PUNE VIDYARTHI GRIHA'S

COLLEGE OF ENGINEERING & TECHNOLOGY AND G K PATE (WANI) INSTITUTE OF MANAGEMENT,PUNE-9

(AFFILIATED TO SAVITRIBAI PHULE PUNE UNIVERSIT, PUNE)

DEPARTMENT OF ELECTRICAL ENGINEERING

CURRICULUM BOOK

ACADEMIC YEAR : 2021-22

FOR THE PROGRAMME

THIRD YEAR – ELECTRICAL ENGINEERING

PUNE VIDYARTHI GRIHA'S

COLLEGE OF ENGINEERING & TECHNOLOGY AND G K PATE (WANI) INSTITUTE OF MANAGEMENT,PUNE-9

VISION

TO ACHIEVE EXCELLENCE IN ENGINEERING EDUCATION

MISSION

- **To satisfy all stakeholders**
- **To develop ethical, highly motivated engineering professionals with good human values, requisite skills and competencies**
- **To adopt innovative teaching mechanisms**
- **To promote research culture**
- **To contribute to country's economic development**
- **To be responsive to changes in technology, socio-economic and environmental conditions**

DEPARTMENT OF ELECTRICAL ENGINEERING

VISION

To develop Electrical Engineering Department as one of the premier facility centre for disseminating the state of the art education.

MISSION

- **Providing Quality education in the field of Electrical Engineering.**
- **Developing State of the art facilities in the department.**
- **Creating platform for Training, Research and Development.**
- **Producing Sound Electrical Engineers catering need of industry and other stake holders.**

PROGRAM EDUCATIONAL OBJECTIVES

PEO1 To produce students with knowledge base of Electrical Engineering to excel in industry and higher studies.

PEO2 To produce competent students with analytical abilities and problem solving capabilities on the basis of strong fundamentals in Electrical Engineering.

PEO3 To produce responsible students developing sustainable solutions for society with ethics and professionalism.

PEO4 To produce students with professional qualities such as team work, leadership, entrepreneurial thinking and communication skills.

PEO5 To produce students habitual to lifelong learning abilities.

PROGRAMME OUTCOMES

Engineering graduates will be able to:

PO1: Engineering Knowledge: An ability to apply knowledge of mathematics, science and Engineering fundamentals to analyze complex engineering problems.

PO2: Problem Analysis: An ability to identify, formulate and analyze complex engineering problems by reviewing research literature to arrive at substantiated conclusions.

PO3 : Design/Development of Solutions: An ability to design solutions for complex engineering problems, system components or processes to meet the specified needs of the society, considering safety and environment.

PO4: Conduct Investigations of Complex problems: An ability to carry out experiments, simulations and apply research methodologies to investigate the data for providing valid conclusions.

PO5 :Modern tool usage : An ability to select and apply appropriate techniques, resources and modern engineering tools such as advanced controllers and application softwares for engineering activities.

PO6: The Engineer and society: An ability to assess and develop professional engineering practices catering the need of society considering safety, health, regulatory and other relevant issues.

PO7: Environment and sustainability: An ability to apply professional engineering knowledge to understand the impact on society and environment demonstrating the need for the sustainable development.

PO8: Ethics: An ability to adopt professional ethics while committing professional and social responsibilities.

PO9: Individual and Team work: An ability to develop multidisciplinary skills as an individual and as a member or leader in diverse teams.

PO10: Communication: An ability to communicate effectively with engineering community and society at large with effective documentation and presentation on engineering activities.

PO11: Project management and Finance: An ability to demonstrate knowledge of Engineering and Management principles as a member or a leader to manage project and multidisciplinary tasks.

PO12: Life-long Learning: An ability to understand need and develop the habit of being lifelong learner to adopt to technological changes.

PROGRAMME SPECIFIC OUTCOMES

Electrical Engineering graduates will have

PSO1 An ability to acquire adequate proficiency in the area of Energy Systems and Sustainability.

PSO2 An ability to acquire multidisciplinary skills in the area of Control and Drives.

PSO3 An ability to acquire enhanced skills and core competency in the field of Electrical Engineering through hands on training.

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Third Year

Curriculum Book

Savitribai Phule Pune University, Pune
Syllabus: Third Year (TE) Electrical Engineering (2019 course)
(w.e.f 2021-22)

SEMESTER-I

Course code	Course Name	Teaching Scheme			Examination Scheme							Credit				
		Th	Pr	Tu	SEM/PW/IN	ISE	ESE	TW	PR	OR	Total	Th	Pr	Tu	SEM/PW/IN	Total
303141	Industrial and Technology Management	3	0	0	0	30	70	0	0	0	100	3	0	0	0	3
303142	Power Electronics	3	4#	0	0	30	70	0	50	0	150	3	2	0	0	5
303143	Electrical Machines-II	3	2	0	0	30	70	25	25	0	150	3	1	0	0	4
303144	Electrical Installation Design and Condition Based Maintenance	3	4#	0	0	30	70	25	0	25	150	3	2	0	0	5
303145	Elective-I	3	0	0	0	30	70	0	0	0	100	3	0	0	0	3
303146	Seminar	0	0	0	1	0	0	50	0	0	50	0	0	0	1	1
303147	Audit course-V	2*	0	0	0	0	0	0	0	0	0	GRADE: PP/NP				0
Total		**15**	**10**	**0**	**1**	**150**	**350**	**100**	**75**	**25**	**700**	**15**	**5**	**0**	**1**	**21**

303144: Elective-I	303147 : Audit Course-V
303145A : Advanced Microcontroller and Embedded System	303147A : Energy storage systems
303145B : Digital Signal Processing	303147B : Start up & Disruptive innovation
303145C : Open Elective	

SEMESTER-II

Course code	Course Name	Teaching Scheme			Examination Scheme							Credit				
		Th	Pr	Tu	SEM/PW/IN	ISE	ESE	TW	PR	OR	Total	Th	Pr	Tu	SEM/PW/IN	Total
303148	Power System-II	3	2	1	0	30	70	25	50	0	175	3	1	1	0	5
303149	Computer Aided Design of	3	4#	0	0	30	70	50	0	25	175	3	2	0	0	5

	Electrical Machines															
303150	Control System Engineering	3	2$	1$	0	30	70	25	0	25	150	3	1	0	0	4
303151	Elective-II	3	0	0	0	30	70	0	0	0	100	3	0	0	0	3
303152	Internship	0	0	0	4	0	0	100	0	0	100	0	0	0	4	4
303153	Audit Course VI	2*	0	0	0	0	0	0	0	0	0	GRADE: PP/NP				0
Total		12	8	2	4	120	280	200	50	50	700	12	4	1	4	21

303151: Elective-II	**303153 : Audit Course-VI**
303151A : IoT and its Applications in Electrical Engineering	303153A: Ethical Practices for Engineers
303151B : Electrical Mobility	303153B :Project Management
303 151C: Cybernetic Engineering	
303151D: Energy Management	

#Practical consists of Part A & part B. PART A; Regular experiments & part B; to bridge the gap between theory & actual industrial practices. For subject 303144; there will be auto cad drawing on Electrical installation, Electrical wiring , cabling etc.For 303149, Part A , Regular drawing by hand & part B same drawing by auto cad.

$ tutorial credit merged with Practical. * Conduct over and above these lectures

TE (ELECTRICAL)

Semester I&II

Industrial And Technology Management

Course Name : Industrial And Technology Management **Course Number : 303141**		
Teaching Scheme **Theory : 3 Hrs. / week**	**Credits** **Th : 03**	**Examination Scheme [Marks]** **In Sem : 30 Marks** **End Sem : 70 Marks**
Designation of the Course : Professional		
Prerequisites :		
Basic Engineering fundamentals, Soft skills		

Course Objectives:	
1.	Possess knowledge of types of business organizations; explore the fundamentals of economics and Management.
2.	Understand the basic concepts of Technology management and Quality management
3.	Explain the fundamentals of Human Resource management
4.	Recognize the importance of Quality management and understand its basic concepts
5.	Analyse and differentiate between marketing management and financial management
6.	Recognize the importance of Motivation, Group dynamics, Team work, leadership skill and entrepreneurship.

Course Outcomes: **At the end of the course, a graduate will be able to –**	
CO1.	Differentiate between different types of business organization and discuss the fundamentals of economics and management.
CO2.	Explain the importance of technology management and quality management.
CO3.	Describe the characteristics of marketing and its
CO4.	Discuss the qualities of a good leader.

Course Contents :

Unit 1 :	**Introduction to Management and Economics**	**[7 Hrs]**

A) Management: Meaning, scope, function, and importance of management. Difference between administration and management.

B) Industrial Economics: Definition of economics, Demand and Supply concept, Demand Analysis. Types of Demand, Determinants of Demand, Law of demand and supply, Elasticity of demand and supply, Law of Diminishing Marginal utility, Demand forecasting: Meaning and methods.

C) Business Organizations: Line organization, Staff organization and Functional Organization, (Project, Matrix, Committee Organization.)

Business Ownership and its Types: Types of business ownership, Sole proprietorship,Partnership(Act1934),LLP(LimitedLiabilityPartnership) (Act2008). One person company, Joint Stock Company: Public Limited and Private Limited, Public Sector Undertaking(PSU)

Unit 2 :	**Technology Management**	**[5 Hrs]**

A) Technology Management: Definition of technology Management and its relation with society, development, application and its scope.

B) Classification of Technology Management: Classification of technology management at various levels- its importance on National Economy, Ethics in technology management, Critical factors in technology management.

Unit 3 :	**Introduction to Intellectual Property Rights (IPR) and uman Resource Management:**	**[6 Hrs]**

A) Introduction to Intellectual Property Rights (IPR): Meaning of IPR, Different forms of IPR, Patents, Criteria for securing Patents. Patent format and structure, Copy rights and trademark (Descriptive treatment only).

B) Human Resource Management: Introduction, importance, scope. HR planning. Recruitment, selection, training and development, Performance management.

Unit 4 :	**Quality Management**	**[8 Hrs]**

A) Quality Management: Definition of quality, continuous improvement, Types of quality. Quality of design, Seven QC Tools, Poka Yoke(Mistake Proofing), Qualitycircles,Kaizen.TQM,5S(CasestudyofToyota,descriptivetreatment). Six-Sigma.
Basic software's used for inventory management and quality management like Zoho inventory, Oracal, Netsuite, Vyapar, Quick book commerce.

B) Quality Management Standards (Introductory aspects only):- The ISO9001:2000QualityManagementSystemStandard-TheISO14001:2004, ISO26000, ISO 10004:2012, ISO 9001:2012 ISO 9001:2016.EnvironmentalManagementSystemStandard.

Unit 5 :	**Marketing and Financial Management**	**[6 Hrs]**

A) Marketing Management: Meaning of Market, Marketing strategy, motives, market characteristic and its types, Perfect Competition, Monopoly, Monopolistic completion and Oligopoly. New product development, Product life cycle, Marketing and selling, methods of selling, marketing planning. Market survey and market research, Online Marketing (Digital Marketing).

Financial Management: Definition of financial management, cost Concept, Types of costs (Fixed, Variable, average, marginal, and total cost)and methods of costing price, capital. Debit, credit, Profit and loss statement, Balance sheet, Depreciation Analysis, causes and significance, methods of calculation of depreciation, Taxation system, and type of taxes.

Unit 6 :	**Motivational Theory and Entrepreneurship**	**[6 Hrs]**

A) Motivation: Introduction to Motivation, theories of work motivation, Content Theories: Maslow's Hierarchy of Needs, Herzberg's Two factor theory, McClelland's Three Needs Theory, McGregor's Theory X and Theory Y.
Process Theories: Adam's Equity Theory, Vroom's Expectancy Theory, Taylor's Motivation Theory

B) Leadership: Importance of Leadership, Types of Leadership: Autocratic, Democratic and Laissez-Faire Leadership, qualities of good Leader. Group dynamics: Types and interactions of groups, stages of group dynamics: Norming, Storming, Forming, Performing and Adjourning.

