B.Tech. in Electrical and Electronics Engineering
Scheme of Instruction and Examination
(Choice Based Credit System)

V Semester

S.No.	Course Code	Course Title	Instruction			Examination			Credits
			Hours per week			Max. Marks		Duration of SEE in Hours	
			L	T	P/D	CIE	SEE		
1	MS501HS	Business Economics and Financial Analysis	3	0	0	30	70	3	3
2	EE501PC	Electrical Measurements and Instrumentation	3	1	0	30	70	3	4
3	EE502PC	Power Systems - II	3	1	0	30	70	3	4
4	EE503PC	Power Electronics	3	1	0	30	70	3	4
5		**Open Elective - I**	2	0	0	30	70	3	2
6	MC502ES	Cyber Security	3	0	0	30	70	3	0
7	EE551PC	Electrical Measurements and Instrumentation Lab	0	0	3	30	70	3	1.5
8	EE552PC	Electrical Systems Simulation Lab	0	0	2	30	70	3	1
9	EE553PC	Power Electronics Lab	0	0	3	30	70	3	1.5
10	MA554BS	Finishing School-III (Quantitative Aptitude & Analytical Ability)	0	0	2	30	70	3	1
Total Hours/Marks/Credits			**17**	**3**	**10**	**300**	**700**		**22**

VI Semester

S.No.	Course Code	Course Title	Instruction			Examination			Credits
			Hours per week			Max. Marks		Duration of SEE in Hours	
			L	T	P/D	CIE	SEE		
1	EE601PC	Microprocessors and Microcontrollers	3	0	0	30	70	3	3
2	EE602PC	Switchgear and Protection	3	1	0	30	70	3	4
3	EE631PC	Signals and Systems	3	0	0	30	70	3	3
4		**Professional Elective - I**	3	0	0	30	70	3	3
5		**Professional Elective - II**	3	0	0	30	70	3	3
6		**Open Elective – II**	2	0	0	30	70	3	2
7	MC601HS	Intellectual Property Rights	3	0	0	30	70	3	0
8	MC601ES	Artificial Intelligence	3	0	0	30	70	3	0
9	EE651PC	Microprocessors and Microcontrollers Lab	0	0	2	30	70	3	1
10	EE652PC	Power Systems Lab	0	0	2	30	70	3	1
11	EE661PC	Signals and Systems Lab	0	0	2	30	70	3	1
12	EN653HS	Finishing School-IV (Advanced Communication Skills Lab)	0	0	2	30	70	3	1
Total Hours/Marks/Credits			**23**	**1**	**8**	**360**	**840**		**22**

13	MC601ESC	*Environmental Science	3	0	0	30	70	3	0

***For Lateral Entry Students**

L: Lecture T: Tutorial D: Drawing P: Practical

CIE - Continuous Internal Evaluation SEE – Semester End Examination

B.Tech. in Electrical and Electronics Engineering
Scheme of Instruction and Examination
(Choice Based Credit System)

VII Semester

S.No.	Course Code	Course Title	Instruction Hours per week			Examination Max. Marks		Examination Duration of SEE in Hours	Credits
			L	T	P/D	CIE	SEE		
1	EE701PC	Power System Operation and Control	3	0	0	30	70	3	3
2		**Professional Elective - III**	3	0	0	30	70	3	3
3		**Professional Elective - IV**	3	0	0	30	70	3	3
4		**Open Elective - III**	3	0	0	30	70	3	3
5	EE751PC	Power Engineering Simulation Lab	0	0	3	30	70	3	1.5
6	EE752PC	Electrical and Electronics Design Lab	1	0	3	30	70	3	2.5
7	EE753PC	Industry Oriented Mini Project	0	0	4	30	70	-	2
8	EE754PC	Seminar	0	0	2	30	70	-	1
9	EE755PC	Project Stage - I	0	0	4	30	70	-	2
Total Hours/Marks/Credits			**13**	**0**	**16**	**270**	**630**		**21**

VIII Semester

S.No.	Course Code	Course Title	Instruction Hours per week			Examination Max. Marks		Examination Duration of SEE in Hours	Credits
			L	T	P/D	CIE	SEE		
1	MS804HS	Fundamentals of Management for Engineers	2	0	0	30	70	3	2
2		**Professional Elective - V**	3	0	0	30	70	3	3
3		**Professional Elective - VI**	3	0	0	30	70	3	3
4	EE851PC	Project Stage - II	0	0	16	30	70	-	8
Total Hours/Marks/Credits			**8**	**0**	**16**	**120**	**280**		**16**

L: Lecture T: Tutorial D: Drawing P: Practical
CIE - Continuous Internal Evaluation SEE – Semester End Examination

Grand Total of Credits

Semester	I	II	III	IV	V	VI	VII	VIII	Total Credits
Credits	18	19	21	21	22	22	21	16	**160**

Department of Electrical and Electronics Engineering

List of professional Electives offered:

Professional Elective - I

EE611PE	Computer Architecture
EE612PE	Power System Analysis
EE613PE	Electrical Machine Design

Professional Elective - II

EE614PE	Optimization Techniques
EE615PE	Power Semiconductor Drives
EE616PE	Wind and Solar Energy systems

Professional Elective - III

EE711PE	High Voltage Engineering
EE712PE	Linear System Analysis
EE713PE	Electrical and Hybrid Vehicles

Professional Elective - IV

EE714PE	Power Quality and FACTS
EE715PE	Power System Reliability
EE716PE	Advanced Electrical Drives

Professional Elective - V

EE811PE	HVDC Transmission
EE812PE	Control Systems Design
EE813PE	AI Techniques in Electrical Engineering

Professional Elective - VI

EE814PE	Smart Grid Technologies
EE815PE	Electrical Distribution Systems
EE816PE	Utilization of Electrical Energy

List of Open Electives offered by EEE Department:

Open Elective-I

EE521OE	Electrical Engineering Materials
EE522OE	Non - Conventional Power Generation

Open Elective-II

EE621OE	Energy Conservation and Green Building
EE622OE	Conventional Power Generation

Open Elective-III

EE721OE	Energy Storage Systems
EE722OE	Electrical Systems and Safety

L	T	P	C
3	0	0	3

B.Tech. in Electrical and Electronics Engineering

V Semester Syllabus

MS501HS: Business Economics and Financial Analysis

(Common to ECE, EEE, ME & MCT)

Course Objectives

1. Students will understand various forms of Business and the impact of economic variables on the business, concepts of Business economics and its significance.
2. Gain the knowledge on various market dynamics namely Demand, elasticity of demand, and demand forecasting.
3. To disseminate the knowledge on production function, laws of production, Market structures, while dealing with the concept of cost and breakeven analysis.
4. To acquaint the students regarding Accounting and various books of accounts.
5. To enable the students to analyze a company's financial statements through ratios and come to a reasoned conclusion about the financial situation of the company.

Course Outcomes

After completion of this course, the student will be able to

1. Select a suitable business organization with available resources.
2. Analyze various aspects of Demand, Elasticity of demand and Demand Forecasting.
3. Gain knowledge of different market structures, production theories, cost variables and pricing methods.
4. Prepare Books of accounts and Financial Statements.
5. Analyze financial well-being of the business while using ratios.

UNIT- I: Introduction to Business and Economics

Economics: Significance of Economics, Micro and Macro Economic Concepts, National Income - Concepts and Importance, Inflation, Business Cycle - Features and Phases.

Business: Structure of Business Firm, Types of Business Entities – Sole Proprietorship – Partnership – Cooperative Societies - Limited Liability Companies, Sources of Capital – Conventional sources and Non-Conventional Sources of Finance.

Business Economics: Nature and Scope of Business Economics, Role of Business Economist, Multidisciplinary nature of Business Economics.

UNIT- II: Demand and Supply Analysis

Demand Analysis: Demand - Meaning, Determinants of Demand, Law of Demand, Exceptions of Law of Demand, Demand Function, Changes in Demand – Increase and decrease in Demand - Extension and Contraction in Demand

Elasticity of Demand: Elasticity – Meaning, Types of Elasticity – Price Elasticity – Income Elasticity – Cross Elasticity–Advertising Elasticity of Demand, Factors affecting Elasticity of Demand, Measurement and Significance of Elasticity of Demand, Elasticity of Demand in decision making

Demand Forecasting: Characteristics of Good Demand Forecasting, Steps in Demand Forecasting, Methods of Demand Forecasting – Survey methods, Statistical methods

Supply Analysis: Supply – Meaning, Determinants of Supply, Supply Function & Law of Supply.

UNIT- III: Production, Cost, Market Structures & Pricing

Production Analysis: Production – Meaning, Factors of Production, Production Function, Production Function with one variable input, two variable inputs, Returns to Scale, Cobb-Douglas production function

Cost analysis: Cost–Meaning, Types of Costs, Short run and Long run Cost Functions.

Market Structures: Nature of Competition, Features of Perfect competition, Monopoly, Oligopoly, Monopolistic Competition.

Pricing: Pricing -Meaning, Objectives of pricing, pricing methods – Cost based pricing methods – Demand based pricing methods – Competition based pricing methods – Strategy based pricing methods - Product Life Cycle based Pricing, Break Even Analysis (simple problems), Cost Volume Profit Analysis.

UNIT- IV: Financial Accounting

Accounting concepts and Conventions, Accounting Equation, Double-Entry system of Accounting, Rules for maintaining Books of Accounts, Journal, Posting to Ledger, Preparation of Trial Balance, Elements of Financial Statements, Preparation of Final Accounts along with adjustments– Trading account – Profit and loss account – Balance sheet (simple problems)

UNIT-V: Financial Analysis through Ratios

Concept of Ratio Analysis, Importance, Liquidity Ratios- Current Ratio – Quick Ratio – Absolute Liquid Ratio, Profitability Ratios – Gross Profit Ratio – Net Profit Ratio – Operating Ratio, Turnover Ratios – Stock Turnover Ratio – Debtors Turnover Ratio – Creditors Turnover Ratio, Leverage Ratios – Debt-to-Assets Ratio - Debt-Equity Ratio - Proprietary Ratios and interpretation (simple problems).

Suggested Readings:

1. Geethika Ghosh, Piyali Gosh, Purba Roy Choudhury, “Managerial Economics”, 2e, Tata McGraw Hill Education Pvt. Ltd. 2012.
2. Dhanesh K Khatri, “Financial Accounting”, Tata McGraw Hill, 2011.
3. Ramachandra Aryasri. A, “Business Economics and Financial Analysis”, McGraw Hill Education India Pvt. Ltd. 2020.

Reference Books:

1. P. L. Mehta, Managerial Economics, Analysis, Problems & Cases, 8th Edition, Sultan Chand & Sons, 2001.
2. S.N. Maheshwari, Sunil K Maheshwari, Sharad K Maheshwari, Financial Accounting, 5e, Vikas Publications, 2013.
3. D.D. Chaturvedi, S.L. Gupta, “Business Economics - Theory and Applications”, International Book House Pvt. Ltd. 2013.

L	T	P	C
3	1	0	4

B.Tech. in Electrical and Electronics Engineering
V Semester Syllabus
EE501PC: Electrical Measurements and Instrumentation

Prerequisites: Basic Electrical Engineering, Analog Electronics, Electrical Circuit Analysis and Electromagnetic fields.

Course Objectives

1. To introduce the basic principles of all measuring instruments.
2. To deal with the measurement of voltage, current, power factor, power and energy measurements.
3. To deal with the measurement of RLC parameters using the bridges.
4. To understand the operation of different types of transducers and their applications.
5. To understand the basic concepts of smart and digital metering.

Course Outcomes

After completion of this course, the student will be able to

1. Understand different types of measuring instruments, their construction, operation and characteristics.
2. Identify the instruments suitable for typical measurements.
3. Understand the resistance measurement through DC Bridge, capacitance and inductance through AC bridges.
4. Apply the knowledge about transducers and instrument transformers to use them effectively.
5. Apply the knowledge of smart and digital metering for industrial applications.

