata Mcgraw Hills, fifth reprint 2008.
4. Vijay K. Sood, "HVDC and FACTS controllers, Application of Static Converters in Power Systems," Kluwer Academic Publishers, 2004.

CO-PO MAPPING:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	-	-	-	-	-	-	-	-	-
CO3	3	-	3	-	-	-	-	-	-	-	-	-
CO4	-	3	3	-	-	-	-	-	-	-	-	-
CO5	3	3	3	2	-	-	-	-	-	-	-	-
CO6	3	3	3	2	-	-	-	-	-	-	-	-
Average	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. FOURTH YEAR SEM B (4 YDC)
ELECTIVE IV
EE42XXX: GRID CONVERTERS FOR PHOTOVOLTIAC & WIND ENERGY CONVERSION SYSTEMS

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
						THEORY		PRACTICAL		TOTAL MARKS
T	P	TU	T	P	TU	CW	END SEM	SW	END SEM	
3	-	-	3	-	-	30	70	-	-	100

PRE-REQUISITE: Power Electronics I & II.

COURSE OBJECTIVES: Following are course objectives,
1. Understand the recent development in semiconductor switches.
2. Explore the different grid interfaced converters for its field applications.
3. Differentiate among the topologies of grid interfaced converters and select the most suitable one.
4. Demonstrate the concept of soft switching in AC/DC converters.

COURSE OUTCOMES: At the end of course, the student will be able to,
CO1: Recognize the development in the semiconductor technology, identify the need of gate drivers, and explain parallel connection of transistors.
CO2: Describe parameters used in PWM operation, observe and analyze performances of different topologies of voltage source converter and choose the appropriate one of given application.
CO3: Discuss and describe principle of operation of CSI, sketch waveforms and power circuit of CSI for given application.
CO4: Explain the differences in ZSI, VSI and CSI based on merits, estimate values of components and analyze performance of topologies.
CO5: Extend the concept of the soft switching in inverters, identify topologies and working principle and show its design considerations.

COURSE CONTENT:

Unit 1: Recent Advances in Power Semiconductor Technology, Introduction, Silicon Power Transistors, Overview of SiC Transistor Designs, Gate and Base Drivers for SiC Devices, Parallel Connection of Transistors
Unit 2: Pulse Width-Modulated voltage source inverter, introduction, Parameters Used in PWM Operation, modulation Ratios and harmonic factor, Three-Phase Full-Bridge VSI, Vector Analysis, Multicell and Multilevel PWM Inverter, design problems.
Unit 3: Three-Phase full-bridge current source inverter (CSI), boost-type CSI, negative polarity input Voltage and positive polarity input voltage, CSI with L-C Filter, design problems, applications.
Unit 4: Impedance source inverters, basic topologies, principle of operation, waveforms, Comparison with VSI and CSI, Equivalent Circuit and Operation, Circuit Analysis and Calculations, basic topologies, Quasi Impedance source inverter (QZSI), Extended Boost QZSI topologies, applications.
Unit 5: Soft-Switching DC/AC Inverters, Resonant Circuit, Design Considerations, Control Scheme, Resonant Pole Inverter, topology, operating principle, applications.

Course Assessment: Continuous evaluation of Students for CW (30 marks) based on

S. No.	Details	weightage
1	Midterm test (2)	50%
2	Quiz (3)	20%
3	Assignment (3)	20%
4	Group Discussion (1)	10%

The end-term theory examination weightage is 70%.

TEXT BOOKS:

1. Fang Lin Luo and Hong Ye **Fang** "Advanced DC/AC Inverters: Applications in Renewable Energy," CRC Press, 2013.
2. Haitham Abu-Rub, Mariusz Malinowski and Kamal Al-Haddad "Power Electronics for Renewable Energy Systems, Transportation and Industrial Applications," IEEE Press, 2014.

REFERENCE BOOKS:

1. Branko L. Dokić • Branko Blanuša "Power Electronics Converters and Regulators," Third Edition, Springer, 2015.
2. Ewald F. Fuchs and Mohammad A.S. Masoum " Power Conversion of Renewable Energy Systems," Springer, 2012.

ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. FOURTH YEAR SEM B (4 YDC)
EE42XXX : REAL TIME OPERATING SYSTEM

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
						THEORY		PRACTICAL		TOTAL MARKS
T	P	TU	T	P	TU	CW	END SEM	SW	END SEM	
3	-	-	3	-	-	30	70	-	-	100

Re-Requisite: Basics of C programming, Basics of microprocessor and Operating System

Course Objectives:

1. To introduce the characteristics of real-time systems & their different types and to discuss the characteristics and constraints of some commercial real-time operating systems.
2. To discuss and analyze different task scheduling algorithms in uniprocessor and multi processor environments.
3. To discuss the features and algorithms for real-time communications to take place in different network structures.
4. To explain the characteristics of real-time databases and their applications in real world.

Course Outcomes (COs):
After completing the course, student will able to:

CO1: Understand and develop real-time applications.
CO2: Develop efficient algorithms for real-time task scheduling in uni-processor and multi processor environments.
CO3: Get an exposure to the different types of commercial real-time operating systems.
CO4: Identify the limitations of a non real-time operating system in running a real-time application.
CO5: Identify and address the important issues in real-time communications and will be able to use real-time databases.

COURSE CONTENTS:

UNIT 1: Introduction to Real-Time systems: Basic concepts, applications of Real-Time systems, basic model of Real-Time systems, characteristics of Real-Time systems, types of Real-Time systems: hard, firm, soft, timing constraints, modeling timing constraints.

UNIT 2: Real-Time task scheduling: Basic concepts, clock driven scheduling, table driven scheduling, cyclic, schedulers, hybrid schedulers, event driven scheduling, EDF Scheduling, RMA, DMA, resource sharing among RT tasks, Priority inversion, Priority Inheritance Protocol, Highest Locker Protocol, Priority Ceiling Protocol.
UNIT 3: Scheduling Real-Time tasks in multiprocessor and distributed systems, Fault tolerant scheduling of tasks, clocks in distributed Real-Time systems.
UNIT 4: Commercial Real-Time Operating Systems: Time services, Features of real-time operating systems, UNIX and Windows as RT OS, POSIX, PSOS, VRTX, QNX, RT Linux, Lynx, other RT OS, bench marking RT OS, Real-Time OS: OS services, I/O subsystem, Network OS.
UNIT 5: RT communications: QoS framework, models, Real-Time Communication in a LAN, IEEE 802.4, RETHER, Communication over Packet Switched Networks, Routing algorithms, RSVP, rate control. RT databases: Applications, characteristics of temporal data, Concurrency control, Commercial RT databases, Special topics in Real-Time systems.

ASSESMENT:

A. Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.
B. The end-term theory examination weightage is 70%.

TEXT BOOKS

1. R. Mall, *Real-Time Systems*, Pearson , 2007
2. J. W. S. Liu, *Real-time Systems*, Pearson Education , 2008
3. J. Puhan, Operating Systems, Embedded Systems, and Real-Time Systems, FE Publishing, 2015
4. K.C. Wang, Embedded and Real-Time Operating Systems, Springer International Publishing, 2017
5. S. Siewert and J. Pratt, Real-time Embedded Components and Systems with Linux and RTOS, Mercury Learning and Information LLC, 2016

REFERENCE BOOKS:

1. **C. M. Krishna and K. G. Shin, *Real-Time Systems*, McGraw Hill , 2004**
2. P. A. Laplante, *Real-Time Systems Design and Analysis*, Willey , 2004

ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. FOURTH YEAR SEM B (4 YDC)
ELECTIVE-V
EE42703: SMART GRID: STRUCTURE, MONITORING AND CONTROL

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
						THEORY		PRACTICAL		TOTAL MARKS
T	P	TU	T	P	TU	CW	END SEM	SW	END SEM	
3	-	-	3	-	-	30	70	-	-	100

PRE- REQUISITE: Power System I & II

COURSE OBJECTIVES:

1. To impart the knowledge of smart grid, need for smart grid domain, enablers, priority areas and regulatory challenges, smart-grid activities in India.
2. To explain the basic fundamentals components of Smart Grid designs, Transmission Automation, Distribution Automation.
3. To accomplish the different tools and computational techniques for smart grid.
4. To interpret students with the different communication technologies in Smart Grid.
5. To estimate the distribution generation technologies.