C) Entrepreneurship-Importance and limitations of rational decision making, Decision making under certainty, uncertainty and risk. Incentives for small business development, Government policies and incentives, Case study on Small scale industries in India.

Text Books:

[T1]	O.P. Khanna, industrial engineering and management, Dhanpat Rai and sons, New Delhi.
[T2]	E. H. McGrah, S. J. Basic managerial skill for all.
[T3]	Tarek Khalil, Management of Technology Tata Mc Graw Hill Publication Pvt. Ltd.
[T4]	Prabuddha Ganguli Intellectual Property rights TATA McGraw-Hill Publishing Company
[T5]	Management Accounting and financial management by "M. Y. Khan and P. K. Jain", Mcgraw Hill-Tata-ISBN.

Reference Books:

[R1]	C. B. Mamoria and V.S.P.Rao- Personnel Management, Himalaya Publishing House, 30th Edition 2014.
[R2]	Harold Koonlz and O D'onnel – Management.McGrawHill Publication 1980
[R3]	Philip Kotler- Marketing Management. Pearson Edition 2008
[R4]	Robert Heller, Managing Teams, Dorling Kindersley, London.
[R5]	Kelly John M, Total Quality Management, InfoTech Standard, Delhi.
[R6]	Joseph M. Juran Juran's Quality Handbook TATA McGraw-Hill.
[R7]	Dale H. Besterfield and CarolBesterfield Total Quality Management Prentice Hall of India Pvt. Ltd.
[R8]	Financial Management by "I M Pandey", Vikas Publishing House Pvt. Ltd., Delhi Philip Kotler- Marketing Management.
[R9]	N. R. Subbaram, What Everyone Should Know About Patents, Pharma Book Syndicate, Hyderabad.
[R10]	Principles and Practices of Management –Dr. P.C. Shejwalkar, Dr. Anjali Ghanekar, Prof. Deepak Bhivpathki.

Self-Learning Topics :

1.Ethics in technology management
2.online marketing

Contents beyond Syllabus :

Assignment Topics :

Questions can be grouped together also

1. Write in detail methods of demand forcasting
2. Write a short note on eleasticity of demand and supply
3. Classify technology
4. Technology management at various levels

5. Write a short note on six sigma
6. 5S, Kaizan,Ishikawa diagram
7. What is cost and name its types
8. What are the different steps of group formation
9. What are the qualities of good leader
10. What are the criteria to write a patent

Presentations :

1. six sigma
2. kaizan, 5S, pokka yoke,pareto analysis,ISO
3. group dymnamics
4. motivation theories: theory X and Theory Y
5. Case study on Small scale industries in India.
6. Patent and copy rights
7. Human resource management

Power Electronics

Course Name : Power Electronics **Course Number : 303142**		
Teaching Scheme **Theory : 3 Hrs. / week** **Practical : 2 Hrs. / week**	**Credits** **Th : 03** **OR : 02**	**Examination Scheme [Marks]** **In Sem (Online) : 30 Marks** **End Sem : 70 Marks** **Practical : 50 Marks**
Designation of the Course : Professional-Core		
Prerequisites : 1. Knowledge of semiconductor material, basic electronics, diode, BJT,UJT,FET and its characteristics 2. Working of Diode based rectifier, concept of rms and average value 3. Use square notebooks for notes and plotting of waveforms		

Course Objectives:	
1.	To enable students to gain knowledge and understanding in the following aspects: Fundamentals of power electronic devices and characteristics.
2.	The understand the concepts and operating principles of power electronics devices and transistor based DC to DC converter
3.	To undertand the operation of single Fully controlled converter, rectification and inversion mode, Half controlled converter (Semi-converter)
4.	To analyse the working principle of three phase Fully controlled converter (rectification and inversion mode), Half controlled converter (Semi- converter)
5.	To recognize the importance of PWM techniquies in working of single phase and three phase DC-AC converters(inverter)
6.	To understand and compare three phase VSC operation using 120 degree and 180 degree mode

Course Outcomes: **At the end of the course, a graduate will be able to –**	
CO1.	Develop characteristics of different power electronic switching devices
CO2.	Reproduce working principle of power electronic converters for different types of loads
CO3.	Analyse the performance of power electronic converters

Course Contents :		
Unit 1 :	**Power Semi Conductor Devices**	**[6 Hrs]**
Construction, Static and dynamic Characteristics, specifications/rating of SCR, Triggering Circuits (R, R-C, UJT), Commutation Circuits (class C&D), Protection (over voltage, over current, and Thermal), Gate Turn Off (GTO) Thyristor (Construction, Working and Application), TRIAC- four mode operation, triggering of TRIAC using DIAC, Application-light dimmer.		
PR :	1. Static VI characteristic of SCR/GTO 2. Static VI Characteristic of TRIAC 3. Study of Gate firing circuits of SCR (R, RC & UJT)	

Unit 2:	**Transistor based Devices and DC-DC converter**	**[6 Hrs]**
Transistor based Devices: MOSFET, IGBT, Construction, working, Static and Dynamic Characteristics, specifications, safe operating area, Latching of IGBT. **DC-DC converter:** Principle of operation of chopper, classification on the basis of Operating quadrants (A,B,C,D,E), Control techniques: CLC, TRC, PWM and FM Techniques. Analysis of Step up Chopper and Numerical with RLE load. Necessity of input filter, Areas of application, Buck Boost Chopper (Descriptive Treatment).		
PR :	1. Output and Transfer Characteristic of MOSFET and IGBT 2.Buck boost chopper	
Unit 3 :	**Single Phase AC-DC Converter**	**[6 Hrs]**
Single phase Converter: Fully controlled converter (rectification and inversion mode), Half controlled converter (Semi- converter), Operation of all converters with R, RL load , derivation of Average and RMS output voltage, power factor, THD, TUF. Numerical based on output voltage and current calculations, Effect of source inductance on operation of converter, Concept of overlap angle and voltage drop calculation. Single phase dual converter (Descriptive treatment only).		
PR :	• Single phase Half controlled converter with R and RLload • Single phase fully controlled converter with Rload. • Single Phase fully controlled converter with and without Free Wheeling diode with RLload	
Unit 4 :	**Three Phase Converter and AC Voltage Regulator**	**[6 Hrs]**
Three phase converter: Fully controlled converter, rectification and inversion mode, Half controlled converter (Semi-converter), Operation of all converters with R, RL load, derivation of Average and RMS output voltage, power factor, THD, TUF. Numerical based on output voltage and current calculations **AC voltage regulator**: DIAC, TRIAC- four mode operation, triggering of TRIAC using DIAC; Single phase AC Voltage regulator principle with R and RL Load, derivation of Average and RMS output voltage, Concept of two stage AC voltage regulator (With R and R-L load).		
PR :	**1.** Three phase AC-DC fully controlled bridge converter R and RLload 2. Single phase A.C. voltage regulator with R and RL load	
Unit 5:	**Single phase DC to AC converter(transistor based)**	**[6 Hrs]**
Full bridge VSC, derivation of output voltage and current, Numericals, current source converter with ideal switches. PWM techniques: Single pulse, multiple pulse and sinusoidal pulse modulation with Fourier analysis.		
PR :	1. Study of 1-ø bridge inverter SPWM 2. Study of Forced commutation circuits of SCR (Class C and Class D) 3. Study and design of SMPS	

	4. Study of PWM controls of a single-phase inverter 5. Power Quality Analysis (Harmonic and PF measurement) at AC side of Single phase controlled Converter.	
Unit6 :	**Three phase DC-AC Converter (Transistor based)**	**[6 Hrs]**
Three phase VSC using 120 degree and 180 degree mode and their comparison, PWM based VSC, voltage control and harmonic elimination techniques (Single Pulse Modulation, Transformer Connection, Multilevel Control, Stepped Wave),Multilevel Converter concept its classification (Neutral Point Clamped Converter, Flying Capacitor Converter, cascaded multilevel converter) comparison between multilevel converters, balancing of dc voltage across capacitor		
PR:	1. Three phase voltage source inverter using 120^0 and 180^0mode 2. Study of three phase inverter(VSI) 3. Performance analysis of three phase diode clamped Multilevel inverter 4. Performance analysis of three phase cascaded H-Bridge Multilevel inverter	
Text Books:		
[T1]	M. H. Rashid - Power Electronics 2nd Edition, Pearson publication	
[T2]	Ned Mohan, T.M. Undeland, W.P. Robbins - Power Electronics, 3rd Edition, John Wiley and Sons	
[T3]	. B.W. Williams: Power Electronics 2nd edition, John Wiley and sons	
[T4]	Ashfaq Ahmed- Power Electronics for Technology, LPE Pearson Edition.	
[T5]	Dr. P.S. Bimbhra, Power Electronics, Third Edition, Khanna Publication.	
[T6]	Hari Babu, Power Electronics , Scitech Publication.	
Reference Books:		
[R1]	Vedam Subramanyam - Power Electronics , New Age International , New Delhi	
[R2]	Dubey, Donalda, Joshi,Sinha, Thyristorised Power controllers, Wiely Eastern New Delhi.	
[R3]	M. D. Singh and K. B. Khandchandani, Power Electronics, Tata McGraw Hill	
[R4]	Jai P. Agrawal, Power Electronics systems theory and design LPE, Pearson Education, Asia.	
[R5]	L. Umanand, Power Electronics – Essentials and Applications Wiley Publication. .	
[R6]	J. Michael Jacob – Power Electronics Principal and Applications.	
[R7]	M.H.Rashid - Power Electronics Handbook, Butterworth-Heinemann publication, 3 edition	
[R8]	M.S. Jamil Asghar, Power Electronics, PHI.	
[R9]	V.R. Moorthi, Power Electronics Devices, circuits, and Industrial applications, Oxford University Press.	

	.
[R10]	NPTEL Web course and video course on Power Electronics by Dr.B.G.Fernandis,IIT,Mumbai.
Self learning Topics:	• Working of BJT,UJT,FET and its characteristics • Diode based rectifier,concept of rms and average value • Single phase dual convertor

Contents beyond Syllabus :

- History of invention of IGBT
- Grey area of application of MOSFET and IGBT.
- Selection of SWITCH in different applications
- Commutation of Type A and Type B class for thyristor

Extra Experiments :

- Study of three phase Active power filter
- Study of Standalone/ Grid connected converters for interfacing of renewable energy sources
- Industrial Visit to Power Electronics manufacturing unit/Renewable energy power plant

Bridging Courses :

- Basic electronics Engineering
- Analog and digital Electronics

Assignment Topics :

- VI characteristics of SCR.
- Chopper-Necessity of input filter, Areas of application, Buck Boost Chopper (Descriptive Treatment).
- 180 degrees and 120 deg mode of 3ph VSI.
- Short note on importance of freewheeling diode in converter system
- Describe the working of single phase full wave converter with RLE load.
- Compare single phase semiconverter and full wave converter
- Compare MOSFET and IGBT

Presentations :

- CLC,TRC,PWM,FM technique for chopper control
- Multilevel convertor
- Flying capacitor convertor

Electrical Machines - II

Course Name : Electrical Machines - II **Course Number : 303143**		
Teaching Scheme **Theory : 3 Hrs. / week** **Practical : 2 Hrs. / week / batch**	**Credits** Th : 03 **PR : 01**	**Examination Scheme [Marks]** **In Sem : 30 Marks** **End Sem : 70 Marks** **Term Work : 25 Marks** **Practical : 25 Marks**
Designation of the Course : Professional-Core		

Prerequisites :

- Magnetic circuits, Force on current carrying conductor placed in magnetic field, Fleming Right hand & Left hand rule.
- Working principle and construction DC Machines, transformer & 3-ph induction motor.
- Phasor diagram and equivalent circuit of single phase transformer

Course Objectives :

1.	Learn construction & working principle of three phase synchronous machines and 1-ph induction motors.
2.	Calculate voltage regulation of Alternator by different methods
3.	Study the applications of different machines in industrial, commercial & social sectors
4.	Determine the performance indices of AC series & single phase motors by experimentation.