UNIT- I: Introduction to Measuring Instruments

Classification, deflecting, control and damping torques, Ammeters and Voltmeters, PMMC, moving iron type instruments, expression for the deflecting torque and control torque, Errors and compensations, extension of range using shunts and series resistance. Electrostatic Voltmeters, electrometer type and attracted disc type, extension of range of E.S. Voltmeters.

UNIT- II: Potentiometers & Instrument Transformers

Principle and operation of D.C. Crompton's potentiometer, standardization, Measurement of unknown resistance, current, voltage, A.C Potentiometers: polar and coordinate type's standardization, applications. Instrument transformers: CT and PT, Ratio and phase angle errors, CT testing using mutual inductor method by null technique.

UNIT- III: Measurement of Power & Energy

Single phase dynamometer wattmeter, LPF and UPF, Double element and three element dynamometer wattmeter, expression for deflecting and control torques, Extension of range of wattmeter using instrument transformers, Measurement of active and reactive powers in balanced and unbalanced systems, Single phase induction type energy meter, driving and braking torques, errors and compensations, testing by phantom loading using R.S.S. meter, three phase energy meter.

UNIT- IV: DC & AC Bridges

Method of measuring low, medium and high resistance, sensitivity of Wheat-stone's bridge, Carey Foster's bridge, Kelvin's double bridge for measuring low resistance, measurement of high resistance using loss of charge method. Measurement of inductance, Maxwell's bridge, Hay's bridge, Anderson's bridge, Owen's bridge, measurement of capacitance and loss angle, Desaunty's Bridge, Wien's bridge, Schering bridge.

UNIT-V: Transducers and Digital Metering

Definition of transducers, Classification of transducers, Advantages of Electrical transducers, Characteristics and choice of transducers; Principle operation of LVDT and capacitor transducers; LVDT Applications, Strain gauge and its principle of operation, gauge factor, Thermistors, Thermocouples, Piezo electric transducers, photovoltaic, photo conductive cells, and photo diodes. **Introduction to Smart and Digital Metering:** Digital Multi-meter, True RMS meters, Clamp-on meters,Digital Storage Oscilloscope

Suggested Readings:

1. G. K. Banerjee, "Electrical and Electronic Measurements", PHI Learning Pvt. Ltd., 2nd Edition,2016
2. S. C. Bhargava, "Electrical Measuring Instruments and Measurements", BS Publications, 2012.

Reference Books:

1. A. K. Sawhney, "Electrical & Electronic Measurement & Instruments", Dhanpat Rai & Co.Publications, 2005.
2. R. K. Rajput, "Electrical & Electronic Measurement & Instrumentation", S. Chand and CompanyLtd., 2007.
3. Buckingham and Price, "Electrical Measurements", Prentice – Hall, 1988.
4. Reissland, M. U, "Electrical Measurements: Fundamentals, Concepts, Applications", New AgeInternational (P) Limited Publishers, 1st Edition 2010.
5. E.W. Golding and F. C. Widdis, "Electrical Measurements and measuring Instruments", fifthEdition, Wheeler Publishing, 2011

L	T	P	C
3	1	0	4

B.Tech. in Electrical and Electronics Engineering
V Semester Syllabus
EE502PC: Power Systems - II

Prerequisites: Power Systems - I and Electromagnetic Fields

Course Objectives

1. To analyse the performance of transmission lines.
2. To understand the voltage control methods.
3. To understand transients in power systems.
4. To analyse symmetrical components and faults in power systems.
5. To know about insulation coordination and overvoltage protection.

Course Outcomes

After completion of this course, the student will be able to

1. Analyse the performance of transmission lines.
2. Understand the voltage control methods.
3. Understand transients in power systems.
4. Analyse symmetrical components and faults in power systems.
5. Understand insulation coordination and overvoltage protection.

UNIT-I: Overhead Transmission Lines

Per Unit Representation of Power Systems: Introduction, Single line diagram, Impedance and reactance diagrams, Expressing p.u. reactance in terms of base MVA and base kV, Advantages of p.u. system, Simple problems.

Performance of Transmission Lines: Introduction, Efficiency and Regulation, Classification, Analysis of short transmission line, Numerical problems, Analysis of medium transmission line by nominal-T and nominal-π methods, Ferranti effect, Numerical problems, Analysis of long transmission line, ABCD constants, Numerical problems, Active and reactive power at sending end and receiving end of a transmission line.

UNIT-II: Voltage Control in Power Systems

Introduction, Internal and external voltage control methods, Expression of receiving end voltage, Analysis of Shunt Capacitor, Shunt Inductor, Series Capacitor, Synchronous Capacitor, Synchronous Inductor and Synchronous Phase Modifier, Numerical problems, Tap changing transformers: on-load and off-load.

UNIT-III: Transients in Power Systems

Introduction, Concept of travelling waves in power systems-Incident, Reflected and Refracted or Transmitted waves, Travelling waves in transmission lines with receiving end open circuited, short circuited, line terminated through a resistance, line connected to a cable, T-junction line, Calculation of reflection and transmission coefficients for voltage wave and current wave for the above conditions, Numerical problems, Attenuation of travelling waves, Velocity of travelling waves.

UNIT-IV: Power System Fault Analysis

Symmetrical Components: Introduction, Significance of positive, negative and zero sequence components, Numerical problems, Sequence generated voltages during fault, Neutral current and voltage to neutral, Neutral to ground connections, Zero sequence networks of three phase Transformer, Sequence networks of Alternator.

Fault Analysis: Classification of faults, Unsymmetrical shunt fault analysis-single line to ground fault, line to line fault, double line to ground fault, Symmetrical shunt fault analysis-three phase fault, Numerical problems, Short circuit capacity of a bus.

UNIT-V: Insulation Coordination and Protection against Overvoltages

Introduction, Insulation Coordination and Volt-Time curves, Horn Gaps, Surge Diverters, Rod Gaps, Expulsion Type Lightning Arrester, Valve Type Lightning Arrester, Ground Wires, Ground Rods, Counter Poise.

Suggested Readings:

1. Stagg and El-Abiad, “Computer Methods in Power System Analysis”, Mc Graw Hill, 1968.
2. C.L.Wadhwa, “Electrical Power Systems”, New Age International Publishers, 6th Edition.
3. I.J.Nagrath and D.P.Kothari, “Modern Power System Analysis”, Tata Mc Graw Hill Publishing Company, 4th Edition, 2011.

Reference Books:

1. Grainger and Stevenson, “Power System Analysis”, Tata Mc Graw Hill, 2003.
2. Hadi Saadat, “Power System Analysis”, Tata Mc Graw Hill, 2002.
3. William D Stevenson, “Elements of Power System Analysis”, Mc Graw Hill, 1982.

L	T	P	C
3	1	0	4

B.Tech. in Electrical and Electronics Engineering
V Semester Syllabus
EE503PC: Power Electronics

Prerequisites: Electrical Circuits, Basic Electronics

Course Objectives

1. To introduce students to the basic theory of power semiconductor devices and passive components and their practical applications in Power Electronics.
2. To familiarize students to the principle of operation, design and synthesis of different power conversion circuits and their applications.
3. To provide strong foundation for further study of power electronic circuits and systems.
4. To design / develop suitable power converter for efficient control or conversion of power in drive applications.
5. To design / develop suitable power converter for efficient transmission and utilization of power in power system applications.

Course Outcomes

After completion of this course, the student will be able to

1. Relate basic semiconductor to properties of power devices.
2. Analyse controlled rectifier circuits.
3. Analyse the AC voltage controllers and Cycloconverters.
4. Analyse the operation of DC-DC choppers.
5. Analyse the operation of voltage source inverters.

UNIT - I: Power Switching Devices

Concept of power electronics, scope and applications, types of power converters, Power semiconductor switches and their V-I characteristics, Power Diodes, Power BJT, SCR, Power MOSFET, Power IGBT, Thyristor ratings and protection, Two Transistor Analogy, Turn-on methods of SCR, methods of SCR commutation, Firing circuits of SCR

UNIT - II: AC-DC Converters (Phase Controlled Rectifiers)

Principles of single-phase fully-controlled converter with R, RL, and RLE load, Principles of single-phase half-controlled converter with RL and RLE load, Principles of three-phase fully-controlled converter operation with RLE load, Effect of load and source inductances, Single phase and Three phase dual converters

UNIT - III: AC-AC Converters

AC Voltage Regulator: Introduction, principle of operation of single-phase voltage controllers for R, R-L loads and its applications, problems. Cyclo-converter, Principle of operation of single phase cyclo-converters, relevant waveforms, Advantages and disadvantages, Applications

UNIT - IV: DC-DC Converters

Introduction, Step down, step up, step up/down choppers, control strategies, chopper classification, Buck, Boost and buck boost converters: Power circuit, analysis and waveforms at steady state, relation between duty ratio and average output voltage, Problems.

UNIT - V: DC-AC Converters

Introduction, principle of operation, performance parameters, single - phase bridge inverters with R, RL loads, Three - phase bridge inverters with 120^0 and 180^0 mode of operation, Voltage control of single-phase inverters, single pulse width modulation, multiple pulse width modulation, sinusoidal pulse width modulation.

Suggested Readings:

1. Dr.P.S.Bimbra, "Power Electronics", Khanna Publishers, 7^{th} Edition, Jan'2022
2. Muhammad H Rashid, Power Electronics Devices, Circuits, and Applications, Pearson, [2017], Fourth edition

Reference Books:

1. R. W. Erickson and D. Maksimovic, "Fundamentals of Power Electronics", Springer Science & Business Media, 2007.
2. L. Umanand, "Power Electronics: Essentials and Applications", Wiley India, 2009.
3. N. Mohan and T. M. Undeland, "Power Electronics: Converters, Applications and Design", John Wiley & Sons, 2007

L	T	P	C
3	0	0	0

B.Tech. in Electrical and Electronics Engineering
V Semester Syllabus
MC502ES: Cyber Security
(Common to all branches)

Prerequisites: Nil

Course Objectives

1. To familiarize various types of cyber-attacks and cyber-crimes
2. To give an overview of the cyber laws
3. To study the defensive techniques against these attacks

Course Outcomes

After completion of this course, the student will be able to

1. To understand various cyber-attacks and cybercrimes.
2. Knowledge about cyberlaws and cyber forensics.
3. Summarize cyber crimes in mobile and wireless devices, how to protect them
4. Knowledge about IPR issues in cyber space and cyber terrorism.

UNIT- I: Introduction to Cyber Security

Basic Cyber Security Concepts, layers of security, Vulnerability, threat, Harmful acts, Internet Governance – Challenges and Constraints, Computer Criminals, CIA Triad, Assets and Threat, motive of attackers, active attacks, passive attacks, Software attacks, hardware attacks, IP spoofing, Security Models, risk management, Cyber Threats-Cyber Warfare, Cyber Crime, Cyber terrorism, Comprehensive Cyber Security Policy.

UNIT- II: Cyberspace and the Law & Cyber Forensics

Introduction, Cyber Security Regulations, Roles of International Law. The INDIAN Cyberspace. Introduction, Historical background of Cyber forensics, Digital Forensics Science, The Need for Computer Forensics, Cyber Forensics and Digital evidence, Forensics Analysis of Email, Digital Forensics Lifecycle, Forensics Investigation, Challenges in Computer Forensics, Special Techniques for Forensics Auditing.

UNIT- III: Cybercrime: Mobile and Wireless Devices

Introduction, Proliferation of Mobile and Wireless Devices, Trends in Mobility, Credit card Frauds in Mobile and Wireless Computing Era, Security Challenges Posed by Mobile Devices, Registry Settings for Mobile Devices, Authentication service Security, Attacks on

Mobile/Cell Phones, Mobile Devices: Security Implications for Organizations.