COURSE OUTCOMES:

After completing this course, the student will be able to

EE42703.(T).1: Understand the function of smart grid is, what is the futuristic grid.
EE42703.(T).2: Assess the role of automation and digitization in Transmission and Distribution.
EE42703.(T).3: Addresses the issues related to implementation of smart grid approach through various techniques.
EE42703.(T).4: Analyze Smart grids and Distributed Energy Resources (DER) with evolutionary algorithms.
EE42703.(T).5: Distinguish potential impacts of emerging technologies on distribution network operation.
EE42703.(T).6: Determining the selected smart distribution and customer system projects.

COURSE CONTENTS:
THEORY:

UNIT: 1

INTRODUCTION TO SMART GRID

Definition of smart grid, need for smart grid, smart grid domain, enablers of smart grid, smart grid priority areas, regulatory challenges, smart-grid activities in India.

UNIT: 2

SMART GRID ARCHITECHTURE

Introduction, Today's Grid versus the Smart Grid, Energy Independence and Security Act of 2007: Rationale for the Smart Grid, Smart grid architecture, standards-policies. The fundamental components of Smart Grid designs, Transmission Automation, Distribution Automation, General View of the Smart Grid Market Drivers, Stakeholder Roles and Function, Working Definition of the Smart Grid Based on Performance Measures, Representative Architecture, Functions of Smart Grid Components.

UNIT: 3

TOOLS AND TECHNIQUES FOR SMART GRID

Computational Techniques – Static and Dynamic Optimization Techniques for power applications such as Economic load dispatch – Computational Intelligence Techniques – Evolutionary Algorithms in power system – Artificial Intelligence techniques and applications in power system.

UNIT: 4

SMART GRID COMMUNICATIONS

Introduction to Communication Technology, Two Way Digital Communications Paradigm, Synchro Phasor Measurement Units (PMUs) – Wide Area Measurement Systems (WAMS)- Introduction to Internet of things (IoT)- Applications of IoT in Smart Grid.

UNIT: 5

DISTRIBUTED GENERATION TECHNOLOGIES

Active distribution networks, microgrids, distribution system automation, reliability and resiliency studies, Smart city pilot projects, essential elements of smart cities.

ASSESMENT:

A. Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.
B. The end-term theory examination weightage is 70%.

TEXT BOOKS RECOMMENDED:

1. Lars.T.Berger, K.Iniewski, "Smart Grid: Applications, Communications & Security" Wiley India Pvt. Ltd, Reprint 2015.
2. James Momoh, "Smart Grid: Fundamentals of design and analysis", John Wiley & sons Inc, IEEE press 2012.

REFERNCES BOOKS:

1. A.G. Phadke and J.S. Thorp, "Synchronized Phasor Measurements and their Applications", Springer, 2nd Edition, 2017.

2. Fereidoon P. Sioshansi, "Smart Grid: Integrating Renewable, Distributed & Efficient Energy", Academic Press, 2012.

CO-PO MAPPING:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	1	1	2	-	-	-	-	-	-	-	-	-
CO2	1	1	2	3	2	1	-	-	-	-	-	-
CO3	-	-	-	3	2	-	-	-	-	-	-	-
CO4	-	-	2	3	2	1	1	-	-	-	-	-
CO5	-	-	2	3	2	1	1	-	-	-	-	-
CO6	-	-	2	3	-	-	-	-	-	-	1	1
Average	1	1	2	3	2	1	1	-	-	-	1	1

ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. FOURTH YEAR SEM B (4 YDC)
ELECTIVE-V
EE42704: OPTIMIZATION TECHNIQUES APPLIED TO POWER SYSTEM

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
						THEORY		PRACTICAL		TOTAL MARKS
T	P	TU	T	P	TU	CW	END SEM	SW	END SEM	
3	-	-	3	-	-	30	70	-	-	100

PRE- REQUISITE: Basic knowledge of Power System, Reliability Engineering and mathematics at XII level are required

COURSE OBJECTIVES:

1. To introduce the concept of maxima and minima of linear and nonlinear programming.
2. To learn the different classical and intelligent optimization methods to solve power system problems.
3. To understand the multi-objective optimization methods in power system problem solving.
4. To explain basics of magnetic circuit and its practical aspects.
5. To impart the knowledge of hybrid optimization of PSO, GAs and EA.
6. To teach students basic algorithms, flowchart, modelling and application of various optimization techniques.

COURSE OUTCOMES:

After completing this course, the student will be able to

EE42704 (T).1: Apply knowledge of science, mathematics and power systems to explain optimization techniques, formulate various objective functions and constrained mathematical models using classical and intelligent approaches.

EE42704 (T).2: Utilize linear programming concepts in power system problems such as Simplex Method-I, analytical and graphical method. Describe integer programming with LPP.

EE42704 (T).3: Carry out non-linear programming calculations and analyse constrained and unconstrained problems of Maxima and Minima including Lagrangian Method & Kuhn Tucker conditions.

EE42704 (T).4: Develop genetic Algorithm and traditional methods to Analyse Principles of Genetic Algorithm, Evolutionary Strategy and Evolutionary Programming.

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EE42704 (T).5: Illustrate the algorithm of Particle Swarm Optimization and develop the ability to hybrid optimization for particular applications.

COURSE CONTENTS:

THEORY:

UNIT: 1 Fundamentals of optimization techniques: Definition-Classification of optimization problems-Unconstrained and Constrained Optimization-Optimality Conditions-Classical Optimization techniques (Lamda Iteration method)
UNIT: 2 Linear programming: Examples of linear programming problem, The Simplex Method I, Fundamental theorem of linear programming, Weak and strong duality theorems, Integer programming, Network flow, develop a linear programming model from problem description.
UNIT: 3 Non-linear Programming: Unconstrained problems of Maxima and Minima, Constrained problems of Maxima and Minima: Equality and inequality constraints, Lagrangian Method, Kuhn Tucker conditions.
UNIT: 4 Genetic Algorithm: Introduction to genetic Algorithm, working principle, Principles of Genetic Algorithm Evolutionary Strategy and Evolutionary Programming-Genetic Operators-Selection, Crossover and Mutation fitness function. GA operators; Similarities and differences between GA and traditional methods; Unconstrained and constrained optimization using Genetic Algorithm.
UNIT: 5 Particle Swarm Optimization: Fundamental Principle-Velocity Updating-Advanced Operators-Parameter selection- Hybrid approaches (Hybrid of GA and PSO, Hybrid of EP and PSO) - Binary, discrete and combinatorial.

ASSESSMENT:

A. Continuous evaluation through two mid-term tests with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.
B. The end-term theory examination weightage is 70%.

TEXT BOOKS RECOMMENDED:

1. S.S.Rao, Engineering Optimization, 3rd Edition, New Age International (P) Ltd.
2. D. E. Goldberg, Genetic Algorithm in Search, Optimization and Machine Learning, Wesley Longman Publishing Co., Inc. Boston, MA, USA.
3. S.N. Sivanandam, S. N. Deepa, Principles of Soft Computing, Wiley India Pvt. Ltd.

REFERENCES BOOKS:

1. K. Y. Lee and M.A. El-Sharkawi (eds.), Modern Heuristic Optimization Techniques with Applications to Power Systems, IEEE Press.
2. Chaturvedi Devendra K., Soft Computing Techniques and Applications in Electrical Engineering, Springer-Verlag Berlin Heidelberg.
3. Jizhong Zhu, Optimization of Power System Operation, John Wiley & Sons.