Course Outcomes :

At the end of the course, a graduate will be able to –

C303.1	Explain construction, working principle of three phase Synchronous Machines, Single phase Induction Motors, A.C. Series Motor, Special Purpose Motors alongwith their field of applications.
C303.2	Estimate regulation of alternator by direct and indirect methods.
C303.3	Demonstrate operation of synchronous motor at constant load and variable excitation and plot its V curve and inverted V curve.
C303.4	Explain Speed control methods of three phase induction motor.
C303.5	Evaluate performance of A C series motor.
C303.6	Obtain performance of single phase induction motor from equivalent circuit by performing no load & blocked rotor test.

Course Contents :

Unit 1 :	**Three phase Synchronous machines:**	**[06 Hrs]**

Three phase Synchronous machines:
Construction, rotating-field type and rotating-armature type, salient-pole type and non-salient-pole type and their comparison. Excitation Methods.

Three phase Synchronous generator (cylindrical rotor type): Principle of operation. Emf equation and winding factors (No derivation), rating of generator. Generator on no-load and on balanced load. Armature reaction and its effect under different load power factors. Voltage drop due to armature resistance, leakage flux and synchronous reactance. Per phase equivalent circuit and Phasor diagram. Power - power angle relation.

Three phase Synchronous generator (salient pole type):
Armature reaction as per Blondel's two reaction theory for salient-pole machines, Direct-axis and quadrature-axis synchronous reactance's and their determination by slip test. Phasor diagram of Salient-pole generator and calculation of voltage regulation.

Practicals:

- Determination of regulation of salient pole alternator by slip test.

Unit 2 :		**[06 Hrs]**

Voltage regulation of Three phase Synchronous generator:

Performance of open circuit and short circuit test on synchronous generator, determination of voltage regulation by emf, mmf, and Potier triangle methods. Determination of voltage regulation by direct loading. Short circuit ratio.

Parallel operation of 3-phase alternators:
Necessity, conditions, Load sharing between two alternators in parallel (Descriptive treatment only). Process of synchronizing alternator with infinite bus-bar by lamp methods and by use of synchroscope (one dark & two equally bright method). Synchronizing current, power and torque (no numerical).

Practicals:

- Determination of regulation of cylindrical rotor alternator by following methods a) EMF method b) MMF method.
- Determination of regulation of cylindrical rotor alternator by Potier method.
- Determination of Regulation of alternator by direct loading.

Unit 3 :	**Three Phase Synchronous Motor:**	**[6 Hrs]**

Principle of operation. Methods of starting. Equivalent circuit, significance of torque angle, Losses, efficiency and Power flow chart. Operation of 3-phase Synchronous motor with constant load and variable excitation ('V' Curves and 'inverted V' curves). Phenomenon of hunting and its remedies. Applications of 3-phase synchronous motors. Comparison of 3 phase synchronous motor with 3-phase induction motor.

Practicals:

- V & inverted V curve of synchronous motor at constant load.

Unit 4 :	**Three Phase Induction Motor, Induction Generator and Special Purpose Motors:**	**[6 Hrs]**

Speed control of three phase induction motor by various methods (Stator side and rotor side controls). Action of 3-phase induction motor as induction generator, applications of induction generator. Introduction to Energy Efficient three phase Induction Motor and Super conducting Generator.

Special Purpose Motors : Construction, principle of working, characteristics ratings and applications of Brush less D.C. motors, Stepper motors (permanent magnet and variable reluctance type only), Permanent Magnet motor (A.C. & D.C.).

Practicals:

- Speed control of three phase induction motor by V/F method.

Unit 5 :	**A.C. series motor**	**[6 Hrs]**

Operation of D.C. series motor on a.c. supply, nature of torque developed, problems associated with AC. operation and remedies.

Compensated series motor: Compensating winding, conductibility and inductively compensated motor. Approximate phasor diagram. Use of compoles for improving commutation. Ratings and applications of Compensated Series motors.

Universal motors: ratings, performance and applications, comparison of their performance on A.C. and D.C. supply.

Practicals:

- Load test on Single phase series motor.

Unit 6 :	**Single Phase Induction Motor**	**[6 Hrs]**

Construction of single phase induction motor, double field revolving theory. Equivalent circuit and torque-slip characteristics on the basis of double revolving field theory. Tests to determine the parameters of equivalent circuit and calculation of performance characteristics of motor.

Methods of self-starting. Types of single phase induction motors: Split-phase motors (Resistor split-phase motor, Capacitor-start motor, Capacitor start and capacitor run motor and permanent capacitor motor). Comparison of 1-phase induction motor with 3-phase induction motor.

Practicals:

- Load test on 1-phase induction motor.

Text Books :

[T1]	Nagrath and Kothari, Electrical Machines, 2nd Ed., Tata McGraw Hill.
[T2]	S. K. Bhattacharya, Electrical Machines, Tata McGraw Hill.
[T3]	A.S. Langsdorf, Theory of Alternating Current Machinery, Tata McGraw Hill
[T4]	P. S. Bimbhra, Electric Machinery, Khanna Publications.
[T5]	B.R. Gupta and Vandana Singhal -Fundamentals of Electric Machines, New Age International (P) Ltd.
[T6]	B. L Theraja –Electrical Technologyvol II , S. Chand publication.
[T7]	V. K. Mehta and Rohit Mehta, Principles of Electrical Machines, S Chand Publication
[T8]	Krishna Reddy –Electrical Machines vol.II and III, SCITECH publications.
[T9]	Ashfaq Husain, Electrical Machines, Dhanpat Rai and Co.

[T10]	M V Deshpande, Electrical Machines, Prentice Hall of India

Reference Books :

[R1]	M.G. Say, Performance and Design of A.C. Machines (3rd Ed.), ELBS
[R2]	J B Gupta - Theory and performance of Electrical Machines, S K Kataria Publications
[R3]	Samarjit Ghosh, Electrical Machines, Pearson Publication.
[R4]	Bhag S Guru and Huseyin R Hiziroglu, Electrical Machinary and Transformer, 3rd Edition,Oxford University Press.
[R5]	E G Janardanan, Special Electrical Machines, Prentice Hall of India.
[R6]	Suvarnsingh Kalsi Application of high Temperature super conductors to electric power equipments (Rotating Machines) Wiley publication.

Contents Beyond Syllabus :

- Shaded pole type single phase IM – construction – working – advantages – disadvantages - Applications

Extra Experiments :

- No load & blocked-rotor test on a 1-phase Capacitor-start induction motor & Determination of its equivalent circuit parameters.

Bridging Courses :

Industrial visit is to be arranged to bridge the gap between theoretical knowledge & practical things.

Assignment Topics :

11. Numerical based on emf equation of alternator, Compare salient & non salient pole construction of synchronous machines, Numerical based on calculation of regulation of alternator by different methods. (Unit 1 & 2 theory and numerical)
12. Numerical and theory questions on 3 phase synchronous motor, Explain Speed control methods of three phase induction motor. (Unit 3 & 4 theory and numerical)
13. What are the problems in d c series motor with a c supply, what are the corrective actions in this case, Draw vector diagram of a c series motor & numerical on a c series motor, Numerical based on equivalent circuit parameter calculation, motor current, power factor, efficiency in case of single phase induction motor, Explain construction, working, advantages & disadvantages of different type of single phase induction motors. (Unit 5 & 6 theory and numerical)

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Electrical Installation Design and Condition based Maintenance

Course Name : Electrical Installation Design and Condition based Maintenance **Course Number : 303144**		
Teaching Scheme **Theory : 3 Hrs. / week** **Practical : 4Hrs/Week** **Tutorial :**	Credits TH: 03 PR : 02	**Examination Scheme [Marks]** **In Sem : 30 Marks** **End Sem : 70 Marks** **Oral : 25 Marks** **Term work : 25 Marks**
Designation of the Course : Professional-Core / Elective / Humanities		
Prerequisites : • Basic Electrical Engg, • Power System 1, • Electrical Machines I and Electrical Machines II		
Fundamental of Electrical, Mechanical and Thermal engineering		

Course Objectives :

1.	To classify different types of distribution supply system and determine economics of distribution system.
2.	To compare and classify various substations, bus-bars and earthing systems.
3.	To demonstrate the importance and necessity of maintenance.
4.	To analyze and test different condition monitoring methods
5.	To carry out estimation and costing of internal wiring for residential and commercial installations.
6.	To apply electrical safety procedures.

Course Outcomes :
At the end of the course, a graduate will be able to –

CO1.	Classify different types of distribution supply system and determine economics of distribution system. compare and classify various substations, bus-bars and earthing systems.
CO2.	Demonstrate the importance and necessity of maintenance.
CO3.	Analyze and test different condition monitoring methods.
CO4.	Carry out estimation and costing of internal wiring for residential and commercial installations
CO5.	Apply electrical safety procedures.
CO6.	Solve simple problems on Cost benefit analysis

Course Contents :

Unit 1 :	**Economics of Distribution Systems:**	**[6 Hrs]**
Classification of supply systems (State Only)		

(i)DC, 2-wire system, (ii) Single phase two wire ac system, (iii) Three phase three wire ac supply system, iv) Three phase four wire ac supply system. Comparison between overhead and underground systems (For above mentioned systems) on the basis of volume requirement for conductor. AC Distribution System: Types of primary and secondary distribution systems, calculation of voltage drops in ac distributors (Uniform and Non Uniform Loading) (Numerical) Economics of power transmission: Economic choice of conductor (Kelvin's law) (Derivation and Numerical) Distribution Feeders: Design considerations of distribution feeders; radial and ring types of primary feeder's voltage levels, energy losses in feeders.		
Unit 2 :	**Substation and Earthing**	**[6 Hrs]**
Substation: Classification of substations, Various equipments used in substation with their specifications, Bus bar arrangements in the substation: Simple arrangements like single bus bar, sectionalized single bus bar, main and transfer bus bar system with relevant diagrams. Earthing: Necessity of Earthing, Types of earthing system (Equipment and Neutral), and Maintenance Free Earthing system. Methods of testing earth resistance, Different electrode configurations (Plate and Pipe electrode), Tolerable step and touch voltages, Steps involved in design of substation earthing grid as per IEEE standard 80 – 2000.		
PR/Tut :	1. Practice of earthing and Measurement of Earth resistance of Campus premises by using 4 Pole, 3 Pole, new technology practicing in industry clamp on method. 2. Single Line diagram of 132 or 220 or 400 kV substation (based on actual field visit) Symbols, Plate or Pipe earthing. (Drawing sheets 1 using AutoCAD or other CAD software) 3. Assignment on design of earthing grid for 132/220 kV substation. 4. Design, Estimation and costing of earthing pit and earthing connection for computer lab, Electrical Machines Lab.	
Unit 3 :	**Maintenance and Condition Monitoring**	**[8 Hrs]**
Importance and necessity of maintenance, different maintenance strategies like breakdown maintenance, planned/preventive maintenance and condition based maintenance. Planned and preventive maintenance of transformer, Induction motor and Alternators. Insulation stressing factors, Insulation deterioration, polarization index, dielectric absorption ratio. Concept of condition monitoring of electrical equipments. Advance tools and techniques of condition monitoring, Thermography. Failure modes of transformer, Condition monitoring of oil as per the IS/IEC standards, Filtration/reconditioning of insulating oil, Condition monitoring of transformer bushings, On load tap changer, dissolved gas analysis, degree of polymerization. Induction motor fault diagnostic methods – Vibration Signature Analysis, Motor Current Signature Analysis. Hot Line Maintenance - Meaning and advantages, special types of non-conducting Materials used for tools for hot line maintenance.		
PR/Tut :	1) Measurement of Dielectric Absorption Ratio and Polarization Index of insulation. 2) Study of thermograph images and analysis based on these images. 3) Measurement of insulation resistance of motors and cables 4) Study of troubleshooting of electrical equipment based on actual visit to repair workshop (Any One). i) Three phase induction motor ii) Transformer iii) Power Cable 5) Trouble shooting of household equipment – Construction, working and troubleshooting of any two household Electrical equipment's (Fan, Mixer, Electric Iron, Washing Machines, Electric Oven, Microwave - Limited to electrical faults) (Here we perform Practical by using PAT Testers)	