UNIT- IV: Cyber Security, Cybercrime and Cyber terrorism

Cyber Security: Organizational Implications: Introduction cost of cybercrimes and IPR issues, web threats for organizations, security and privacy implications, social media marketing.

Cybercrime and Cyber terrorism: Introduction, intellectual property in the cyberspace, the ethical dimension of cybercrimes the psychology, mindset and skills of hackers and other cyber criminals.

UNIT-V: Privacy Issues

Basic Data Privacy Concepts: Fundamental Concepts, Data Privacy Attacks, Data linking and profiling, privacy policies and their specifications, privacy policy languages, privacy in different domains- medical, financial, etc.

Suggested Readings:

1. Nina God bole and Sunit Belpure, Cyber Security Understanding Cyber Crimes, ComputerForensics and Legal Perspectives, Wiley, India 2012.
2. B. B. Gupta, D. P. Agrawal, Haoxiang Wang, Computer and Cyber Security: Principles, Algorithm, Applications, and Perspectives, CRC Press, ISBN 9780815371335, 2018.

Reference Books:

1. Mark F. Grady, Fransesco Parisi, " The Law and Economics of Cyber security", Cambridge University Press,2006.
2. Cyber Security Essentials, James Graham, Richard Howard and Ryan Otson, CRC Press, 2016.
3. Introduction to Cyber Security, Chwan - Hwa (john) Wu, J. David Irwin, CRC Press T&F Group.

L	T	P	C
0	0	3	1.5

B.Tech. in Electrical and Electronics Engineering
V Semester Syllabus
EE551PC: Electrical Measurements and Instrumentation Lab

Prerequisites: Electrical Measurements and Instrumentation

Course Objectives

1. To calibrate LPF Wattmeter, energy meter, P. F. meter using electro dynamo meter type instrument as the standard instrument.
2. To determine unknown inductance, resistance, capacitance by performing experiments on D.C Bridges & A. C Bridges.
3. To determine three phase active & reactive powers using single wattmeter method practically.
4. To determine the displacement and strain using transducers.
5. To determine the ratio and phase angle errors of current transformer.

Course Outcomes

After completion of this course, the student will be able to

1. To choose instruments.
2. Test any instrument.
3. Find the accuracy of any instrument by performing experiment.
4. Calibrate PMMC instrument using DC potentiometer.
5. Understand the measurement of displacement using LVDT and measurement of strain using resistance strain gauge.

Any Ten experiments are required to be conducted from the following list of experiments.

1. Calibration and Testing of single-phase energy Meter.
2. Calibration of dynamometer power factor meter.
3. Crompton D.C. Potentiometer – Calibration of PMMC ammeter and PMMC voltmeter.
4. Kelvin's double Bridge – Measurement of resistance – Determination of Tolerance.
5. Dielectric oil testing using H.T. testing Kit.
6. Schering Bridge & Anderson Bridge.
7. Measurement of 3 - Phase reactive power with single-phase wattmeter.
8. Measurement of displacement with the help of LVDT.
9. Calibration of LPF wattmeter by Phantom testing.

10. C.T. testing using mutual Inductor – Measurement of % ratio error and phase angle of given CT by Null method.
11. Resistance strain gauge – strain measurements and Calibration.
12. Measurement of parameters of a choke coil using 3-voltmeter and 3-ammeter methods.

Suggested Readings:

1. G. K. Banerjee, “Electrical and Electronic Measurements”, PHI Learning Pvt. Ltd., 2nd Edition, 2016
2. S. C. Bhargava, “Electrical Measuring Instruments and Measurements”, BS Publications, 2012.

Reference Books:

1. A. K. Sawhney, “Electrical & Electronic Measurement & Instruments”, Dhanpat Rai & Co. Publications, 2005.
2. R. K. Rajput, “Electrical & Electronic Measurement & Instrumentation”, S. Chand and Company Ltd., 2007.

L	T	P	C
0	0	2	1

B.Tech. in Electrical and Electronics Engineering
V Semester Syllabus
EE552PC: Electrical Systems Simulation Lab

Prerequisites: Electrical and Electronic circuits, Power System Analysis & Power Electronics

Course Objectives

1. To calculate the time constants of series RL, RC circuit.
2. To understand the concept of resonance in series RLC circuit.
3. To perform tariff estimation.
4. To evaluate the voltage distribution across an insulator string.
5. To perform parameter estimation of transmission lines.

Course Outcomes

After completion of this course, the student will be able to

1. Understand the different circuits time constants.
2. Understand the tariff based on load curve.
3. Understand the distribution of voltage across the insulator string.
4. Evaluate the performance of various transmission line calculations.
5. Understand the concept of Ferranti effect.

Any Ten experiments are required to be conducted from the following list of experiments using simulation software.

1. Basic operations on Matrices
2. Time constant calculation of RL circuit
3. Time constant calculation of RC circuit
4. Calculation of Resonant frequency, Bandwidth for series RLC Network.
5. Estimation of Tariff based on load curve
6. Voltage distribution across insulator string
7. Calculation of R, L, C, Z_S of 3-phase Transmission Line
8. Calculation of Critical disruptive voltage and Corona loss for a Transmission Line
9. Performance evaluation of Short Transmission lines
10. Ferranti Effect
11. Active and reactive power consumption by 3-phase load
12. Measurement of primary and secondary voltages and currents of a single phase and Three phase transformers

Suggested Readings:

1. C.L. Wadhwa: Electrical Power Systems –Third Edition, New Age International Pub. Co., 2001.
2. Hadi Sadat: Power System Analysis –Tata Mc Graw Hill Pub. Co. 2002.

Reference Books:

1. D. P. Kothari: Modern Power System Analysis-Tata Mc Graw Hill Pub. Co. 2003.

L	T	P	C
0	0	3	1.5

B.Tech. in Electrical and Electronics Engineering
V Semester Syllabus
EE553PC: Power Electronics Lab

Prerequisites: Power Electronics

Course Objectives

1. Apply the concepts of power electronic converters for efficient conversion/control of power from source to load.
2. To familiarize students to the principle of operation, design and synthesis of different power conversion circuits and their applications.
3. To provide strong foundation for further study of power electronic circuits and systems.
4. To Design/develop suitable power converter for efficient control or conversion of power in drive applications.
5. Design the power converter with suitable switches meeting a specific load requirement.

Course Outcomes

After completion of this course, the student will be able to

1. Understand the characteristics of SCR, MOSFET and IGBT.
2. Understand the operating principles of AC to DC, AC to AC converters.
3. Analyse and choose the appropriate converters for various applications.
4. Understand the operating principles of DC to DC and DC to AC converters.
5. Use power electronic simulation packages & hardware to develop the power converters.

Any Seven experiments are required to be conducted from the following list of experiments.

1. Study of Characteristics of SCR, MOSFET & IGBT,
2. Gate firing circuits for SCR's
3. Single Phase AC Voltage Controller with R and RL Loads
4. Single Phase half controlled bridge converter with R and RL loads
5. Single Phase fully controlled bridge converter with R and RL loads
6. Forced Commutation circuits (Class A, Class B, Class C, Class D & Class E)
7. Single Phase Cyclo-converter with R and RL loads
8. Single Phase series inverter with R and RL loads
9. Single Phase parallel inverter with R and RL loads
10. Single Phase Bridge inverter with R and RL loads
11. DC Jones chopper with R and RL Loads
12. Single-phase dual converter with R load.

In addition to the above, any three experiments are required to be conducted from the following list of experiments.

1. (a)Simulation of single-phase Half wave converter using R and RL loads
   (b)Simulation of single-phase full converter using R, RL and RLE loads
   (c)Simulation of single phase Semi converter using R, RL and RLEloads
2. (a)Simulation of Single phase AC voltage controller using R and RL loads
   (b)Simulation of Single phase Cyclo-converter with Rand RL-loads
3. Simulation of Buck chopper
4. Simulation of single-phase Inverter with PWM control
5. Simulation of three phase fully controlled converter with R and RL loads, with and without freewheeling diode

Suggested Readings:

1. M. H. Rashid, Simulation of Electric and Electronic Circuits using PSPICE – by PHI Publications.
2. User's manual of related softwares

Reference Books:

1. Reference guides of related softwares
2. Rashid, SPICE for Power Electronics and Electric Power, CRC Press

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B.Tech. in Electrical and Electronics Engineering
V Semester Syllabus
MA554BS: Finishing School-III
(Quantitative Aptitude & Analytical Ability)
(Common to CE, EEE, ECE, ME, MCT & MME)

Course Objectives

This is a foundation course and aims to enhance employability skills in students.

1. Students will be introduced to higher order thinking skills and problem-solving on the following areas - Arithmetic ability, Numerical ability and General reasoning
2. Students will be trained to work systematically with speed and accuracy while solving problems.

Course Outcomes

At the end of the course students will be able to:

1. Solve questions on the above-mentioned areas using shortcut and smart methods
2. Understand the fundamental concepts of Aptitude skills
3. Perform calculations with speed and accuracy

UNIT- I: QUANTITATIVE APTITUDE - NUMERICAL ABILITY

- Number system
  - Divisibility Rules
  - Square root
  - Cube root
  - Problems on numbers
  - LCM and HCF

UNIT- II: QUANTITATIVE APTITUDE- ARITHMETIC ABILITY-I

- Percentage
- Ratio proportions
- Averages
- Profit, loss and discounts
- Simple and Compound interest

UNIT- III: QUANTITATIVE APTITUDE- ARITHMETIC ABILITY-II

- Pipes and Cisterns
- Ages
- Time-Work-Speed-Distance
- Clocks & Calendars

- Venn diagrams
- Tables and graphs

UNIT- IV: REASONING ABILITY – GENERAL REASONING-I

- Coding decoding
- Directions
- Series completions - Letter, Number & Element Series
- Seating arrangements
- Symbols and Notations

UNIT-V: REASONING ABILITY- GENERAL REASONING –II

- Analogies
  - Alphabet Analogy
  - Numerical Analogy
- Classification
  - Alphabet Classification
  - Word Classification
  - Miscellaneous Classification
- Alphabet test
  - Arranging words in Alphabetical Order
  - Problems based on Letter-Word
  - Problems based on Alphabetical Quibble
- Blood Relations

Suggested Readings:

1. R.S. Aggarwal - Quantitative Aptitude for Competitive Examinations.
2. Arun Sharma - Quantitative Aptitude for CAT.
3. Arihant Publications - Fast Track Objective Arithmetic.
4. Sarvesh K.-Quantitative aptitude
5. A New Approach to Reasoning Verbal & Non-Verbal, Book by B.S. Sijwalii and Indu Sijwali
6. A Modern Approach to Logical Reasoning, Book by Agarwala Vikas and R.S. Aggarwal

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B.Tech. in Electrical and Electronics Engineering
VI Semester Syllabus
EE601PC: Microprocessors and Microcontrollers

Prerequisites: Digital Logic, Fundamentals of Computers

Course Objectives

1. To familiarize the architecture of microprocessors.
2. To familiarize the instruction set and assembly language program.
3. To familiarize the architecture and instruction set of microcontrollers.
4. To provide the knowledge about interfacing techniques.
5. To understand the concepts of ARM architecture and advanced ARM processors.

Course Outcomes

After completion of this course, the student will be able to

1. Understand the internal architecture, organization of 8086 processors.
2. Design simple programs using assembly language programming of 8086 processors.
3. Understands the internal architecture, organization and assembly language programming of 8051/controllers.
4. Understands the interfacing techniques to 8086 and 8051 based systems.
5. Understands the internal architecture of ARM processors and basic concepts of advanced ARM processors.