CO-PO MAPPING:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	-	-	-	-	-	-	-
CO2	3	3	-	1	-	-	-	-	-	-	-	-
CO3	3	3	-	-	-	-	-	-	-	-	-	-
CO4	3	3	-	1	-	-	-	-	-	-	-	1
CO5	3	3	-	1	-	-	-	-	-	-	-	1
Average	**3**	**3**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**

ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. FOURTH YEAR SEM B (4 YDC)
EE42XXX: HIGH PERFORMANCE COMPUTING

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
						THEORY		PRACTICAL		TOTAL MARKS
T	P	TU	T	P	TU	CW	END SEM	SW	END SEM	
3	-	-	3	-	-	30	70	-	-	100

RE-REQUISITE: Basics of C programming, Basics of microprocessor,

COURSE OBJECTIVES:

1. Introduce the concept of high performance computing to the electrical engineers
2. Explain the concept of Parallelism in embedded CPU and GPUs
3. Explain programming model, optimization and performance analysis of embedded systems.
4. Demonstrate the communication mechanism among processors in the multiprocessor environment.

COURSE OUTCOMES (COs):

After completing the course, student will able to:

CO1: Apply high performance computing techniques to the electrical systems

CO2: Enhance the performance of compute intensive algorithms using embedded CPU and GPUs architectures

CO3: Redefine the programming model to optimize the performance of embedded systems.

CO4: Design the communication mechanism among processors in the multiprocessor environment.

COURSE CONTENTS:

UNIT: 1

Fundamental problems in embedded computing, Cyber-physical systems and embedded computing, Design methodologies and system modeling for embedded systems, Models of computation, Reliability and security, Consumer electronics

UNIT: 2

Architectural mechanisms for embedded processors, Parallelism in embedded CPU and GPUs, Code compression and bus encoding, Security mechanisms, CPU simulation, Configurable processors

UNIT: 3 Code generation and back-end compilation, Memory-oriented software optimizations, Software performance analysis, Programming models and languages, Real-time scheduling, Scheduling for power/energy, Performance estimation, Operating system mechanisms and overhead, Embedded file systems, Concurrent system verification
UNIT: 4 Architectures for embedded multiprocessing, Interconnection networks for embedded multiprocessors, Memory systems for embedded multiprocessors, Physically distributed multiprocessors, Design methodologies for embedded multiprocessors, Performance analysis of multiprocessor software, Middleware and software services, Design verification of multiprocessor software
UNIT: 5 Electronic system-level design, Hardware/software co-synthesis, Thermal-aware design and design-for-reliability, System-level co-simulation, Control/computing co-design, Networked control systems, CPS design methodologies and formal methods, CPS security

ASSESMENT:

A. Continuous evaluation through two mid-term test with a weightage of 30% of the total marks. It includes class attendance as well as assignments on the course topics.
B. The end-term theory examination weightage is 70%.

TEXT BOOKS

1. Marilyn Wolf, High-Performance Embedded Computing, Elsevier Inc, 2014
2. Georg Hager, Introduction to High Performance Computing for Scientists and Engineers, Taylor and Francis Group, 2011
3. Wim Vanderbauwhede, High-Performance Computing Using FPGAs, Springer Science+Business Media, 2013

REFERENCES BOOKS:

1. Chao Wang, High Perfromance Computing for Big Data, Taylor & Francis Group, 2018
2. Matt Pharr, GPU Gems 2, Programming Techniques for High - Performance Graphics and General - Purpose Computation, NVIDIA Corporation, 2005

ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. FOURTH YEAR SEM B (4 YDC)
EE42999: MAJOR PROJECT PHASE II

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
						THEORY		PRACTICAL		TOTAL MARKS
T	P	TU	T	P	TU	CW	END SEM	SW	END SEM	
-	8	-	-	4	-	-	-	40	60	100

COURSE OUTCOMES:

After completing the Major Project Phase II, the student will able to:

EE42999 (P).1: Communicate and work in team for developing leadership quality.