Unit 4 :	**Basics of Estimation and Costing**	**[4 Hrs]**
Purpose of estimating and costing, qualities of good estimator, essential elements of estimating and costing, tender, guidelines for inviting tenders, quotation, price catalogue, labour rates, schedule of rates and estimating data (only theory),		
PR/Tut :	1 Activity: Preparation of Tender notice and studying the Tender notices published in newspapers	
Unit 5 :	**Installation and estimation of distribution system**	**[6 Hrs]**
Introduction cable sizing, Estimation and conductor size calculations of internal wiring for Residential and Commercial (Numerical) installations and estimate for underground LT service lines.		
PR/Tut :	1 Use REVIT / any BOQ (Bill of Quantity)estimation software for estimation and costing 2 Design and estimation of light and power circuit of residential wiring. 3. Estimation and costing for 11 kV feeders and substation.(voltage drop calculation, SLD, substation layout) 4. WIRING INSTALLATION AND MAINTENANCE OF PUMP MOTOR 5. Activity: Interview of Electrical maintenance personnel/Technician/Electrician	
Unit 6 :	**Testing and Electrical Safety**	**[6 Hrs]**
Understanding CAT Ratings & Using CAT rated Instrument, Electrical Installation Testing Procedures-Insulation resistance test between installation and earth, Insulation resistance test between conductors (use of GUARD Terminal in IR test & Application) (methods used for IR Testing) Testing of polarity, Testing of earth continuity paths (Applications of PAT Tester "Portable Appliance Tester" in commercial like hotels hospital & Industry also) and Earth resistance test (methods for earth testing 2-pole,3-pole new methods clamp on type where we can performs test in Live) Contents of first aid box, treatment for cuts, burns and electrical shock. Procedures for first aid (e.g. removing casualty from contact with live wire and administering artificial respiration). Various statutory regulations (Electricity supply regulations, factory acts and Indian electricity rules of Central Electricity Authority (CEA), Classification of hazardous area. *(Introduction to OSHA)*		
PR/Tut :	1. PRECAUTIONS FROM ELECTRIC SHOCK AND METHOD OF SHOCK TREATMENT. 2. Using of Installation Multifunction Testers for RCD testing, Phase Sequence Indication, Insulation resistance measurement, Continuity testing	
Text Books :		

[T1]	B. R. Gupta- Power System Analysis and Design, 3rd edition, Wheelers publication.
[T2]	S. Rao, Testing Commissioning Operation and Maintenance of Electrical Equipment, Khanna publishers.
[T3]	S. L. Uppal - Electrical Power - Khanna Publishers Delhi.
[T4]	Hand book of condition monitoring by B. K. N. Rao, Elsevier Advance Tech., Oxford (UK).
[T5]	S. K. Shastri – Preventive Maintenance of Electrical Apparatus – Katson Publication House.
[T6]	B. V. S. Rao – Operation and Maintenance of Electrical Equipment – Asia Publication.
[T7]	Hand book on Electrical Safety.

Reference Books :

[R1]	P.S. Pabla –Electric Power Distribution, 5th edition, Tata McGraw Hill.
[R2]	S. L. Uppal, Electrical Wiring and Costing Estimation, Khanna Publishers, New Delhi.
[R3]	Surjit Singh, Electrical wiring, Estimation and Costing, Dhanpat Rai and company, New Delhi.
[R4]	Raina K.B. and Bhattacharya S.K., Electrical Design, Estimating and Costing, Tata McGraw Hill, New Delhi .
[R5]	B.D. Arora-Electrical Wiring, Estimation and Costing,- New Heights, New Delhi.
[R6]	M.V. Deshpande, Elements of Power Station design and practice, Wheelers Publication.
[R7]	S. Sivanagaraju and S. Satyanarayana, Electric Power Transmission and Distribution, Pearson Publication .
[R8]	Power Equipment Maintenance and Testing (Power Engineering Book 32) by Paul Gill

Unit	Text Books	Reference Books
Unit 1	T1,T3	R7
Unit 2	T1,T3	R2, R3
Unit 3	T2, T4, T5, T6	R8
Unit 4	T3	R2, R3, R4, R5
Unit 5		R2, R3, R4, R5
Unit 6	T2,T7	

List of Experiments

Part-A: (Any Eight of the following)

1) Measurement of Dielectric Absorption Ratio and Polarization Index of insulation.
2) Study of thermograph images and analysis based on these images.
3) Practice of earthing and Measurement of Earth resistance of Campus premises by using 4 Pole, 3 Pole, new technology practicing in industry clamp on method.
4) Single Line diagram of 132 or 220 or 400 kV substation (based on actual field visit) Symbols, Plate or Pipe earthing. (Drawing sheets 1 using AutoCAD or other CAD software)
5) Assignment on design of earthing grid for 132/220 kV substation.
6) Design and estimation of light and power circuit of labs/industry.
7)Measurement of insulation resistance of motors and cables
8) PRECAUTIONS FROM ELECTRIC SHOCK AND METHOD OF SHOCK TREATMENT.
9) Using of Installation Multifunction Testers for RCD testing, Phase Sequence Indication, Insulation resistance measurement, Continuity testing
10)Use REVIT / any BOQ (Bill of Quantity)estimation software for estimation and costing
11) Design and estimation of light and power circuit of residential wiring.

Part-B:(Any 4 out of these)

1) Estimation and costing for 11 kV feeders and substation.(voltage drop calculation,SLD, substation layout)
2. Study of troubleshooting of electrical equipment based on actual visit to repair workshop (Any One). i) Three phase induction motor ii) Transformer iii) Power Cable

3. Trouble shooting of household equipment – Construction, working and troubleshooting of any two household Electrical equipment's (Fan, Mixer, Electric Iron, Washing Machines, Electric Oven, Microwave - Limited to electrical faults) (Here we perform Practical by using PAT Testers) 4) Design, Estimation and costing of earthing pit and earthing connection for computer lab, Electrical Machines Lab. 5)WIRING INSTALLATION AND MAINTENANCE OF PUMP MOTOR 6)Activity: Interview of Electrical maintenance personnel/Technician/Electrician 7)Activity: Safety awareness for housing societies/schools/Junior colleges 8)Activity: Preparation of Tender notice and studying the Tender notices published in newspapers 9)Any innovative activity related to EIMT syllabus Industrial Visit (if any): Visit to substation/ installation sites
Guidelines for Student's Lab Journal :
1. Report on Tutorial can be written separately for different batches. 2. Report shall be based on actual work done, regarding visit, power and lighting circuit design Studies executed. 3. Report shall include following points a) Objective b) Procedure c) Equipment d) Details of Name/Place/Location e) Type and nature of activity f) Result and Calculations if any g) Questions for assessment of Tutorial h) Outcome of activity
Guidelines for Instructor's Manual :
Instructor's Manual shall have 1. Brief relevant theory. 2. Equipment with specifications. 3. Connection diagram/ methodology. 4. Format of observation table and sample results.
Guidelines for Lab /TW Assessment :
1. There should be continuous assessment for TW. 2. Assessment must be based on understanding level, attentiveness, presentation skills, efficiency and quality of report. 3. Timely submission of act.
Guidelines for Laboratory Conduction :
1. Discussion on practical/Tutorial 2. Exercise /Assessment /Calculations
Self-Learning Topics :
1. Electrical Safety Procedures 2. Study of Energy polices of different companies 3. Duties and responsibilities of Energy Manager and Auditor
Contents beyond Syllabus :
1 2 Phase systems, Modified Kelvins law 2 Electrical Accidents/Industrial Accidents
Extra Experiments :
1. Trouble shooting in Transformer and AC Motors 2. Demonstration PAT/CAT instruments
Guest Lecture

1. Condition monitoring and case studies on vibration analysis and thermography 2. Enhancing electrical safety at work place by use of Electrical Appliances 3. Practical Aspects of Electrical Estimation and wiring design
Bridging Courses :
Operation and conventional testing of electrical equipment
Assignment Topics/Tutorial topics
• Distribution systems with numerical • Substation and earthing system design • Condition monitoring and different tools • Estimation and Wiring Design • Electrical safety
Case Studies :
• Visit to Transformer or Induction motor industry report on trouble shoot exercises • Substation visit

Elective-I: Advanced Microcontroller and Embedded System

Course Name : Elective-I: Advanced Microcontroller and Embedded System **Course Number : 303145A**		
Teaching Scheme **Lecture : 03 Hrs/ Week**	**Credits** **Th: 03**	**Examination Scheme [Marks]** **In Sem : 30 Marks** **End Sem : 70 Marks**

Designation of the Course : Professional-Elective

Prerequisites :

1. Knowledge of Number system and Basic logic components.
2. Programming basics of C language.
3. Advantage of Microcontroller over Microprocessor.

Course Objectives:

1. Help Students understand Architecture of PIC 18F458 microcontroller.
2. Create and enhance ability to write and Interpret Assembly and C language for PIC 18f458.
3. Make students understand procedure to interface peripherals with PIC 18f458 for various Applications.

Course Outcomes:

At the end of the course, a graduate will be able to –

CO1.	Explain architecture of P18F458 microcontroller and basic concepts in embedded C programming.
CO2.	Use Ports and timers for peripheral interfacing and delay generation
CO3.	Explain CCP module of P18F458 and generate events using it.
CO4.	Explain interrupt structure and write program in C for Timer0 and INT0 interrupts
CO5.	Explain interfacing of ADC and LCD with P18F458 and write program in C
CO6.	Use Serial Communication and various serial communication protocols

Course Contents :

Unit 01	**PIC Architecture and Embedded C**	**07 hrs**

Comparison of CISC and RISC Architectures, Data and Program memory organization, Program Counters, Stack pointer, Bank Select Register, Status register, Embedded C concepts, Header and source files and pre-processor directives, Data types, data structures, Control loops, functions, bit operations.

Unit 02	**Port and Timer 0 Programming**	**05 hrs**

I/O Ports and related SFRs, I/O port programming in C. PIC 18 Timer 0 Programing in C. Delay programming (with and without Timer0). LED Interfacing and its programming.

Unit 03	**CCP Module and its applications**	**06 hrs**

CCP module in PIC 18 microcontroller, Timers required for CCP Applications, Applications of CCP mode Generation of Square waveform using Compare mode of CCP module. Period measurement of unknown signal using Capture mode in CCP module, Speed control of DC motor using PWM mode of CCP module.