UNIT - I: 8086 Architecture

8086 Architecture-Functional diagram, Register Organization, Memory Segmentation, Programming Model, Memory addresses, Physical Memory Organization, Architecture of 8086, Signal descriptions of 8086, interrupts of 8086.

UNIT - II: Instruction Set

Instruction Set and Assembly Language Programming of 8086: Instruction formats, Addressing modes, Instruction Set, Assembler Directives, Macros, and Simple Programs involving Logical, Branch and Call Instructions, Sorting, String Manipulations.

UNIT - III: Introduction to Microcontrollers

Overview of 8051 Microcontroller, Architecture, I/O Ports, Memory Organization, Addressing Modes and Instruction set of 8051. 8051 Real Time Control: Programming Timer Interrupts, Programming External Hardware Interrupts, Programming the Serial Communication Interrupts, Programming 8051 Timers and Counters

UNIT – IV: I/O and Memory Interface

Interfacing 8086 to peripherals using 8255, Interfacing 8051- LCD, Keyboard, External Memory, ADC, DAC, External Communication Interfaces-RS232, USB.

UNIT – V: ARM Architecture and Advanced ARM Processors

ARM Processor fundamentals, ARM Architecture – Register, CPSR, Pipeline, exceptions and interrupts interrupt vector table, ARM instruction set – Data processing, Branch instructions, load store instructions, Software interrupt instructions, Program status register instructions, loading constants, Conditional execution, Introduction to Thumb instructions. **Advanced ARM Processors:** Introduction to CORTEX Processor and its architecture, OMAP Processor and its Architecture.

Suggested Readings:

1. Advanced Microprocessors and Peripherals – A. K. Ray and K. M. Bhurchandani, TMH, 2nd Edition 2006.
2. ARM System Developers guide, Andrew N SLOSS, Dominic SYMES, Chris WRIGHT, Elsevier, 2012

Reference Books:

1. The 8051 Microcontroller, Kenneth. J. Ayala, Cengage Learning, 3rd Ed, 2004.
2. Microprocessors and Interfacing, D. V. Hall, TMGH, 2nd Edition 2006.
3. The 8051 Microcontrollers, Architecture and Programming and Applications -K. Uma Rao, Andhe Pallavi, Pearson, 2009.
4. Digital Signal Processing and Applications with the OMAP- L138 Experimenter, Donald Reay, WILEY 2012.

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B.Tech. in Electrical and Electronics Engineering
VI Semester Syllabus
EE602PC: Switchgear and Protection

Prerequisites: Power Systems-I, Power Systems-II, Electrical Machines – I, Electrical Machines – II

Course Objectives

1. To introduce the fundamental concepts of protection and various relays used in the power system for the protection of transmission lines and other equipment.
2. To understand the concept of overcurrent and distance protection in the power system.
3. To describe the wire pilot protection schemes and protective schemes for transformer, generator, and busbar.
4. To introduce the concept of comparators and explain the various static relays.
5. To understand the concepts and principles of circuit Breakers employed in the power system.

Course Outcomes

After completion of this course, the student will be able to

1. Compare and contrast the different generations of protective relay schemes and understand the importance of power system protection.
2. Select the relay settings and characteristics for overcurrent in distance protection schemes and analyse their performance.
3. Apply the differential protection scheme to transformer, generators, and bus bars.
4. Understand the use of comparators in static relays and their operation.
5. Understand the introductory concepts of circuit breakers and analyse the various arc quenching mechanisms used in air, oil, vacuum and SF_6 circuit breakers.

UNIT - I: Fundamentals of Power System Protection and Relaying Schemes

Introduction, Need for power system protection, effects of faults, evolution of protective relays, zones of protection, primary and backup protection, essential qualities of protection, classification of protective relays and schemes, current transformers, potential transformers, basic relay terminology. Operating Principles and Relay Construction - Electromagnetic relays, thermal relays, static relays, microprocessor based protective relays.

UNIT – II: Overcurrent and Distance Relaying Schemes

Over-Current Protection: Time-current characteristics, current setting, over current protective schemes, directional relay, protection of parallel feeders, protection of ring mains,

Phase fault and earth fault protection, Combined earth fault and phase fault protective scheme, Directional earth fault relay.

Distance Protection: Impedance relay, reactance relay, MHO relay, input quantities for various types of distance relays, Effect of arc resistance, Effect of power swings, effect of line length and source impedance on the performance of distance relays, selection of distance relays, MHO relay with blinders, auto reclosing.

UNIT- III: Equipment Protection

Pilot Relaying Schemes - Wire Pilot protection, Protection of Generators, Protection of transformers, Bus zone protection, frame leakage protection.

UNIT - IV: Static Relays

Amplitude and Phase comparators, Duality between Amplitude and Phase comparators, static over current relays, static directional relay, static differential relay, static distance relays

UNTI-V: Circuit Breakers

Introduction, arcing in circuit breakers, arc interruption theories, re-striking and recovery voltage, resistance switching, current chopping, oil circuit breaker, air blast circuit breakers, SF_6 circuit breaker, operating mechanism, ratings of circuit breakers.

Suggested Readings:

1. Badriram and D.N. Vishwakarma, Power System Protection and Switchgear, TMH 2001.
2. U.A.Bakshi, M.V.Bakshi: Switchgear and Protection, Technical Publications, 2009.

Reference Books:

1. C.Russel Mason – “The art and science of protective relaying, Wiley Eastern, 1995
2. L.P.Singh “Protective relaying from Electromechanical to Microprocessors”, New Age International

Online Resources:

1. https://nptel.ac.in/courses/108/101/108101039/
2. https://nptel.ac.in/courses/108/105/108105167/
3. https://nptel.ac.in/courses/108/107/108107167/

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B.Tech. in Electrical and Electronics Engineering
VI Semester Syllabus
EE631PC: Signals and Systems

Prerequisites: Linear algebra, Calculus, Ordinary Differential Equation and Laplace Transforms

Course Objectives

1. To understand the behaviour of signal in time domain and frequency domain.
2. To understand the behaviour of signal in frequency domain.
3. To understand the characteristics of LTI systems.
4. To understand the concepts of signals and their analysis using different transform techniques.
5. To understand the concept of sampling.

Course Outcomes

After completion of this course, the student will be able to

1. Differentiate various signal functions.
2. Represent any arbitrary signal in time and frequency domain.
3. Understand the characteristics of linear time invariant systems.
4. Analyse the signals with different transform technique.
5. Find the Nyquist rate of a given signal.

UNIT – I: Signal Analysis

Analogy between Vectors and Signals, Orthogonal Signal Space, Signal approximation using Orthogonal functions, Mean Square Error, Orthogonality in Complex functions, Classification of Signals and systems, Exponential and Sinusoidal signals, Concepts of Impulse function, Unit Step function, Signum function.

UNIT – II: Fourier series and Fourier Transforms

Fourier series: Representation of Fourier series-Continuous time periodic signals, Dirichlet's conditions, Trigonometric Fourier Series and Exponential Fourier Series, Complex Fourier spectrum. **Fourier Transforms:** Deriving Fourier Transform from Fourier series, Fourier Transform of arbitrary signal, standard signals, Periodic Signals, Fourier Transforms involving Impulse function and Signum function, Properties of Fourier Transform.

UNIT – III: Signal Transmission through Linear Systems

Linear System, Impulse response, Response of a Linear System, Linear Time Invariant(LTI) System, Linear Time Variant (LTV) System, Transfer function of a LTI System, Filter

characteristic of Linear System, Distortion less transmission through a system, Signal bandwidth, System Bandwidth, Ideal LPF, HPF, and BPF characteristics, Causality and Paley-Wiener criterion for physical realization, Relationship between Bandwidth and rise time, Convolution of Signals, Concept of convolution in Time domain and Frequency domain, Graphical representation of Convolution. Introduction to Correlation

UNIT – IV: Laplace Transforms and Z–Transforms

Laplace Transforms: Laplace Transforms (L.T), Relation between L.T and F.T of a signal Concept of Region of Convergence (ROC) for Laplace Transforms, Properties of L.T., Inverse Laplace Transform, Laplace Transform of certain signals using waveform synthesis. **Z–Transforms:** Concept of Z- Transform of a Discrete Sequence, Distinction between Laplace, Fourier and Z Transforms, Region of Convergence in Z-Transform, Constraints on ROC for various classes of signals, Inverse Z-transform, Properties of Z-transforms.

UNIT – V: Sampling theorem

Graphical and analytical proof for Band Limited Signals, Impulse Sampling, Natural and Flat top Sampling, Reconstruction of signal from its samples, Effect of under sampling – Aliasing

Suggested Readings:

1. Signals, Systems & Communications - B.P. Lathi, 2013, BSP.
2. Signals and Systems - A.V. Oppenheim, A.S. Willsky and S.H. Nawabi, 2 Ed.

Reference Books:

1. Signals and Systems – Simon Haykin and Van Veen, Wiley 2 Ed.,
2. Signals and Systems – A. Rama Krishna Rao, 2008, TMH
3. Fundamentals of Signals and Systems - Michel J. Robert, 2008, MGH International Edition.
4. Signals, Systems and Transforms - C. L. Philips, J. M. Parr and Eve A. Riskin, 3 Ed., 2004, PE.
5. Signals and Systems – K. Deergha Rao, Birkhauser, 2018.

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B.Tech. in Electrical and Electronics Engineering
VI Semester Syllabus
EE611PE: Computer Architecture (PE-I)

Prerequisites: Digital Electronics

Course Objectives

1. To understand basic components of computers.
2. To understand the architecture of 8086 processor and memory organization.
3. To understand pipelining in Computer Organization.
4. To understand the instruction sets, instruction formats and various addressing modes of 8086.
5. To understand the concepts of Advanced Architectures.

Course Outcomes

After completion of this course, the student will be able to

1. Understand the concepts of microprocessors, their principles and practices.
2. Understand the concepts of architecture of 8086 processor and memory organization.
3. Organize a modern computer system and be able to relate it to real examples.
4. Develop the programs in assembly language for 80x86 and MIPS processors in real and protected modes.
5. Understand the concepts of RISC and CISC architectures.

UNIT - I: Introduction to Computer Organization

Functional Units of general computer system, System bus, Multi-bus organization, Data types, Data representation, **Fixed and Floating-point representation Computer arithmetic:** Addition, Subtraction, Multiplication and Division algorithms, Control unit, Micro programmed control unit, Hardware implementation of CU, Micro instruction format, microprogramming.

UNIT - II: Memory Organization and **Input – Output Organization**

Memory Organization: System memory, Cache memory, types and organization, Virtual memory and its implementation, Memory management unit, Magnetic Hard disks, Optical Disks. **Input - Output Organization:** Accessing I/O devices, Direct Memory Access and DMA controller, Interrupts and Interrupt Controllers, Arbitration, Multilevel Bus Architecture, Interface circuits, Parallel and serial port. Features of PCI and PCI Express bus.

UNIT - III: Pipelining

Introduction to pipelining, Instruction level pipelining (ILP), compiler techniques for ILP, Data hazards, Dynamic scheduling, Dependability, Branch cost, Branch Prediction, Influence on instruction set.

UNIT - IV: 8086 Microprocessor

8086 Architecture, Concurrent operation of EU and BIU, Real mode addressing, Segmentation, addressing modes of 8086, Instruction set of 8086, Programming model, I/O addressing in 8086, Introduction to IA - 32 and IA - 64.

UNIT - V: Advanced Architectures

Introduction to RISC and CISC architectures, VLIW Architecture, DSP Architecture, SoC architecture, MIPS Processor and programming

Suggested Readings:

1. V. Carl, G. Zvonko and S. G. Zaky, **"**Computer organization**"**, McGraw Hill, 1978.
2. B. Brey and C. R. Sarma, **"**The Intel microprocessors**"**, Pearson Education, 2000.