EE42999 (P).2: Execute proposed action plan , analysis and design.

EE42999 (P).3: Apply Software /hardware solution methodologies for the implementation of the proposed design.

EE42999 (P).4: Practise social and professional ethical standards.

EE42999 (P).5: Exercise quality writing skills for technical report and presentation.

CRITERIA AND RUBRICS

INTERNAL ASSESSMENT

Maximum Marks: 40 Marks
Student will be judged using following criteria and rubrics:

S. No	Criteria	Marks	CO
1	Selection of Problem	5	CO2
2	Proposed Design	10	CO3
3	Implementation of Design	10	CO1,CO2,CO3
4	Impact on Society	5	CO4
5	Report	10	CO5

EXTERNAL ASSESSMENT:

Maximum Marks: 60 Marks

Student will be judged using following criteria and rubrics:

S. No	Criteria	Marks	CO
1	Presentation	10	CO1, CO2
2	Organization of Thesis	20	CO5
3	Learning Outcome	10	CO3
4	Ethical Practise	5	CO4
5	Results	10	CO1,CO2, CO3
6	Confidence	5	CO1

CO-PO MAPPING:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	-	-	-	-	-	-	-	3	3	-	-
CO2	3	3	3	3	-	-	1	-	-	-	-	-
CO3	-	-	-	-	3	-	-	-	3	-	3	2
CO4	-	-	-	-	-	3	-	3	-	-	-	-
CO5	-	-	-	-	-	-	-	-	-	3	-	-
Average	3	3	3	3	3	3	1	3	3	3	3	2

ELECTRICAL ENGINEERING DEPARTMENT
B.TECH. FOURTH YEAR (4 YDC) SEM B

EE42881: INDUSTRIAL TRAINING AND INTERNSHIP

HOURS PER WEEK			CREDITS			MAXIMUM MARKS				
						THEORY		PRACTICAL		TOTAL MARKS
T	P	TU	T	P	TU	CW	END SEM	SW	END SEM	
-	-	-	-	4	-	-	-	40	60	100

COURSE OUTCOMES:
After completing the Industrial Internship and seminar, student will able to:

EE42881(P).1: Select industry/institute of interest for internship.
EE42881(P).2: Identify the technical problems and its causes and propose a suitable practical solution.
EE42881(P).3: Interact with industry professional/institute faculty for the faced challenges and their solution adopted.
EE42881(P).4: Apply soft skills such as time management , positive attitude and communication skills.
EE42881(P).5: Summarize the findings in terms of technical report.
EE42881(P).6: Get exposure of real life industrial or other higher side institute environment.

CRITERIA AND RUBRICS:

INTERNAL ASSESSMENT:

Maximum Marks: 40 Marks
Student will be judged using following criteria and rubrics:

S. No.	Criteria	Marks	CO
1	Learning Outcome	10	CO1, CO2, CO6
2	Time line	5	CO4
3	Leadership Developed	10	CO3, CO4
4	Organisation of Report	15	CO5, CO6

EXTERNAL ASSESSMENT

Maximum Marks: 60 Marks
Student will be judged using following criteria and rubrics:

S. No.	Criteria	Marks	CO
1	Future Goals	5	CO6
2	Presentation	10	CO3
3	Technical Knowledge	20	CO1, CO2
4	Organisation of Report	20	CO5
5.	Confidence	5	CO4

CO-PO MAPPING:

CO's	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	-	3	-	-	-	-	-	-	-	-	-	-
CO2	3	3	3	3	3	1	1	-	-	-	-	-
CO3	3	3	-	3	-	-	-	-	-	-	-	-
CO4	-	-	-	-	-	-	-	-	3	3	-	-
CO5	-	-	-	-	-	-	-	1	-	3	-	-
CO6	-	-	-	-	-	-	-	-	-	-	3	3
Average	3	3	3	3	3	1	1	1	3	3	3	3