Unit 04	**Interrupt structure and its Programming**	**05 hrs**
Interrupt Programming, Programming of Timer0 interrupts, Programming of External interrupts INT0.		
Unit 05	**ADC structure and LCD interfacing**	**07 hrs**
PIC ADC, Programming of ADC using interrupts, Measurement of temperature and Power. Using PIC microcontroller. Interfacing of LCD (16x2) in 4 bit mode.		
Unit 06	**Serial Communication and its protocols**	**06 hrs**
Serial Communication structure and its programming (Data transmit and Receive), Introduction to Communication protocols as SPI and MODE BUS		

Text Books:

[T1]	PIC Microcontroller and Embedded Systems Using Assembly and C for PIC18 by Muhammad Ali Mazidi, Rolind D. McKinley, Danny Causey, Pearson Education.
[T2]	Fundamentals of Microcontrollers and Applications in Embedded Systems with PIC by Ramesh Gaonkar, Thomson and Delmar learning, First Edition.
[T3]	Programming And Customizing the PIC Microcontroller by Myke Predko, TATA McGraw-Hill.
[T4]	PIC microcontroller: An introduction to software and Hardware interfacing by Han- Way-Huang Thomson Delmar Learning.
[T5]	Microcontroller Theory and Applications with PIC18F, M.Rafiquzzaman, John Wiley and Sons

Reference Books:

[R1]	PIC18F458 datasheet
[R2]	MPLAB IDE user guides
[R3]	MICROCHIP Technical Reference Manual of 18F4520 Embedded Design with PIC 18F452 Microcontroller by John B. Peatman, Prentice Hall

Contents beyond Syllabus :

- Introduction to MPLAB IDE
- Simulation programs of I/O ports, LCD, PWM, Interrupt using MPLAB IDE and video sessions

Assignment Topics :

Assignment 1 on Architecture and memory organization of P18F458 microcontroller.
Assignment 2 on Port and Timer programming in P18F458
Assignment 3 on Interrupt and ADC programming

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Elective-I: Digital Signal Processing

Course Name: Elective-I: Digital Signal Processing
Course Number: 303145B

Teaching Scheme			Credits		Examination Scheme	
Theory	03	Hr/Week	**TH**	**03**	**ISE**	30 Marks
					ESE	70 Marks

Designation of the Course : Professional-Core

Prerequisites :

Laplace transform, Fourier Transform, Basics of signals

Course Objectives:
At the end of this course, student will be able to

1.	Understand the basic concepts of discrete signals and systems and their representation.
2.	Analyze discrete systems using z transform and Discrete forms of Fourier transforms.
3.	Develop concepts related to frequency domain analysis of discrete systems and signals
4.	Design digital filters for different specifications

Course Outcomes:
At the end of the course, a graduate will be able to –

CO1	Analyze discrete signals and systems
CO2	Represent and analyze given discrete system using z and Fourier transform
CO3	Obtain frequency domain response of discrete system using DTFT and DFT
CO4	Design and realize IIR filters for given specifications
CO5	Design and realize FIR filters for given specifications
CO6	Apply the concepts from DSP to practical problems in Electrical Engineering

Course Contents :

Unit 1 :	**Discrete time signal and system**	**[6 Hrs]**

Analog, Discrete-time and Digital signals, Basic sequences and sequence operations, Discretetime systems, Properties of D. T. Systems and Classification, Linear Time Invariant Systems, impulse response, linear convolution and its properties, properties of LTI systems: stability, causality, Periodic Sampling, Sampling Theorem, Frequency Domain representation of sampling, reconstruction of a band limited Signal, A to D conversion Process: Sampling, quantization and encoding.

Unit 2 :	**Z and Inverse Z transform**	**[6 Hrs]**

Revision of Z-transform, Numerical of Z transform, Inverse Z transform using partial fraction and power series method, Linear constant coefficient difference equations, Solution of difference equation, stability and causality using ROC of of Z-transform

Unit 3 :	**Discrete Time Fourier Transform**	**[6 Hrs]**

Representation of Sequences by Fourier Transform, Symmetry properties of D. T., F. T. theorems: Linearity, time shifting, frequency shifting, time reversal, differentiation, convolution theorem, Frequency response analysis of first and second order system, steady state and transient response		
Unit 4 :	**Discrete Fourier Transform**	**[6 Hrs]**
Sampling in frequency domain, The Discrete Fourier Transform, Relation with z transform Properties of DFT: Linearity, circular shift, duality, symmetry, Circular Convolution, Linear Convolution using DFT, Effective computation of DFT and FFT, DIT FFT, DIF FFT		
Unit 5 :	**Design of IIR filter**	**[6 Hrs]**
Ideal frequency selective filters, Concept of filtering, specifications of filter, IIR filter design from continuous time filters: Characteristics of Butterworth and Chebyshev, impulse invariant and bilinear transformation techniques, Design examples (Butterworth low pass filter) , Basic structures for IIR Systems: direct form, cascade form		
Unit6:	**Design of FIR Filter and DSP Applications**	**[6 Hrs]**
A) Specifications of properties of commonly used windows, Design Examples using rectangular and hanning windows. Basic Structures for FIR Systems: direct form. Comparison of IIR and FIR Filters Applications: Measurement of magnitude and phase of voltage, current, power, frequency and power factor correction, harmonic Analysis and measurement, applications to machine control, DSP based protective relaying		

Text Books :

[T1]	Proakis J., Manolakis D., "Digital signal processing", 3rd Edition, Prentice Hall, ISBN 81-203-0720-8
[T2]	P. Ramesh Babu, "Digital Signal Processing", 4th Edition Scitech Publication
[T3]	Dr.S. D. Apte, "Digital Signal Processing",2nd Edition Wiley India Pvt. Ltd ISBN: 97881-265-2142-5
[T4]	W.Rebizant, J.Szafran, A.Wiszniewski, "Digital Signal Processing in Power system Protection and Control", Springer 2011 ISBN 978-0-85729-801-0

References :

[R1]	Mitra S., "Digital Signal Processing: A Computer Based Approach", Tata McGrawHill, 1998, ISBN 0-07-044705-5
[R2]	A.V. Oppenheim, R. W. Schafer, J. R. Buck, "Discrete Time Signal Processing", 2nd Edition Prentice Hall, ISBN 978-81-317-0492-9
[R3]	Steven W. Smith, "Digital Signal Processing: A Practical Guide for Engineers and Scientists",1st Edition Elsevier, ISBN: 9780750674447

Contents beyond Syllabus :

- Applications of signal processing for image and speech processing

Seminar

Course Name: Seminar **Course Number : 303146**		
Teaching Scheme **Theory : NA** **Practical : NA** **Tutorial : NA** **SEM /PW /IN: 1**	**Credits** **Th / Tut : NA** **PR : NA** SEM /PW /IN:1	**Examination Scheme [Marks]** **TW : 50 Marks**
Designation of the Course : Humanities		

Course Objectives :

1.	Gaining of actual knowledge (terminology, classification, methods and advanced trends)
2.	Learning fundamental principles, generalization or theories
3.	Discussion and critical thinking about topics of current intellectual importance
4.	Developing specific skills, competencies, and points of view needed by professionals in the field most closely related to the course

Course Outcomes :
At the end of the course, a graduate will be able to –

CO1.	Relate with the current technologies and innovations in Electrical engineering.
CO2.	Improve presentation and documentation skill
CO3.	Apply theoretical knowledge to actual industrial applications and research activity.
CO4.	Communicate effectively.

Course Contents :

Seminar should be based on a detailed study of any topic related to the advance areas/applications of Electrical Engineering. Topic should be related to Electrical Engineering. However, it must not include contents of syllabus of Electrical Engineering. It is expected that the student should collect the information from journals, internet and reference books in consultation with his/her teacher/mentor, have rounds of discussion with him/her. The report submitted should reveal the student assimilation of the collected information. Mere compilation of information from the internet and any other resources is discouraged.

Format of the Seminar report should be as follows:

1. The report should be neatly typed on white paper. The typing shall be with normal spacing, Times New Roman (12 pt) font and on one side of the paper. (A-4 size).
2. Illustrations downloaded from internet are not acceptable.
3. The report should be submitted with front and back cover of card paper neatly cut and bound together with the text.
4. Front cover: This shall have the following details with Block Capitals a. Title of the topic. b. The name of the candidate with roll no. and Exam. Seat No. at the middle. c. Name of the guide with designation below

the candidate's details. d. The name of the institute and year of submission on separate lines at the bottom.
5. Certificate from institute as per specimen, Acknowledgement and Contents.
6. The format of the text of the seminar report should be as follows I. The introduction should be followed by literature survey. II. The report of analytical or experimental work done, if any. III. The discussion and conclusions shall form the last part of the text. IV. They should be followed by nomenclature and symbols used. V. The Reference Books are to be given at the end.
7. The total number of typed pages, excluding cover shall from 20 to 25 only.
8. All the pages should be numbered.
9. Two spiral bound copies of the seminar report shall be submitted to the college.
10. Candidate shall present the seminar before the examiners.
11. The total duration of presentation and after-discussion should be about 30 minutes.
The assessment for the subject shall be based on: 1. Content. 2. Presentation 3. Report

Self-Learning Topics :

Online courses related to electrical field and seminar topic

Audit Course V : Energy Storage System

Course Name: Audit Course V -: Energy Storage System **Examination Scheme** **Course Number : 303147 A**		
Teaching Scheme **Theory : 2 Hrs/week** **Practical : NA** **Tutorial : NA**	**Credits** **Th / Tut : NA** **PR : NA** **GRADE : PP/NP**	**Examination Scheme [Marks]** **ISE : 00** ESE: 00 OR-PR-TW : 00
Designation of the Course : Humanities		

Course Objectives :

1.	To elaborate various energy storage systems
2.	To be familiar with various aspects such as hybridization, selection of storage system.

Course Outcomes :
At the end of the course, student will be able to –

CO1.	Explain and differentiate various types of energy storage for suitable applications.
CO2.	Understand battery recycling techniques.

Course Contents :

Course Contents :

Unit 1 :	**Energy Storage Fundamentals**	**[6 Hrs]**

(A)Battery : Energy Density, Power Density, Cycle life, C-rate, State of Charge (SoC), State of Health (SoH), Depth of Discharge (DoD), Characteristic.
(B)Types of Batteries, : Nickel Metal Hydrate, Nickel Cadmium, Lithium ion, Lithium Polymer, Flow Batteries (Vanadium, Zinc, Manganese)
(C)Supercapacitor, Superconducting Magnetic Energy Storage, Compressed Air Energy Storage, Flywheel storage
(D)Hybridization of energy storage
Energy storage sizing, Selection of storage as per application

Unit 2 :	**Recent Trends in Storage**	**[6 Hrs]**

Solid state batteries, Aluminum air and Aluminum ion batteries, Lithium ion Capacitor, Advances in Thermal energy storage systems.Batteries recycling techniques and policies, Case studies.

Reference Books:	
[R1]	Handbook of Energy Storage: Demand, Technologies, IntegrationMichael Sterner, Ingo Stadler
[R2]	Energy Storage: Fundamentals, Materials and Applications, Robert Huggins
Industrial Visit : Manufacturing industry of battery or Capacitor	

Power Systems - II

Course Name : Power Systems - II **Course Number : 303148**		
Teaching Scheme **Theory : 3 Hrs. / week** **Practical : 2 Hrs. / week** **Tutorial : 1 Hr/ week/Batch**	**Credits** **Th / Tut : 03** **PR : 01** **TU: 01**	**Examination Scheme [Marks]** **In Sem : 30 Marks** **End Sem : 70 Marks** **Practical : 50 Marks** **TW:25 Marks**
Designation of the Course : Professional-Core		
Prerequisites :		
Performance of short & Medium transmission lines, Inductance & capacitance of transmission lines		

Course Objectives :

1.	Develop analytical ability for Power system.
2.	Introduce concept of EHVAC and HVDC System.
3.	Demonstrate different computational methods for solving problems of load flow.
4.	Analyze the power system under symmetrical and Unsymmetrical fault conditions.

Course Outcomes :

At the end of the course, a graduate will be able to –

CO1.	Solve problems involving modelling, design and performance evaluation of HVDC and EHVAC power transmission lines. CO2
CO2.	Calculate per unit values and develop Y bus for solution power flow equations in power transmission networks
CO3.	Calculate currents and voltages in a faulted power system under both symmetrical and asymmetrical faults, and relate fault currents to circuit breaker ratings.