Reference Books:

1. J. L. Hennessy and D. A. Patterson, **"**Computer Architecture A Quantitative Approach**"**, Morgan Kauffman, 2011.
2. W. Stallings, **"**Computer organization**"**, PHI, 1987.
3. P. Barry and P. Crowley, **"**Modern Embedded Computing**"**, Morgan Kaufmann, 2012.
4. N. Mathivanan, **"**Microprocessors, PC Hardware and Interfacing**"**, Prentice Hall, 2004.
5. Y. C. Lieu and G. A. Gibson, **"**Microcomputer Systems: The 8086/8088 Family**"**, Prentice Hall India, 1986.
6. J. Uffenbeck, **"**The 8086/8088 Design, Programming, Interfacing**"**, Prentice Hall, 1987.
7. B. Govindarajalu, **"**IBM PC and Clones**"**, Tata McGraw Hill, 1991.
8. P. Able, **"**8086 Assembly Language Programming**"**, Prentice Hall India.

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B.Tech. in Electrical and Electronics Engineering
VI Semester Syllabus
EE612PE: Power System Analysis (PE-I)

Prerequisites: Power Systems - I and Power Systems - II

Course Objectives

1. To understand and develop incidence matrices and nodal admittance matrix.
2. To know the importance of load flow studies.
3. To understand and develop bus impedance matrix.
4. To understand stability of power system network.
5. To understand equal area criterion and it's applications.

Course Outcomes

After completion of this course, the student will be able to

1. Develop incidence matrices and nodal admittance matrix.
2. Analyse load flow for various requirements of the power system.
3. Develop bus impedance matrix.
4. Understand stability of power system network.
5. Understand equal area criterion and it's applications.

UNIT - I: Graph Theory and Nodal Admittance matrix

Power System Network Matrices: Graph Theory: Definitions, Incidence matrices: Element-Node incidence matrix, Bus incidence matrix, Primitive element and primitive network, Impedance form and admittance form representation, Primitive admittance matrix and primitive impedance matrix, Numerical problems.

Nodal Admittance Matrix, Y_{bus}: Introduction, Classification of buses, Nodal admittance matrix of an interconnected power system network, Properties of nodal admittance matrix, Direct inspection method and step by step method, Numerical problems, Static load flow equations and voltage at i^{th} bus.

UNIT - II: Power Flow Studies

Introduction, Gauss Seidel method in complex form with and without PV buses, Newton Raphson method in rectangular form and polar form, Derivation of Jacobian elements, Decoupled load flow method, Fast Decoupled load flow method, Numerical problems for one or two iterations, Comparison of different load flow methods.

UNIT - III: Bus Impedance Matrix, Z_{bus}

Introduction, Formation of branch, determination of diagonal and off - diagonal elements, Formation of link, determination of diagonal and off-diagonal elements, determination of modified bus impedance matrix, Simple numerical problems based on addition of branch and link with and without mutual coupling between transmission lines.

UNIT - IV: Power System Stability Analysis-I

Introduction, Definition of steady state stability, transient stability and dynamic stability, Properties of a stable power system network, Determination of steady state stability by static model, synchronizing power coefficient, ABCD constants and swing equation, Methods to improve steady state stability, Numerical problems, Determination of transient stability by dynamic model, Inertia constant, Concept of transfer reactance, Numerical problems.

UNIT - V: Power System Stability Analysis-II

Coherent and non-coherent swinging, Equal area criterion method, Applications-Sudden increase in mechanical input to a synchronous generator, Sudden increase in mechanical output of a synchronous motor, Removal of one of the parallel transmission lines using fast acting circuit breakers, Occurrence of fault at the middle of one of the parallel transmission lines, Occurrence of fault on a transmission line near bus bar and Occurrence of fault on bus bar, Critical clearing angle and critical clearing time, Numerical problems, Point by point method to determine transient stability, Methods to improve transient stability.

Suggested Readings:

1. Stagg and El-Abiad, “Computer Methods in Power System Analysis”, Mc Graw Hill, 1968.
2. C. L. Wadhwa, “Electrical Power Systems”, New Age International Publishers, 6th Edition.
3. I. J. Nagrath and D. P. Kothari, “Modern Power System Analysis”, Tata Mc Graw Hill Publishing Company, 4th Edition, 2011.

Reference Books:

1. Grainger and Stevenson, “Power System Analysis”, Tata Mc Graw Hill, 2003.
2. Hadi Saadat, “Power System Analysis”, Tata Mc Graw Hill, 2002.
3. William D Stevenson, “Elements of Power System Analysis”, Mc Graw Hill, 1982.

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B.Tech. in Electrical and Electronics Engineering
VI Semester Syllabus
EE613PE: Electrical Machine Design (PE-I)

Prerequisites: Electrical Machines - I, Electrical Machines - II

Course Objectives

1. To know the major considerations in electrical machine design, electrical engineering materials, space factor, choice of specific electrical and magnetic loading, analyse the thermal considerations, heat flow, temperature rise, rating of machines.
2. To understand the design of transformers.
3. To study the design of induction motors.
4. To know the design of synchronous machines.
5. To understand the CAD design concepts.

Course Outcomes

After completion of this course, the student will be able to

1. Understand the various factors which influence the design: electrical, magnetic and thermal loading of electrical machines.
2. Understand the design of transformers.
3. Understand the design of induction motors.
4. Understand the design of synchronous machines.
5. Understand the design of CAD concepts.

UNIT - I: Introduction electrical machine design

Major considerations in electrical machine design, electrical engineering materials, space factor, choice of specific electrical and magnetic loadings, thermal considerations, heat flow, temperature rise, rating of machines.

UNIT - II: Transformers

Sizing of a transformer, main dimensions, kVA output for single- and three-phase transformers, window space factor, overall dimensions, operating characteristics, regulation, no load current, temperature rise in transformers, design of cooling tank, methods for cooling of transformers.

UNIT - III: Induction Motors

Sizing of an induction motor, main dimensions, length of air gap, rules for selecting rotor slots of squirrel cage machines, design of rotor bars & slots, design of end rings, design of wound rotor, magnetic leakage calculations, leakage reactance of poly-phase machines, magnetizing current, short circuit current, circle diagram, operating characteristics.

UNIT - IV: Synchronous Machines

Sizing of a synchronous machine, main dimensions, design of salient pole machines, short circuit ratio, shape of pole face, armature design, armature parameters, estimation of airgap length, design of rotor, design of damper winding, determination of full load field mmf, design of field winding, design of turbo alternators, rotor design.

UNIT - V: Computer Aided Design (CAD)

Limitations (assumptions) of traditional designs need for CAD analysis, synthesis and hybrid methods, design optimization methods, variables, constraints and objective function, problem formulation. Introduction to FEM based machine design. Introduction to complex structures of modern machines: PMSMs, BLDCs, SRM and claw-pole machines.

Suggested Readings:

1. A. K. Sawhney, “A Course in Electrical Machine Design”, Dhanpat Rai and Sons, 1970.
2. M.G. Say, “Theory & Performance & Design of A.C. Machines”, ELBS London.

Reference Books:

1. S. K. Sen, “Principles of Electrical Machine Design with computer programmes”, Oxford and IBHPublishing, 2006.
2. K. L. Narang, “A Text Book of Electrical Engineering Drawings”, Satya Prakashan, 1969.
3. A. Shanmugasundaram, G. Gangadharan and R. Palani, “Electrical Machine Design Data Book”,New Age International, 1979.
4. M. V. Murthy, “Computer Aided Design of Electrical Machines”, B.S. Publications, 2008.
5. Electrical machines and equipment design exercise examples using Ansoft’s Maxwell 2D machine design package.

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B.Tech. in Electrical and Electronics Engineering
VI Semester Syllabus
EE614PE: Optimization Techniques (PE-II)

Prerequisites: Mathematics –I and Mathematics –II

Course Objectives

1. To introduce various optimization techniques i.e classical- Single variable Optimization – multi variable Optimization without constraints and inequality constraints.
2. To set-up simplex tables and solve LP problems using simplex algorithm and interpret the optimal solution of LP problems and recognize & formulate a transportation problems.
3. Constrained and unconstrained optimization techniques for solving and optimizing an electrical and electronic engineering circuits design problems in real world situations.
4. To explore the constrained non-linear programming methods and its optimal solution.
5. To explain the concept of dynamic programming and its applications to project implementation.

Course Outcomes

After completion of this course, the student will be able to

1. Understand the need of optimization of engineering systems and classical optimization techniques.
2. Understand optimization of linear programming, simplex algorithm and transportation problems.
3. Apply classical optimization techniques and unconstrained optimization techniques.
4. Apply unconstrained optimization and constrained non-linear programming.
5. Formulate optimization problems in applications of dynamic programming.

UNIT - I: Introduction and Classical Optimization Techniques

Statement of an optimization problem, design vector, design constraints, constraint surface, objective function, objective function surfaces, classification of optimization problems. **Classical Optimization Techniques:** Single variable Optimization, multi variable Optimization without constraints, necessary and sufficient conditions for minimum/maximum, multivariable Optimization with equality constraints, Solution by method of Lagrange multipliers, Multivariable Optimization with inequality constraints, Kuhn, Tucker conditions.

UNIT - II: Linear Programming

Standard form of a linear programming problem, geometry of linear programming problems, definitions and theorems, solution of a system of linear simultaneous equations, pivotal reduction of a general system of equations, motivation to the simplex method, simplex

algorithm. **Transportation Problem:** Finding initial basic feasible solution by north, west corner rule, least cost method and Vogel's approximation method, testing for optimality of balanced transportation problems.

UNIT - III: Unconstrained Non-linear Programming

One dimensional minimization methods, Classification, Fibonacci method and applications **Unconstrained Optimization Techniques:** Uni-variant method and Powell's method

UNIT - IV: Constrained Non-linear Programming

Characteristics of a constrained problem, classification, basic approach of penalty function method, Basic approach of Penalty Function method.

UNIT - V: Dynamic Programming

Dynamic programming multistage decision processes, types, concept of sub optimization and the principle of optimality, computational procedure in dynamic programming, Applications of Dynamic programming, shortest path problem, linear programming problem.

Suggested Readings:

1. Singiresu S. Rao, Engineering Optimization: Theory and Practice by John Wiley and Sons, 4th edition, 2009.
2. H. S. Kasene & K. D. Kumar, Introductory Operations Research, Springer (India), Pvt. Ltd.,2004

Reference Books:

1. George Bernard Dantzig, Mukund Narain Thapa, "Linear programming", Springer series inoperations research 3rd edition, 2003.
2. H. A. Taha, "Operations Research: An Introduction", 8th Edition, Pearson/Prentice Hall, 2007.
3. J.K Sharma, Operations Research: Theory and Applications, 6th edition, Trinity press, 2016.
4. Kalyanmoy Deb, "Optimization for Engineering Design – Algorithms and Examples", PHILearning Pvt. Ltd, New Delhi, 2005.

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B.Tech. in Electrical and Electronics Engineering
VI Semester Syllabus
EE615PE: Power Semiconductor Drives (PE-II)

Prerequisites: Power Electronics, Electrical Machines – I and Electrical Machines – II

Course Objectives

1. To introduce the drive system and operating modes of DC drive and its characteristics.
2. To introduce the chopper controlled DC drive system and four quadrant operation.
3. To understand the fundamentals and control of induction motor from stator side.
4. To understand the control of induction motor from rotor side.
5. To understand the control of synchronous motor.

Course Outcomes

After completion of this course, the student will be able to

1. Understand the speed control of DC motors and Identify the drawbacks of DC Motor drives.
2. Understand the chopper-controlled DC drives, speed-torque characteristics, merits and demerits.
3. Understand AC motor drive speed–torque characteristics using different control strategies on stator side.
4. Understand speed control of induction motor from rotor side and concept of slip power recovery.
5. Understand control of synchronous motor and their characteristics using different control strategies.