Course Contents :

Unit 1 : Performance of Transmission Lines [06 Hrs]

Evaluation of ABCD constants and equivalent circuit parameters of Long transmission line. Concept of complex power, power flow using generalized constants, receiving end power circle diagram for transmission line (assuming ABCD constants are already given), surge impedance loading, Line efficiency, Regulation and compensation, basic concepts. Numerical based on: ABCD constants of Long transmission line, Power flow, circle diagram.

Practicals:

1.Measurement of ABCD parameters of a medium transmission line

2. Measurement of ABCD parameters of a long transmission line

3. Plotting of receiving end circle diagram to evaluate performance of medium transmission line

4. Study of the effect of VAR compensation using capacitor bank.

Tutorials:

1. ABCD parameters of long transmission line
2. Power flow using generalized constant
3. Receiving end Power Circle diagram

Unit 2 :	**EHV-AC transmission:**	**[08 Hrs]**

Role of EHV-AC transmission, standard transmission voltages, average values of line parameters, power handling capacity and line losses, phenomenon of corona, disruptive critical voltages, visual critical voltages, corona loss, factors and conditions affecting corona loss, radio and television interference, reduction of interference, Numerical Based on Corona, Corona loss and power handling capacity.

Tutorials:

1. Power flow and losses in EHVAC transmission line for specified ratings

Unit 3 :	**Per unit system and Load Flow Analysis**	**[08 Hrs]**

Per unit system: Single line diagram, Impedance and reactance diagrams and their uses, per unit quantities, relationships, selection of base, change of base, reduction to common base, advantages and application of per unit system. Numerical based on network reduction by using per unit system.

Load Flow Analysis: Network topology, driving point and transfer admittance, concept of Z-bus and formulation of Y-bus matrix using Direct method, singular transformation method, Introduction to load flow analysis, power- flow equations generalization to n bus systems, classification of buses, Newton- Raphson method (using polar coordinates), Numerical based on Y bus Matrix

Practicals:- 1. Formulation and calculation of Y- bus matrix of a system

Tutorials:

1. Determination of Y-bus for three, four and five bus system

Unit 4 :	**Symmetrical Fault Analysis**	**[8 Hrs]**

3-phase short-circuit analysis of unloaded alternator, sub-transient, transient and steady state current and impedances, D.C. Offset, and effect of the instant of short-circuit on the waveforms, estimation of fault current without pre-fault current for simple power systems, selection of circuit breakers and current limiting reactors and their location in power system (Descriptive treatment only) Numerical Based on symmetrical fault analysis

Practicals:

1. Static measurement of sub-transient reactance's of a salient-pole alternator.

Symmetrical fault analysis of a 3-bus system

Tutorials:

1. Calculation of symmetrical fault current and determine value of current limiting reactor suitable for given circuit breaker rating

2.

Unit 5 :	**Unsymmetrical Fault Analysis**	**[8 Hrs]**

Symmetrical components, transformation matrices, sequence components, power in terms of symmetrical components, sequence impedances of transmission line and zero sequence networks of transformer, solution of unbalances by symmetrical components, L-L, L-G, and L-L-G fault analysis

of unloaded alternator and simple power systems with and without fault impedance. Numerical based on symmetrical component and unsymmetrical fault calculation.

Practicals:

1. Measurement of sequence reactance's of a synchronous machine (Negative and zero)

Unsymmetrical fault analysis of a 3-bus system

Tutorials:

1. Determination of line/phase current, voltage and power calculation using symmetrical component
2. Calculation of unsymmetrical fault current

Unit 6 :	**HVDC Transmission** (Descriptive treatment only)	**[8 Hrs]**

Classification and components of HVDC system, advantages and limitations of HVDC

transmission, comparison with HVAC system, introduction to HVDC control methods –

constant current, constant ignition angle and constant extinction angle control, recent developments.

Tutorials:

1. Write a report on different HVDC project in India / world wide

Text Books :

[T1]	I.J. Nagrath and D.P. Kothari – Modern Power System Analysis – Tata McGraw Hill, New Delhi.
[T2]	B R Gupta , "Power System Analysis and Design", S.Chand.
[T3]	Abhijit Chakraborty and Sunita Haldar, "Power System Analysis" PHI, New Delhi.
[T4]	. J.B.Gupta. "A course in power systems" S.K. Kataria Publications.
[T5]	P.S.R. Murthy, "Power System Analysis", B.S. Publications.

Reference Books :

[R1]	H. Hadi Sadat: Power System Analysis, Tata McGraw-Hill New Delhi.
[R2]	G. W. Stagg and El- Abiad – Computer Methods in Power System Analysis – Tata McGraw Hill, New Delhi.
[R3]	M.E.El-Hawary, Electric Power Systems: Design and Analysis, IEEE Press, New York.
[R4]	Rakash Das Begamudre, Extra High voltage A.C. Transmission Engineering, New age publication.
[R5]	M.A.Pai, Computer Techniques in Power System Analysis", Tata McGraw Hill Publication.

[R6]	Stevenson W.D. Elements of Power System Analysis (4th Ed.) Tata McGraw Hill, New Delhi.
[R7]	K.R.Padiyar: HVDC Transmission Systems, New Age International Publishers Ltd, New Delhi.
[R8]	Olle I. Elgard – Electric Energy Systems Theory – Tata McGraw Hill, New Delhi.
[R9]	NPTEL Web course and video course on power system analysis

Self-Learning Topics :

Modern trends in HVDC system

Contents beyond Syllabus :

- Introduction to pre fault current for fault analysis
- Introduction to FACTS devices for VAR compensation
- Introduction to MATLAB software

Extra Experiments :

1. Introduction to MATLAB

Bridging Courses :

- Derivation of ABCD constants of medium transmission line
- Gauss seidal method for solution of nonlinear equations

Assignment Topics :

14. Performance of transmission lines, EHVAC system and Per Unit system & Load flow analysis
15. Symmetrical and unsymmetrical fault analysis, HVDC system

Presentations :

1. Reactance diagram

Computer Aided Design of Machines

Course Name : Computer Aided Design of Machines
Course Number : 303149

Teaching Scheme	Credits	Examination Scheme [Marks]
Theory : 3 Hrs. / week Practical : 4 Hrs. / week Tut :00	Th : 03 PR : 02 Tut :00	In Sem : 30 Marks End Sem : 70 Marks Oral : 25 Marks TW:50 Marks

Designation of the Course : Professional-Core

Prerequisites :
1. Knowledge of fundamentals of electrical engineering.
2. Knowledge of various materials used in electrical machines.
3. Knowledge of types, construction and working of transformer.
4. Knowledge of types, construction and working of three phase induction motor.

Course Objectives :

1.	Design of transformer based on specifications.
2.	Determine performance based on the parameters of transformer.
3.	Design of Induction motor based on specifications.
4.	Determine performance based on the parameters of Induction motor.
5.	Apply computer aided design techniques to transformer and induction motor design.

Course Outcomes :
At the end of the course, a graduate will be able to –

CO1.	Summarize temperature rise, methods of cooling of transformer and consider IS 2026 in transformer design.
CO2.	Design the overall dimensions of the transformer.
CO3.	Analyze the performance parameters of transformer.
CO4.	Design overall dimensions of three phase Induction motor
CO5.	Analyze the performance parameters of three phase Induction motor.
CO6.	Implement and develop computer aided design of transformer and induction motor.

Course Contents :

Unit 1 : Transformer Design: Part 1 [06 Hrs]

Modes of heat dissipation. Heating and cooling curves. Calculations of heating and cooling time constants. Methods of cooling of transformer. Types and constructional features of core and windings used in transformer. Transformer auxiliaries such as tap changer, pressure release valve, breather and conservator. Specifications of three phase transformers as per IS 2026 (Part I). Introduction to computer aided design.

Unit 2 : Transformer Design: Part 2 [06 Hrs]

Output equation with usual notations, optimum design of transformer for minimum cost and loss. Design of core, estimation of overall dimensions of frame and windings of transformer. Design of tank with cooling tubes.

Practicals:

1. Details and assembly of transformer with design report. (Sheet in CAD)

Unit 3 :	**Performance parameters of Transformer**	**[06 Hrs]**

Estimation of resistance and leakage reactance of transformer. Estimation of no-load current, losses, efficiency and regulation of transformer. Calculation of mechanical forces developed under short circuit conditions, measures to overcome this effect. Computer aided design of transformer, generalized flow chart for design of transformer.

Practicals:-

1. Report based on transformer manufacturing/repairing unit.

Unit 4 :	**Three phase Induction Motor Design: Part 1**	**[6 Hrs]**

Specifications and constructional features. Types of ac windings. Specific electrical and magnetic loadings, ranges of specific loadings. Output equation with usual notations. Calculations for main dimensions, turns per phase and number of stator slots

Practicals:

1. Details and layout of single layer three phase winding with design report. (Sheet in CAD)

Unit 5 :	**Three phase Induction Motor Design: Part 2**	**[6 Hrs]**

Suitable combinations of stator and rotor slots. Selection of length of air gap, factors affecting length of air gap. Design of rotor slots, size of bars and end rings for cage rotor. Conductor size, turns and area of rotor slots for wound rotor.

Practicals:

1. Details and layout of double layer three phase winding with design report. (Sheet in CAD)

Unit 6 :	**Performance parameters of Three Phase Induction motor**	**[6 Hrs]**

. Leakage flux and leakage reactance: Slot, tooth top, zig - zag, overhang. Leakage reactance calculation for three phase machines. MMF Calculation for air gap, stator teeth, stator core, rotor teeth and rotor core, effect of saturation, effects of ducts on calculations of magnetizing current, calculations of no-load current. Calculations of losses and efficiency. Computer aided design of induction motor, generalized flow chart for design of induction motor

Tutorials:

1. Assembly of three phase induction motor. (Sheet in CAD)
2. Report based on induction motor manufacturing/repairing unit.

Text Books :

[T1]	M. G. Say–Theory and Performance and Design of A.C. Machines,3rd Edition, ELBS London.
[T2]	A.K. Sawhney–A Course in Electrical Machine Design, -Dhanpat Rai and sons New Delhi
[T3]	K. G. Upadhyay- Design of Electrical Machines, New age publication
[T4]	R. K. Agarwal–Principles of Electrical Machine Design, S. K. Katariya and sons.

[T5]	Indrajit Dasgupta –Design of Transformers–TMH
Reference Books :	
[R1]	K. L. Narang, A Text Book of Electrical Engineering Drawings, Reprint Edition, Satya Prakashan, New Delhi.
[R2]	A Shanmuga sundaram,G. Gangadharan, R. Palani,-Electrical Machine Design Data Book,3rd Edition, 3rd Reprint 1988- Wiely Eastern Ltd.,- New Delhi
[R3]	Vishnu Murti, "Computer Aided Design for Electrical Machines", B. S. Publications.
[R4]	Bharat Heavy Electricals Limited, Transformers - TMH.