UNIT - I: Thyristor controlled DC Motors

Introduction to Thyristor controlled Drives, Single Phase semi and fully controlled converters connected to DC separately excited and DC series motors - continuous current operation, output voltage and current waveforms, Speed and Torque expressions, Speed - Torque Characteristics, Problems on Converter fed DC motors. Three phase semi and fully controlled converters connected to DC separately excited and DC series motors, output voltage and current waveforms, Speed and Torque expressions, Speed - Torque characteristics, Problems on 3-phase converter fed DC motors.

UNIT - II: Four Quadrant Operation and Control of DC Motors by Choppers

Introduction to Four quadrant operation, Motoring operations, Electric Braking, Plugging, Dynamic and Regenerative Braking operations. Four quadrant operation of D.C motor by single phase and three phase dual converters, closed loop operation of DC motor (Block

Diagram Only). **Control of DC Motors by Choppers:** Single quadrant, Two quadrant and four quadrant chopper fed DC separately excited and series motors, Continuous current operation, Output voltage and current wave forms, Speed and torque expressions, speed-torque characteristics, Problems on Chopper fed DC Motors, Closed Loop operation (Block Diagram approach Only)

UNIT - III: Stator Side Control of Induction Motor

Variable voltage characteristics, Control of Induction Motor by AC Voltage Controllers, Waveforms, speed - torque characteristics. Variable frequency characteristics, Variable frequency control of induction motor by Voltage source, current source inverter and cyclo converters, PWM control, Comparison of VSI and CSI control of induction motor, numerical problems on induction motor drives - Closed loop operation of induction motor drives (Block Diagram approach Only).

UNIT - IV: Rotor Side Control of Induction Motor

Introduction, Static rotor resistance control, Slip power recovery schemes: Static Scherbius drive, Static Kramer Drive, performance of slip power recovery schemes and speed torque characteristics, advantages, applications and problems on induction motor from rotor side.

UNIT - V: Control of Synchronous Motors

Separate control and self-control of synchronous motors - Operation of self-controlled synchronous motors by VSI, CSI and cyclo converters. Load commutated CSI fed Synchronous Motor drive, Applications, Advantages and Numerical Problems, Closed Loop control operation of synchronous motor drives (Block Diagram Only).

Suggested Readings:

1. G K Dubey, Fundamentals of Electric Drives, CRC Press, 2002.
2. Muhammad H Rashid, Power electronics : Devices, Circuits, and Applications, Pearson, [2017], Fourth edition

Reference Books:

1. S K Pillai, A First course on Electrical Drives, New Age International (P) Ltd. 2nd Edition. 1989
2. B. K. Bose, Modern Power Electronics, and AC Drives, Pearson 2015.
3. P. C. Sen, Thyristor DC Drives, Wiley-Blackwell, 1981
4. R. Krishnan, Electric motor drives - modeling, Analysis and control, Prentice Hall PTR, 2001
5. Vedam Subramanyam, Thyristor Control of Electric drives, Tata McGraw Hill Publications,1987.

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B.Tech. in Electrical and Electronics Engineering
VI Semester Syllabus
EE616PE: Wind and Solar Energy Systems (PE-II)

Prerequisites: Renewable Energy Systems

Course Objectives

1. To study the physics of wind energy and understand the principle of operation of wind generators.
2. To know the solar power resources.
3. To analyse the solar photo-voltaic cells.
4. To discuss the solar thermal power generation.
5. To identify the network integration issues.

Course Outcomes

After completion of this course, the student will be able to

1. Understand the energy scenario and the consequent growths of the power generation by renewable energy sources.
2. Understand the basic physics of wind and solar power generation.
3. Understand the power electronic interfaces for wind and solar generation.
4. Understand the issues related to the grid-integration of solar and wind energy systems
5. Understand the solar collectors and storage mechanisms.

UNIT - I: Physics of Wind Power

History of wind power, Indian and Global statistics, Wind physics, Betz limit ratio, stall and pitch control, Wind speed statistics-probability distributions and Wind power-cumulative distribution functions.

UNIT - II: Wind Generator Topologies

Review of modern wind turbine technologies, Fixed and Variable speed wind turbine, Induction Generators, Doubly-Fed Induction Generators and their characteristics, Permanent Magnet Synchronous Generators, Power electronics converters, Generator configurations, Converter Control.

UNIT - III: The Solar Resource and **Solar Photovoltaic**

Introduction, solar radiation spectra, solar radiation geometry, estimation of solar energy availability, Solar Photovoltaic Technologies-Amorphous, mono-crystalline, polycrystalline; V-I characteristics of a PV cell, PV module, array, Power Electronic Converters for Solar Systems, Maximum Power point Tracking (MPPT) algorithms. Converter control.

UNIT - IV: Solar Thermal Power Generation

Technologies, parabolic trough, central receivers, parabolic dish, Fresnel solar pond, elementary analysis.

UNIT - V: Network Integration Issues

Overview of grid code technical requirements, Fault ride-through for wind farms - real and reactive power regulation, voltage and frequency operating limits, solar PV and wind farm behavior during grid disturbances, power quality issues, power system interconnection experiences in the world, Hybrid andisolated operations of solar PV and wind systems.

Suggested Readings:

1. T. Ackermann, "Wind Power in Power Systems", John Wiley and Sons Ltd., 2005.
2. G. M. Masters, "Renewable and Efficient Electric Power Systems**",** John Wiley and Sons, 2004.

Reference Books:

1. S. P. Sukhatme, "Solar Energy: Principles of Thermal Collection and Storage", McGraw Hill,1984.
2. H. Siegfried and R. Waddington, "Grid integration of wind energy conversion systems" JohnWiley and Sons Ltd., 2006.
3. G. N. Tiwari and M. K. Ghosal, "Renewable Energy Applications", Narosa Publications, 2004.
4. J. A. Duffie and W. A. Beckman, "Solar Engineering of Thermal Processes", John Wiley & Sons,1991.
5. Dr.Sanjeev Singh, Umesh Rathore, "Energy management", Second Edition, S.K.Kataria and Sons, 2014.

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B.Tech. in Electrical and Electronics Engineering
VI Semester Syllabus
MC601HS: Intellectual Property Rights
(Common to CE, EEE, ECE, ME, MCT & MME)

Course Objectives

1. To enable the students to have an overview of Intellectual Property Rights
2. To provide comprehensive knowledge to the students regarding Trademarks Registration process and law related to it.
3. To disseminate knowledge on Copyrights, its related rights and recent developments.
4. To make the students understand Patent Regime in India and abroad.
5. To understand the framework of Trade secrets

Course Outcomes

After completion of this course, the student will be able to

1. Gain knowledge on Intellectual property rights and their importance.
2. Understand Indian and international Trademark Law and procedure for registration of Trademarks.
3. Acquire knowledge on Copyright Law, and the privileges awarded to the copyright owners.
4. Familiarized with the process of acquiring the patent and relevant laws.
5. Learn the importance of trade secrets for business sustainability.

UNIT- I: Introduction to Intellectual property

Introduction of IPR-Meaning of intellectual property, types of intellectual property-trademarks, copyrights, patents, trade secrets, importance of intellectual property rights, International organizations-WTO-WIPO-USPTO-INTA, International Conventions, agencies and treaties- Paris Convention-Berne Convention- Madrid Protocol-NAFTA-PCT-GATT-TRIPS.

UNIT- II: Trademarks

Trademarks: Purpose and functions of Trademarks-Categories of marks, acquisition of Trademark rights - Protectable matter - Selecting and evaluating Trademark- Trademarks registration process – Trademark Infringement - Remedies for infringement in Trademarks-New developments in Trademark Law- International Trademarks Law.

UNIT- III: Copyright

Copyrights-Fundamental of Copyright Law -Requirements of Copyrightability- Originality of material, fixation of material, Authorship works, exclusions from copyright protection- Rights of Copyright Owner-Right of reproduction of copyrighted work, right to do derivative works

,right to distribute copies of the copyrighted work, right to perform the work publicly, right to display the copyrighted work, – Copyright Ownership issues – Joint Works, Works made for Hire, Specially commissioned works, Copyright Registration - Notice of Copyright – Copyright Infringement -

Remedies for infringement in Copyrights- New developments in Copyright Law- International Copyright Law.

UNIT- IV: Patents

Patents: Concept of Patent - Classification – Utility Patents – Design Patents and Plant Patents, Patent searching process-Types of Patent Applications-Patent Registration Process, Ownership, Transfer, Assignment and Licensing of Patent-Patent Infringement, Remedies for Infringement of Patents, New developments in Patent Law- International Patent Law.

UNIT-V: Trade Secrets & Law of Unfair Competition

Trade Secrets: Trade secret law, determination of trade secrete status, measures for protecting trade secret status-Liability for misappropriations of trade secrets, protection for submissions, trade secret litigation. New developments in Trade secrets Law- International Trade Secrets.

Law of Unfair competition: Passing off, Misappropriation, right of publicity, dilution of trademarks, product disparagement, false advertising.

Suggested Readings:

1. Deborah. E. Bouchoux, Intellectual property, 4 e,Cengage learning India Pvt.Ltd., 2013
2. Prabuddha Ganguli, Intellectual property right, 8e,Tata McGraw Hill Publishing company, 2016
3. Dr.B.L.Wadehra, Law Relating to Intellectual Property,5 e, Universal Law Publishing Co. 2011.

Reference Books:

1. Richard Stim, Intellectual Property, 3e Cengage learning India Pvt.Ltd., 2017
2. Vinod.V.Sopele, Asoka K.Ghosh,Managing Intellectual Property, 2 e,2010
3. Ananth Padmanabhan, Intellectual Property Rights – Infringement and Remedies, Lexis Nexis Publishers, 2012

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B.Tech. in Electrical and Electronics Engineering
VI Semester Syllabus
MC601ES: Artificial Intelligence
(Common to all Branches)

Prerequisites: Nil

Course Objectives

1. To learn the distinction between optimal reasoning Vs. human like reasoning
2. To understand the concepts of state space representation, exhaustive search, heuristic search together with the time and space complexities.
3. To learn different knowledge representation techniques.
4. To understand the applications of AI, namely game playing, theorem proving, and machine learning.

Course Outcomes

After completion of this course, the student will be able to

1. Ability to formulate an efficient problem space for a problem expressed in natural language.
2. Select a search algorithm for a problem and estimate its time and space complexities.
3. Possess the skill for representing knowledge using the appropriate technique for a given problem.
4. Possess the ability to apply AI techniques to solve problems of game playing, and machine learning.

UNIT- I:

Introduction: AI Definition, Agents and Environments, Structure of Agents, Types of Agents. Problem Solving Agents: Problem spaces, states, goals and operators.

Uninformed Search Strategies: Breadth First Search, Depth First Search, Depth Limited Search, Iterative Deepening depth first search, Bidirectional Search.

UNIT- II:

Informed Search: Heuristic Search strategies, Hill Climbing, A*, Hill climbing search. **Game Playing:** Adversarial Searches. Two player games. Min-max Search: Algorithm, Problems. Draw Back of Min-Max Algorithm. Alpha-beta pruning: Algorithm, Problems. **Constraint Satisfaction Problems:** Definition, Crypt-Arithmetic Problems, Map Coloring, Backtracking.

UNIT- III:

Basic Knowledge Representation and Reasoning: Propositional Logic: Basics of logic, truth tables and sentence conversions. First order logic: Difference between Proposition & First order logic. Conjunctive Normal form. Disjunctive Normal Form. Conversion of English sentences into First order logic. Resolution and theorem proving. Problems of Resolution. Forward Chaining: Definition, Example problems. Backward Chaining: Definition, Example problems.