Self-Learning Topics :

Types of Leakage Flux

Contents beyond Syllabus :

- LAP Winding Diagram for DC Machines
- WAVE Winding Diagram for DC Machines

Extra Experiments :

- LAP Winding Diagram for DC Machines on graph paper / using Auto CAD
- WAVE Winding Diagram for DC Machines on graph paper / using Auto CAD

Bridging Courses :

- Auto CAD commands/ instructions, required for drawing Winding Diagrams
- Introduction to Finite Element Analysis

Assignment Topics :

16. Heating and Cooling Curves
17. Derivation of Output Equation of Transformer and problems based on it
18. Derivation of No Load Current of Transformer
19. Derivation of Output Equation of an Induction Motor and problems based on it
20. Derivation of End Ring Current of an Induction Motor
21. Types of Leakage Flux

Presentations :

- Windings for Induction Motor
- Circle Diagram of an Induction Motor
- MMF Calculations for an Induction Motor

Control Systems Engineering

Course Name: Control Systems Engineering
Course Number: 303150

Teaching Scheme			Credits		**Examination Scheme**	
Theory	03	Hr/Week	**TH**	**03**	**ISE**	30 Marks
Practical	02	Hr/Week/batch	**TU**	**01**	**ESE**	70 Marks
Tutorial	01	Hr/Week/batch	**PR**		**OR**	25 Marks
					TW	25 Marks

Designation of the Course : Professional-Core

Prerequisites :

Laplace transform, Network Analysis, Ordinary Differential Equations, Applied Mechanics, Electrical Machines

Course Objectives:
At the end of this course, student will be able to

1.	To understand basic concepts of the classical control theory.
2.	To model physical systems mathematically.
3.	To analyze behavior of system in time and frequency domain.
4.	To design controller to meet desired specification

Course Outcomes:
At the end of the course, a graduate will be able to –

CO 1	Model the given physical system in transfer function form.
CO 2	Analyze the response of second order system for step, ramp as well as parabolic input.
CO 3	Draw and analyze root locus of a given system.
CO 4	Draw and analyze the frequency response of a given system in the form of a Bode plot, Polar plot and Nyquist plot.
CO 5	Determine stability of a system in time and frequency domain.

CO 6	Explain PID controller and design P, PI, PD and PID controller.

Course Contents :

Unit 1 :		**[8 Hrs]**
Basic concepts of control system, classification of control systems, types of control system: feedback, tracking, regulator system, feed forward system, transfer function, concept of pole and zero, modeling of Electrical and Mechanical systems (Only series linear and rotary motion) using differential equations and transfer function , analogy between electrical and mechanical systems, block diagram algebra, signal flow graph, Mason's gain formula		
PR/Tut :	Tutorials: 1. Block diagram reduction problems 2. Signal flow graph problems 3. Mathematical modeling of electrical and mechanical systems Experiments: 1. . Experimental determination of DC servo motor parameters for mathematical modelling, transfer function and characteristics	

Unit 2 :	**Time domain analysis**	**[7 Hrs]**
Concept of transient and steady state response, standard test signals: step, ramp, parabolic and impulse signal, type and order of control system, time response of first and second order systems to unit impulse, unit step input, time domain specifications of second order systems, derivation of time domain specifications for second-order under-damped system for unit step input, steady state error and static error coefficients		
PR/Tut :	Tutorials: 1. Time domain response of given second order system 2. Determine time domain specifications of a given second order system 3. Calculation of steady state errors and error coefficients Experiments 1. Experimental study of time response characteristics of R-L-C second order system: Validation using simulation 2. Simulation of second order system on analog computer	

Unit 3 :	**Stability Analysis and Root Locus**	**[6 Hrs]**
Concept of stability: BIBO, nature of system response for various locations of poles in S-plane. Routh's-Hurwithz criterion. Root Locus: Angle and magnitude condition, Basic properties of root locus. Construction of root locus, Stability analysis using root locus.		
PR/Tut	Tutorials 1. Investigate closed loop stability of a given systems using Routh Hurwitz stability criterion. 2. Sketch the root locus of a given systems and comment on stability Experiments:	

	1. Effect of addition of pole-zero on root locus of second order system. 2. Stability analysis using root locus technique.
Unit 4 :	**Frequency Domain Analysis-I** **[6 Hrs]**
Introduction, Frequency domain specifications, correlation between time and frequency domain specifications, polar Plot, Nyquist plot, stability analysis using Nyquist plot	
PR/Tut :	Tutorials: 1. Sketch the polar plot of given systems. 2. Sketch the Nyquist plot of a given systems, determine stability margins and comment on stability. Experiments: 3. Stability analysis using Nyquist plot using software. 4. Experimental frequency response determination of Lag and Lead compensator
Unit 5 :	**Frequency Domain Analysis-II** **[6 Hrs]**
Introduction to Bode plot, Asymptotic approximation: sketching of Bode plot, stability analysis using Bode plot	
PR/Tut :	Tutorials: 1. Sketch the Bode plot of a given systems, determine stability margins and comment on stability Experiments: 1. Stability analysis using Bode plot using software .
Unit 6 :	**PID controllers** **[6 Hrs]**
Basic concept of P, PI, PID controller, design specifications in time domain and frequency domain. design of PID controller by Root Locus, tuning of PID controllers using Ziegler-Nichol Methods Control System Components: Working principle and transfer function of Lag network, lead network, potentiometer, DC servo motors	
PR/Tut :	Tutorials 1. Determine the tuning parameters of PID controller using open loop step response and closed loop ultimate cycle methods of Ziegler and Nichol. 2. Design the PID controller for desired specifications using root locus approach Experiments: 1. PID control of level/Pressure/Temperature control system. 2. Experimental analysis of D.C. Position Control System. 3. Time response of second order system effect of P,PI, PID on it.
Text Books :	

[T1]	I.J. Nagrath, M. Gopal, "Control System Engineering", New Age International Publishers, 4th Edition, 2006.
[T2]	Katsuhiko Ogata, "Modern control system engineering", Prentice Hall, 2010.
[T3]	B. C. Kuo, "Automatic Control System", Wiley India, 8th Edition, 2003.
[T4]	Natarajan Ananda, Babu P. Ramesh "Control Systems Engineering" , Second Edition, Scitech Publication, 2010.

References :

[R1]	Richard C Dorf and Robert H Bishop, "Modern control system", Pearson Education, 12th edition, 2011.
[R2]	Nise N. S. "Control Systems Engineering", John Wiley & Sons, Incorporated, 2011
[R3]	Jacqueline Wilkie, Michael Johnson, Reza Katebi, "Control Engineering: An Introductory Course", Palgrave Publication, 2002.
[R4]	D. Roy Choudhary, "Modern Control Engineering", PHI Learning Pvt. Ltd., 2005.
[R5]	Smarajiti Ghosh, "Control Systems : Theory and Applications" , Dorling Kindersley (RS), 2012

Guidelines for Student's Lab Journal :

The Student's Lab Journal should contain following related to every experiment

- Theory related to the experiment
- Apparatus with their detailed specifications.
- Connection diagram /circuit diagram/Simulink diagram/MATLAB program
- Observation table/ simulation results
- Sample calculations for one/two reading
- Result table, Conclusion
- Few short questions related to the experiment

Guidelines for Instructor's Manual :

- Assessment must be based on understanding of theory, attentiveness during practical session.
- Assessment should be done how efficiently student is able to perform experiment/simulation and get the results. Understanding fundamentals and objective of experiment, timely submission of journal

Guidelines for Lab /TW Assessment :

Each experiment will be evaluated out of 10 marks. The evaluation will be based on

1. Involvement of the student in performing the experiment. 2. His/her understanding about the concept involved. 3. His sincerity in the submission of the experiment manual.
Guidelines for Laboratory Conduction :
A group of 4-5 students will be working on the experiment for taking readings. For software based practicals, individual student will be working on the computer node for practical session.
Self-Learning Topics :
1. A.C./D.C. tachogenerators, Gear trains
Contents beyond Syllabus :
• Analog Computer simulation for transient analysis of a control system.
Extra Experiments: **Analog computer simulation for second order control system for various damping factors.**

Elective II : IoT and Its Applications in Electrical Engineering

Course Name : Elective II :IoT and Its Applications in Electrical Engineering
Course Number : 303151A

Teaching Scheme	Credits	Examination Scheme [Marks]
Lecture : 03 Hrs/ Week	Th: 03	In Sem : 30 Marks End Sem : 70 Marks

Designation of the Course : Professional-Elective

Prerequisites :

Basics of Electrical generation, transmission, distribution and utilization, Fundamentals of logic circuits, C, C+

Course Objectives:

1. Understand the architecture of Internet of Things
2. Evaluate the electrical systems for making them IoT enable
3. Assess the automated processes and retrofit it for enhancement is user accessibility.

Course Outcomes:

At the end of the course, a graduate will be able to –

CO1.	Explain basic architecture of IoT systems, IoT standards and gateways and discuss security issues and challenges in IoT system
CO2.	Compare various microcontrollers and IoT development platforms
CO3.	Develop programs in C and Python using various IDEs.
CO4.	Experiment with sensors and actuators and choose the right sensor for particular application
CO5.	Explain and compare various communication technologies used in IoT systems
CO6.	Design and develop simple IoT based applications

Course Contents :

Unit 01	**Introduction to IoT**	**06 hrs**

Fundamental components of IoT, Evolution of Connected Devices, Basic Architecture of IoT, ISO and IEC Standards, IoT categories, IoT gateways, challenges, Security concerns and hurdles, Overview of applications - home automation, agriculture, Industrial, health care, Smart Grid.

Unit 02	**IoT Development platforms**	**06 hrs**

Basics of Microcontroller and Microprocessor, Introduction to Edge devices eg. Arduino, Node MCU, Raspberry Pi. Comparative analysis of the Platforms.

Unit 03	**Programming the hardware**	**06 hrs**

Introduction to Integrated Development Environment, Overview of different IDE's, Example of programs using Arduino IDE, Basics of Python, Example of programs using Python.

Unit 04	**Sensing and Actuation**	**06 hrs**

Sensors, Types of sensors – Digital and Analog, characteristics, choosing right sensor for Application, Interfacing Sensor with Node MCU, Reading data from Sensors like LM35, DHT 11, Ultrasonic Sensor, IR

Sensor, sound sensor, touch sensor, LDR, Potentiometer, Current and voltage Sensor, Connecting actuators - relay, stepper motor.		
Unit 05	**Communication Technologies and Cloud**	**06 hrs**
Introduction to communication Technologies like Wi-Fi, Bluetooth, RFID, Z-Wave, Zigbee, 6LoWPAN, LORA, Wireless HART, MQTT, Introduction to cloud platforms.		
Unit 06	**Development of IoT based Application**	**06 hrs**
Reading sensor data and sending it to cloud platform, Visualization and analysis of the data on cloud, actuation and control, case study – Home automation		

Text Books:

[T1]	Daniel Minoli, "Building the Internet of Things with IPv6 and MIPv6: The Evolving World of M2M Communications", ISBN: 978-1-118-47347-4, Willy Publications
[T2]	Bernd Scholz-Reiter, Florian Michahelles, "Architecting the Internet of Things", ISBN 978-3-642-19156-5 e-ISBN 978-3-642-19157-2, Springer
[T3]	Parikshit N. Mahalle& Poonam N. Railkar, "Identity Management for Internet of Things", River Publishers, ISBN: 978-87-93102-90-3 (Hard Copy), 978-87-93102-91-0 (ebook).