UNIT- IV:

Planning Classical Planning: Definition of Classical Planning, Algorithms for Planning with State-Space Search, Planning Graphs, other Classical Planning Approaches, Analysis of Planning approaches. **Planning and Acting in the Real World:** Time, Schedules, and Resources, Hierarchical Planning, Planning and Acting in Nondeterministic Domains, Multi agent Planning.

UNIT-V:

Uncertain knowledge and Learning Uncertainty: Acting under Uncertainty, Basic Probability Notation, Inference Using Full Joint Distributions, Independence, Bayes' Rule and Its Use, **Probabilistic Reasoning:** Representing Knowledge in an Uncertain Domain, The Semantics of Bayesian Networks, Efficient Representation of Conditional Distributions, Approximate Inference in Bayesian Networks, Relational and First-Order Probability

Learning: Forms of Learning, Supervised Learning, Learning Decision Trees.

Knowledge in Learning: Logical Formulation of Learning, Knowledge in Learning, Explanation-Based Learning, Learning Using Relevance Information, Inductive Logic Programming.

Suggested Readings:

1. Artificial Intelligence: A Modern Approach by S. Russell and P. Norvig, Prentice Hall. 2010, third edition.
2. Artificial Intelligence by Elaine Rich, Kevin Knight and Shivashankar B Nair, Tata McGraw Hill.

Reference Books:

1. Introduction to Artificial Intelligence and Expert Systems by Dan W. Patterson, Pearson Education.
2. George F. Luger, Artificial Intelligence: Structures and Strategies for Complex Problem Solving, Pearson Education, 6th ed., 2009.
3. Artificial Intelligence – Patric Henry Winston – Third Edition, Pearson Education

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B.Tech. in Electrical and Electronics Engineering
VI Semester Syllabus
EE651PC: Microprocessors and Microcontrollers Lab

Prerequisites: Nil

Course Objectives

1. To enable students to write simple assembly language programs using 8086/8051 like arithmetic, logical, string operation.
2. To enable students to execute ALP using MPMC kit or an assembler software.
3. To enable students to write programs to perform array operations, looping & branching operations.
4. To enable students to develop applications using timers and interrupts.
5. To interface peripheral devices to Microprocessor or Microcontroller and do relevant operations.

Course Outcomes

After completion of this course, the student will be able to

1. Write simple assembly language programs like arithmetic operations, logical operations, string operations on 8086/8051.
2. Demonstrate skill to work with software assembler or hardware kit of MPMC.
3. Develop programs for applications with jump, branching operations.
4. Develop applications using timers or interrupts in 8051.
5. Interface various peripherals to 8086/8051.

PART-A (Conduct any four using Microprocessor kit / Assembler)

Assembly language programs to perform

1. Arithmetic Operations on 16 bit data (different addressing modes)
2. Logical Operations on 16 bit data
3. String Operations
4. Sorting of an array (ascending and descending)
5. Rotate, swap, shift and branching instructions
6. Generate Fibonacci series

PART-B (Conduct any three Microcontroller kit / Assembler)

1. Program to do arithmetic operations on 8 bit data (different addressing modes)
2. Logical operations (Bit level & Byte level)

3. Program to find largest & smallest number in an array
4. Program to develop time delay generation using Timers of 8051
5. Program to display the series of no.s ‘1’ to ‘5’ using interrupts of 8051

PART-C (Conduct any three Microprocessor / Microcontroller kit)

1. Interfacing ADC to 8086
2. Generate square wave / triangular wave / sawtooth wave by interfacing DAC to 8086
3. Interface stepper motor to a Microprocessor 8086 and rotate in clockwise or anti-clockwise direction
4. Interface a 7 segment display to 8051 Microcontroller
5. Interface a Matrix keyboard to 8051 Microcontroller
6. Interface a DAC to 8051 Microcontroller and generate square wave / triangular wave / sawtooth wave

Suggested Readings:

1. Advanced Microprocessors and Peripherals by A K Ray, Tata McGraw-Hill Education, 2006
2. The 8051 Microcontrollers: Architecture, Programming & Applications by Dr. K. Uma Rao, Andhe Pallavi, Pearson, 2009.

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B.Tech. in Electrical and Electronics Engineering
VI Semester Syllabus
EE652PC: Power Systems Lab

Prerequisites: Power Systems - I, Power Systems - II, Power System Protection and Control, Electrical Machines

Course Objectives

1. To perform testing of CT, PT and Insulator strings.
2. To find sequence impedances of 3-Φ synchronous machine and Transformer.
3. To perform fault analysis on Transmission line models and Generators.

Course Outcomes

After completion of this course, the student will be able to

1. Perform various load flow techniques.
2. Understand Different protection methods.
3. Analyse the experimental data and draw the conclusions.

Any Ten experiments are required to be conducted from the following list of experiments.

1. Performance of short transmission line
2. A,B,C,D constants of a Long Transmission line
3. Finding the sequence impedances of 3-Φ synchronous machine.
4. Finding the sequence impedances of 3-Φ Transformer.
5. Voltage Distribution across and Insulator String
6. Testing of CT and PT
7. Characteristics of IDMT Overcurrent Relay.
8. Differential protection of 1-Φ transformer.
9. Characteristics of Microprocessor based Over Voltage/Under Voltage relay.
10. Formation of Y_{BUS} using MATLAB
11. Load Flow Analysis using Gauss Seidel (GS) Method using MATLAB
12. Load Flow Analysis using Fast Decoupled (FD) Method using MATLAB

Suggested Readings:

1. C.L. Wadhwa: Electrical Power Systems –Third Edition, New Age International Pub. Co., 2001.
2. Hadi Sadat: Power System Analysis –Tata Mc Graw Hill Pub. Co. 2002.

Reference Books:

1. D. P. Kothari: Modern Power System Analysis-Tata Mc Graw Hill Pub. Co. 2003.

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B.Tech. in Electrical and Electronics Engineering
VI Semester Syllabus
EE661PC: Signals and Systems Lab

Prerequisites: Linear algebra, Calculus, Ordinary Differential Equation and Laplace Transforms

Course Objectives

1. To develop ability to analyse linear systems and signals.
2. To develop critical understanding of mathematical methods to analyse linear systems and signals.
3. To know the various transform techniques.
4. To analyse sampling principles.
5. To understand the operations on signals.

Course Outcomes

After completion of this course, the student will be able to

1. Understand the concepts of continuous time and discrete time systems.
2. Analyse systems in time and frequency domain.
3. Perform the operations on signals.
4. Find the response of system.
5. Understand sampling theorem and its implications.

Any Ten experiments are required to be conducted from the following list of experiments using simulation software.

1. Introduction to MATLAB- Basic Matrix Operations
2. Write a program to generate and plot the discrete sequences and signals
   (i). Unit step (ii) Unit impulse (iii) Ramp (iv) Periodic sinusoidal sequences.
3. Basic transformations on Signals
4. Determine the Even part and Odd part of the signals and sequences
5. Determine the trigonometric and exponential Fourier series coefficients of a periodic rectangular signal. Plot the discrete spectrum of the signal.
6. Find the Fourier transform of a Sinusoidal Signal, Square Pulse and Impulse Signal and plot the spectrum
7. Write a program to convolve two discrete time sequences. (Plot all the sequences).Verify the result by analytical calculation.

8. Impulse and unit-step response of LTI system.
9. Generate a discrete time sequence by sampling a continuous time signal. Show that with sampling rates less than Nyquist rate, aliasing occurs while reconstructing the signal.
10. Write a program to find the magnitude and phase response of first order low pass and high pass filter. Plot the responses in logarithmic scale.
11. Draw the Pole-Zero plot in s-plane and z-plane for the given transfer function

Suggested Readings:

1. A. V. Oppenheim, A. S. Willsky and S. H. Nawab, “Signals and systems”, Prentice Hall India, 1997.
2. J. G. Proakis and D. G. Manolakis, “Digital Signal Processing: Principles, Algorithms, and Applications”, Pearson, 2006.

Reference Books:

1. H. P. Hsu, “Signals and systems”, Schaum’s series, McGraw Hill Education, 2010.
2. S. Haykin and B. V. Veen, “Signals and Systems”, John Wiley and Sons, 2007.
3. A. V. Oppenheim and R. W. Schafer, “Discrete-Time Signal Processing”, Prentice Hall, 2009.
4. M. J. Robert “Fundamentals of Signals and Systems”, McGraw Hill Education, 2007.
5. B. P. Lathi, “Linear Systems and Signals”, Oxford University Press, 2009.

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B.Tech. in Electrical and Electronics Engineering

VI Semester Syllabus

EN653HS: Finishing School-IV

(Advanced Communication Skills Lab)

(Common to CE, EEE, ECE, ME, MCT and MME)

Course Objectives

This Lab focuses on using multi-media instruction for language development to meet the various needs of the students. The objectives of the course are as follows:

1. To improve students' fluency in English, through a well-developed vocabulary and enable them to listen to English spoken at normal conversational speed by educated English speakers and respond appropriately in different socio-cultural and professional contexts.
2. To enable them to communicate their ideas relevantly and coherently in writing.
3. To facilitate placement activities for the students.
4. To make the students participate in both oral as well as written presentation skills.
5. To equip the students to be efficient in Group Discussions, Presentation Skills and Interview Skills.

Course Outcomes

At the end of the course students will be able to:

1. Acquire English language vocabulary and use it contextually
2. Listen and speak effectively in English language
3. Develop proficiency in academic reading and writing skills
4. Increase possibilities of job prospects in their respective domain
5. Communicate confidently in formal and informal contexts

INTRODUCTION:

Advanced English Communication Skills Lab is considered essential as the students need to prepare themselves for their careers which may require them to listen, speak, read and write in English both for their professional and interpersonal communication in the globalized context. This course would enable students to use English effectively and perform the following:

1. Gathering ideas and information to organize ideas relevantly and coherently.
2. Participating in group discussions.
3. Facing interviews.
4. Writing project/research reports/technical reports.
5. Making oral presentations.
6. Writing formal letters.
7. Transferring information from non-verbal to verbal texts and vice-versa.
8. Taking part in social and professional communication.

UNIT- I: Inter-personal Communication – Building General, Technical and Business English Vocabulary

Formal meeting–planning and circulating agenda–opening the meeting–during the meeting–closing the meeting-responding appropriately and relevantly – using the right body language-general-technical-business- vocabulary, analogy.

UNIT- II: Reading Comprehension

Reading for facts-skimming-scanning-guessing meanings from context, inferring meaning, critical reading, effective online navigation, sample passages from TOEFL/GRE/IELTS.

UNIT- III: Writing Skills

Planning for writing, structure and presentation of different types of writing - letter writing/resume writing, email netiquette, project report writing – feasible/business/ periodical/academic reports.

UNIT- IV: Presentation Skills

Brief speeches-introduction to a structured talk**– o**ral presentations (individual and group) /PPTs, gambits of presentation skills – use of tag questions, summarising after a brief talk, opening/during/concluding a presentation.

UNIT-V: Group Discussion and Interview Skills

Dynamics of group discussion, intervention, summarizing, modulation of voice, body language, relevance, fluency and organization of ideas and rubrics for evaluation - concept and process, pre-interview planning, opening strategies, answering strategies, interview through tele-conference & video-conference and mock interviews.

Suggested Readings:

1. Effective Technical Communication by M Ashraf Rizvi. McGraw Hill Education (India) Pvt. Ltd. 2nd Edition
2. Academic Writing: A Handbook for International Students by Stephen Bailey, Routledge, 5th Edition.

Reference Books:

1. Learn Correct English – A Book of Grammar, Usage and Composition by Shiv K. Kumar and Hemalatha Nagarajan. Pearson 2007
2. Professional Communication by Aruna Koneru, McGraw Hill Education (India) Pvt. Ltd, 2016.
3. Technical Communication by Meenakshi Raman & Sangeeta Sharma, Oxford University Press 2009.
4. Technical Communication by Paul V. Anderson. 2007. Cengage Learning Pvt. Ltd. New Delhi.
5. English Vocabulary in Use Series, Cambridge University Press 2008.