Reference Books:

[R1]	Hakima Chaouchi, " The Internet of Things Connecting Objects to the Web" ISBN : 978-1-84821-140-7, Willy Publications
[R2]	Olivier Hersent, David Boswarthick, Omar Elloumi, The Internet of Things: Key Applications and Protocols, ISBN: 978-1-119-99435-0, 2nd Edition, Willy Publications
[R3]	Daniel Kellmereit, Daniel Obodovski, "The Silent Intelligence: The Internet of Things",. Publisher: Lightning Source Inc; 1 edition (15 April 2014). ISBN-10: 0989973700, ISBN-13: 978-0989973700.
[R4]	Fang Zhaho, Leonidas Guibas, "Wireless Sensor Network: An information processing approach", Elsevier, ISBN: 978-81-8147-642-5.
[R5]	Michael Margolis, Arduino Cookbook, 2nd Edition, O'Reilly Media, Inc, 2011.
[R6]	Alex Bradbury & Ben Everard, Learning Python with Raspberry Pi, 1st Edition, John Wiley & Sons, Feb 2014.
[R7]	Charles Bell, Beginning Sensor Networks with Arduino and Raspberry Pi, 1st Edition, Apress, 2014

Self-Learning Topics :

- LDR Sensor and its interfacing with NodeMCU
- LORA Communication Technology

Assignment Topics :

Assignment 1 on Architecture and Security challenges of IoT system
Assignment 2 on Advanced microcontrollers used in IoT system
Assignment 3 on Sensors and its interfacing with NodeMCU
Assignment 4 on Communication technologies used in IoT system
Assignment 5 on IoT Cloud Platforms

Elective II : Electric Mobility

Course Name: Electric Mobility **Course number: Elective II : 303151B**				
Teaching Scheme	**Credits**		**Examination Scheme**	
Lectures	**03 hrs/week**	**03**	**In-Sem Assessment**	**30**
			End-Sem Assessment	**70**
Designation of the Course : Professional-Core / Elective / Humanities				
Prerequisites :				
Basic concept of Batteries, Electrical Motors, Power Electronics				
Course Objectives : The course aims:-				
	1. To make students understand the need & importance of Electric & Hybrid Electric vehicles.			
	2. To differentiate and analyze the various energy storage devices.			
	3. To impart the knowledge about architecture and performance of Electric and Hybrid Vehicles			
	4. To classify the different drives and controls used in electric vehicles.			
Course Outcomes :At the end of the course, a graduate will be able to –				
CO1.	Analyze the concepts of Hybrid and Electric vehicles.			
CO2.	Describe the different types of energy storage systems.			
CO3.	Comprehend the knowledge of the battery charging and management systems.			
CO4.	Classify the different mode of operation for hybrid vehicle.			
CO5. **CO.6**	Apply the different Charging standards used for electric vehicles. Differentiate between Vehicle to home & Vehicle to grid concepts.			
Course Contents :				
Unit 1 :	**Introduction to Hybrid and Electric vehicles**		**[6 Hrs]**	
Need and importance of Electric Vehicle and Hybrid Electric Vehicles, Environmental importance of Hybrid and Electric vehicles. Hybrid Electric vehicles: Concept and architecture of HEV drive train (Series, parallel and series-parallel). Micro Hybrid, Mild Hybrid, Full Hybrid, Plug-in Hybrid, Electric vehicles: Components, configuration, performance, tractive effort, Advantages and challenges in EV.				
Unit 2 :	**Energy Storage Systems**		**[6 Hrs]**	
Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery specifications, Battery based energy storage and its analysis, Classification of lithium-ion batteries, Aluminum Air and Aluminum ion battery. Fuel Cell based energy storage, Super Capacitor based energy storage, Hybridization of Ultra capacitor and Battery. Selection methodology for the energy storage. Selection of energy storage technology.				
Unit 3 :	**Battery charging and Management systems**		**[6 Hrs]**	

Introduction: Different Charging algorithms and Charging method, Cell Balancing methods. Battery Management System: Functions of BMS, Block diagram of BMS. SoC Estimation methods, Thermal Management of Battery.		
Unit 4 :	**Hybrid Power Train and mode of operation**	**[6 Hrs]**
Control Strategies and Design of the Major Components: Series and Parallel Hybrid Electric Drive Train. Energy Consumption in Braking, Braking Power and Energy on Front and Rear Wheels, Brake System of EVs and HEVs, Regenerative braking		
Unit 5 :	**Drives and Charging Infrastructure**	**[6 Hrs]**
Selection of drives for Electric vehicle: PMSM drive and BLDC drive, Sizing of motor, Charging Levels: 01,02 and 03, Charging Standards: CCS, CHAdeMO, SAE J1772, IEC 60309, Bharat DC 001, Bharat AC 001, Electric Vehicle Supply Equipment (EVSE).		
Unit 6 :	**Vehicle to Home, Vehicle to Vehicle and Vehicle to Grid energy systems**	**[6 Hrs]**
Vehicle to Home: Introduction, applications, V2H with demand response, Case Study of V2H. Vehicle to Grid: Introduction of V2G, V2G infrastructure in the smart grid, Role of aggregator for V2G, Case study of V2G, Vehicle to Vehicle: Introduction of V2V, Concept & structure.		
Text Books :		
[T1]	James Larminie and John Lowry, "Electrical Vehicle", John Wiley and Sons, 2012.	
[T2]	Ronald K. Jurgen, "Electric and Hybrid-Electric Vehicles", SAE InternationalPublisher**.**	
[T3]	K T Chau, "Energy Systems for Electric and Hybrid Vehicles", The institution of Engineering and Technology Publication	
[T4]	D.A.J Rand, R Woods, R M Dell, "Batteries for Electric Vehicles", Research studies press Ltd, New York, John Willey and Sons	
[T5]	Electric and Hybrid Vehicles-Design Fundamentals, CRC press	
Reference Books :		
[R1]	Mehrdad Ehsani, Yimin Gao and Ali Emadi, "Modern Electrical Hybrid Electric and Fuel Cell Vehicles: Fundamental, Theory and design", CRC Press, 2009.	
[R2]	Junwei Lu, Jahangir Hossain,"Vehicle-to-Grid: Linking Electric Vehicles to the Smart Grid", IET Digital Library.	
[R3]	"Automobile Electrical and Electronic systems", Tom Denton, SAE International publications.	
[R4]	"Automotive handbook 5th edition", Robert Bosch, SAE international publication.	
[R5]	Mark Warner, The Electric Vehicle Conversion handbook –HP Books, 2011.	
Self-Learning Topics :		
• Impact of modern drive-trains on energy supplies. • Selection of energy storage technology. • Over speed indicating systems • Auto-parking systems		

Contents beyond Syllabus :
• Various application of electric mobility such as electrical traction, hybrid electric and electric vehicles, elevators, personal mobility and special applications such as wheel chairs. • Driverless vehicles, road safety and traffic control and monitoring.
Extra Experiments :
NIL
Bridging Courses :
NIL
Assignments:
One assignment question based on each Unit.

Internship

Course Name : Internship **Course Number : 303152**		
Teaching Scheme **Theory : NA** **Practical : NA** **Tutorial : NA** **IN: 04**	**Credits** **Th / Tut : NA** **PR : NA** IN: 04	**Examination Scheme [Marks]** **TW : 100 Marks**
Designation of the Course : Internship		
Preamble: Internship is a short-term industrial working experience for the students. The internship aims at providing entry-level exposure to a particular industry. It is expected that students should spend time working on relevant projects or part of the project and acquire learning about the field, along with developing industry connections, and employability skills.		

Course Objectives :	
1.	Encourage and provide opportunities to the students to acquire professional learning experiences.
2.	Empower students to relate and then apply the theoretical knowledge in real-life industrial situations.
3.	Provide exposure for handing and using various tools, measuring instruments, meters, and technologies used in industries.
4.	Enable students to develop professional and employability skills and expand their professional network.
5.	Empower students to apply the internship learnings to the academic courses and project completions.
6.	Impart professional and societal ethics in students through the internship.
7.	Make students aware of social, economic, and administrative aspects influencing the working environment of the industry.

Course Outcomes :
At the end of the course, a graduate will be able to –

CO1.	Understand the working culture and environment of the Industry and get familiar with various departments and practices in the industry.
CO2.	Operate various meters, measuring instruments, tools used in industry efficiently and develop technical competence.
CO3.	Apply internship learning in other course completions and final year project management, i.e.topic finalization, project planning, hardware development, result interpretations, report writing, etc.
CO4.	Create a professional network and learn about ethical, safety measures, and legal practices.
CO5.	Appreciate the responsibility of a professional towards society and the environment.
CO6.	Identify career goals and personal aspirations.

Duration:

1. The internship should be started after semester 5 and should be completed before the commencement of semester 6.
2. It should be for at least 4 to 6 weeks.
3. It should be assessed and evaluated in semester 6.

Internship Identification:

A student may choose to undergo an Internship at Industries, Government organizations, NGOs, Micro-Small-Medium enterprises, startups, Innovation and Incubation Centers, Institutes of National interests, organizations working for rural development, organizations promoting IPR and Entrepreneurship, etc. Approaching various industries for Internships and finalizing the same should be initiated in the 5th semester in consultation with Institute's Training and Placement Cell, Industry- Institute Cell, or Internship Cell. This will help students to start their internship work on time. Also, it will allow students to work in a vacation period after their 5th-semester examination and before the

start of the 6th semester. Student can take internship work in the form of Online/Onsite work from any of the following but not limited to:

1. Working for consultancy or the funded research project of the institute/Department.
2. Contributing at Incubation, Innovation, Entrepreneurship Cell, Institutional Innovation Council, Start-up Cell of Institute where students will get learning opportunities on projects.
3. Learning at Departmental Lab leading to lab development and modernization, Tinkering Lab, Institutional workshop for prototyping and model development, etc.
4. Working at Industry or Government Organization on project or part of the project.
5. Internship through Internshala, AICTE, Government initiatives, etc.
6. In-house product or working model development, intercollegiate, inter-department research under research lab or research group, etc.
7. Working at micro-small-medium enterprises on solving their specific problems.
8. Research internship under professors at IISc, IIT's, NIT's, Research organizations, etc.
9. Working with NGOs or Social Internships, Rural Internship, etc.

Evaluation and Assessment of Internship:

Internship Record Book – 25 Marks + Internship Report - 25 Marks + Post Internship Internal Evaluation-50 Marks = Total 100 Marks.

Post Internship Internal Evaluation:

The student will give a presentation based on his Internship report before an expert committee constituted by the concerned department as per norms of the institute. The evaluation will be based on the following criteria:

1. Internship Identification and Selection
2. Problem Studied with objectives and expected outcomes
3. Consideration of Environment/ Social /Ethics/ Safety measures/Legal aspects.
4. Methodology/System/Procedure Q&A
5. Block-diagram, flow-chart, algorithm, system description Q&A
6. Final results, discussions, suggestions, comments, etc. Q&A
7. Presentation and Communication

Audit Course VI: Project Management

Course Name: Audit Course VI: Project Management **Examination Scheme** **Course Number : 303153 B**		
Teaching Scheme **Theory : 2 Hrs/week** **Practical : NA** **Tutorial : NA**	**Credits** **Th / Tut : NA** **PR : NA** **GRADE : PP/NP**	**Examination Scheme [Marks]** **ISE : 00** ESE: 00 OR-PR-TW : 00
Designation of the Course : Audit Course		

Course Objectives :

1.	Plan a successful project through project management
2.	Select the right members of a team for a project.

Course Outcomes :
At the end of the course, student will be able to –

CO1.	Elaborate importance of project management and its process
CO2.	Learn about the role of high performance teams and leadership in project management.

Course Contents :

Unit 1 :	**Basics of Project Management:**	**[12Hrs]**

Introduction, Need for Project Management, Project Management Knowledge Areas and Processes, The Project Life Cycle, The Project Manager (PM), Phases of Project Management Life Cycle, Project Management Processes, Impact of Delays in Project Completions, Essentials of Project Management Philosophy, Project Management Principles

Unit 2 :	**Project Identification, Selection, planning**	**[12Hrs]**

Project Identification, Selection Introduction, Project Identification Process, Project Initiation, Pr-Feasibility Study, Feasibility Studies, Project Break-even point
Project Planning: Introduction, Project Planning, Need of Project Planning, Project Life Cycle, Roles, Responsibility and Team Work, Project Planning Process, Work Breakdown Structure (WBS)

Test Books:

[T1]	Project Management: A Systems Approach to Planning, Scheduling, and Controlling by Harold Kerzner
[T2]	Guide to Project Management: Getting it right and achieving lasting benefits by Paul Roberts
Online Resources:	
[O1]	https://www.coursera.org/learn/project-planning?specialization=project-management
[O2]	Project management for managers By Prof. Mukesh Kumar Barua, IIT Roorkee https://onlinecourses.nptel.ac.in/noc20_mg48/preview