6. Handbook for Technical Communication by David A. Mc Murrey & Joanne Buckley, 2012,

Cengage Learning:

7. Communication Skills by Leena Sen, PHI Learning Pvt Ltd., New Delhi, 2009.
8. Job Hunting by Colm Downes, Cambridge University Press 2008.
9. English for Technical Communication for Engineering Students, AyshaVishwamohan, Tata Mc Graw-Hill 2009.
10. How to Write and Speak Better, Reader's Digest, 2003
11. Cambridge IELTS 16 Academic student's book with answers, 2017
12. TOEFL Reading & Writing Workout, The Princeton Review.
13. GRE Reading Comprehension: Detailed Solutions to 325 questions. Vibrant Publishers, 2017
14. How to prepare for Group Discussions and Interviews by Harimohan Prasad and Rajneesh Prasad, Tata Mcgraw Hill.
15. Keep Talking, Frederick Klippel, Cambridge University Press, South Asian edition (6 May 2010),
16. Objective English, Edgar Thorpe & Showick Thorpe, Pearson; 5th edition (1 August 2013).

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B.Tech. in Electrical and Electronics Engineering

VI Semester Syllabus

MC601ESC: Environmental Science

(Common to all Branches)

Prerequisites:

Course Objectives

1. To understand the natural resources and their conservation.
2. To understand the importance of ecosystem, biodiversity and ecological balance for sustainable development.
3. To gain knowledge about environmental pollution, effects and controlling measures.
4. To study about global environmental problems and global issues.
5. To understand the environmental policies, regulations and sustainable development.

Course Outcomes

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

1. Learn about different types of natural resources and take up the measures to protect the resources.
2. Get the information about ecosystem, biodiversity and their usage and conservation.
3. Get the information about the types of pollution, understand their effects and controlling measures.
4. Gain the knowledge about current global environmental issues and initiations to be taken to protect the environment.
5. Gain the knowledge about environmental acts, EIA, sustainable development and follow the rules and regulations.

UNIT- I: NATURAL RESOURCES

Classification: Renewable and Non-renewable resources. **Forest resources** - Uses, deforestation- causes, effects and preventive measures. **Water Resources** - Uses and over utilization of ground water, rain water harvesting, dams - benefits and problems. Causes, effects and management of floods and drought. **Mineral resources** - Uses and Impacts of mining. **Energy resources -** Growing energy needs, renewable and non-renewable energy resources, use of alternate energy resources.

UNIT- II: ECOSYSTEM AND BIODIVERSITY

Ecosystem: Concept of ecosystem - Structure and functions of ecosystem. Food chain, food web and ecological pyramids - significance. Primary and Secondary production - Energy flow models: universal and single channel. Biogeochemical Cycles: Carbon cycle and Nitrogen cycle.

Biodiversity: Definition, Levels of Biodiversity, Values of biodiversity, Hotspots of biodiversity, Threats to biodiversity, Conservation of biodiversity: In-Situ and Ex-situ conservation methods.

UNIT- III: ENVIRONMENTAL POLLUTION

Pollution - Definition and classification. **Air pollution:** Definition, sources, causes, effects and control measures. Ambient air quality parameters, case Study. **Water pollution:** Definition, sources, causes, effects and control measures. Waste water treatment. Case study (Namami Ganga Project), **Soil pollution:** Sources, Land degradation - Soil erosion – effects and control measures. Impacts of modern agriculture on soil. Biomagnification and Bioaccumulation (Minamata disease). **Noise pollution:** Sources, effects and control measures. **Solid Waste:** E-Waste and Municipal solid waste management.

UNIT- IV: GLOBAL ENVIRONMENTAL ISSUES AND GLOBAL EFFORTS

Global warming: Greenhouse effect - definition, sources and effects of greenhouse gases. Ozone layer depletion - Importance of ozone layer, Ozone depleting substances - sources and effects. Acid rain -causes and effects. Climate change - National Action Plan on Climate Change (NAPCC) – Government of India Initiatives. International conventions/protocols: The Earth summit, Kyoto Protocol and Montreal Protocol. Carbon credits - Emission trading, Green Chemistry Principles. Biodiesel-concept - transesterification and advantages.

UNIT-V: ENVIRONMENTAL ACTS, EIA & SUSTAINABLE DEVOLOPMENT

Environmental Protection Act - **Legal aspects**: Air (Prevention and Control of pollution) Act 1981, Water (Prevention and control of pollution) Act -1974, Wildlife (Protection) Act – 1972, Biodiversity Act - 2002. Environmental Impact Assessment – Concept, structure and flow chart of EIA. Concept of sustainable development - Environmental education, Concept of green building, Ecological foot print, Low carbon life style, Life cycle assessment (LCA) and Clean development mechanisms.

Project Work: Related to Current environmental issues.

Suggested Readings:

1. Erach Bharucha, Textbook of Environmental Studies for Undergraduate Courses, University Grants Commission, Universities Press, 3rd Edition.
2. Kaushik A., Kaushik C.P., Text Book of Environmental Studies, New age International Publishers, 4th Edition.

Reference Books:

1. Anji Reddy M ., Textbook of Environmental Sciences and Technology, BS Publication.
2. Rajagopalan R., Environmental Studies, Oxford University Press, 3rd Edition
3. Raghavan Nambiar K., Text Book of Environmental Studies, SciTech Publications 2nd Edition.

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B.Tech. in Electrical and Electronics Engineering
VII Semester Syllabus
EE701PC: Power System Operation and Control

Prerequisites: Power Systems - I, Power Systems – II and Power System Analysis

Course Objectives

1. To understand economic operation of thermal generating stations.
2. To understand economic operation of hydro-thermal generating stations.
3. To model isolated power system.
4. To analyse single area load frequency control.
5. To analyse two area load frequency control.

Course Outcomes

After completion of this course, the student will be able to

1. Understand economic operation of thermal generating stations.
2. Understand economic operation of hydro-thermal generating stations.
3. Model isolated power system.
4. Analyse single area load frequency control.
5. Analyse two area load frequency control.

Unit-I: Economic Operation of Thermal Generating Stations

Introduction, System constraints, Incremental fuel rate, Incremental efficiency, Cost curve, Incremental fuel and production costs, Input-output characteristics, Economic operation of thermal generating stations neglecting losses and considering losses, Penalty factor, Transmission line losses in terms of power loss or 'B' coefficients, Numerical problems.

Unit-II: Economic Operation of Hydro-Thermal Generating Stations

Introduction, Scheduling hydro systems-Scheduling energy, short term hydro-thermal scheduling with losses neglected and considered, Short term hydro-thermal scheduling using penalty factor, overview of unit commitment method.

Unit-III: Load Frequency Control

Introduction, Load frequency problem, Governor characteristic, Mega Watt frequency or P-f control channel, MVAR Voltage or Q-V control channel, Turbine speed governing system and it's components, Modeling of Speed Governor: Block diagram and transfer function, Modeling of Turbine: Reheat and non-reheat type turbines, Block diagram and transfer function, Modeling of Generator-Load model: Block diagram and transfer function, Block diagram of Isolated Power System.

Unit-IV: Single Area Load Frequency Control

Introduction, Definitions of Coherent group and Control area, Steady state analysis of Load Frequency control of single area system-uncontrolled case and controlled case, Dynamic response, Integral Load Frequency control and it's transient analysis, Numerical problems.

Unit-V: Two Area Load Frequency Control:

Introduction, Expression of change in tie-line power and frequency, Definition of Area Control Error, Composite block diagram of two area load frequency control, Steady state analysis of two area load frequency control-uncontrolled case, Advantages of interconnected systems, Numerical problems.

Suggested Readings:

1. Allen J. Wood and Bruce F. Wollenberg, "Power Generation Operation and Control", John Wiley and Sons, Inc.2004.
2. C.L. Wadhwa, "Electrical Power Systems", New Age International Publishers, 6th Edition.
3. I.J. Nagrath and D. P. Kothari, "Modern Power System Analysis", Tata Mc Graw Hill Publishing Company, 4th Edition, 2011.
4. Leon K. Kirchmayer, "Economic Operation of Power Systems", Wiley India Pvt Ltd (6 March 2009).

Reference Books:

1. Dr.K. Uma Rao, "Power System Operation and Control", Wiley-India, 2016.
2. Prabha Kundur, "Power System Stability and Control", Tata Mc Graw Hill, 2008.

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B.Tech. in Electrical and Electronics Engineering
VII Semester Syllabus
EE711PE: High Voltage Engineering (PE-III)

Prerequisites: Power Systems – I and Electro Magnetic Fields

Course Objectives

1. To deal with the detailed analysis of breakdown occurring in gaseous, liquids and solid dielectrics.
2. To inform about generation of High voltage and current.
3. To inform about measurement of High voltage and current.
4. To introduce the concept of Lightning and Switching Overvoltages.
5. To introduce high voltage testing methods.

Course Outcomes

After completion of this course, the student will be able to

1. Understand the basic physics related to various breakdown processes in solid, liquid, and gaseous insulating materials.
2. Gain knowledge of generation of DC, AC and Impulse voltages.
3. Gain knowledge of measurement of DC, AC and Impulse voltages.
4. Gain knowledge of how over-voltages arise in a power system, and protection against these overvoltages.
5. Gain knowledge of tests on H. V. equipment as per the standards.

Unit-I: Breakdown in Gases, Liquids and Solid Insulating Materials

Introduction to insulating materials – for LV and HV, Breakdown in Gases - Primary and Secondary Ionization processes, Townsend's theory, Paschen's Law, Streamer mechanism, Breakdown in pure liquids - Electronic Breakdown, Breakdown in commercial liquids- Suspended Particle Mechanism, Cavitation and Bubble Mechanism, Stressed Oil Volume Mechanism, Breakdown in solids - Intrinsic, Electromechanical, Thermal, Chemical and electrochemical breakdown mechanisms, breakdown due to treeing and tracking, breakdown due to internal discharges

Unit-II: Generation of High Voltages

Generation of high DC Voltages - Voltage doubler circuit, Cockroft-Walton voltage multiplier circuit, Electrostatic machines: Basic principle, Van de Graff generator, Generation of high AC Voltages - Cascaded transformers, Series Resonant circuits, Generation of Impulse Voltages - Single stage impulse generator, multi-stage impulse generator, Generation of high impulse currents, tripping and control of impulse generators

Unit-III: Measurements of High Voltages and Currents

Measurement of High DC Voltages - High ohmic series resistance with micro-ammeter, resistance potential dividers, generating voltmeters, Measurement of High AC Voltages - Series impedance voltmeter, Potential dividers, Potential Transformers, Electrostatic voltmeter, Measurement of High Currents - Resistive Shunts, Hall generators, Electro-optical Technique, Rogowski Coil, Faraday Generator, Measurement of dielectric constant and loss factor - High Voltage Schering Bridge

Unit-IV: Lightning and Switching Overvoltages

Classification of overvoltages, Lightning Phenomena, Wilson's theory of charge separation, mechanism of lightning stroke, Causes of Switching Overvoltages, Protection of Overvoltages - Ground wires, ground rods, Counterpoise wires, Horn gaps, Rod gap, Surge diverters.

Unit-V: High Voltage Testing of Electrical Apparatus

Testing of insulators and bushings, testing of isolators and circuit breakers, testing of cables, testing of power transformers, testing of Surge Arresters

Suggested Readings:

1. M. S. Naidu and V. Kamaraju, “High Voltage Engineering”, McGraw Hill Education, 2013.
2. C. L. Wadhwa, “High Voltage Engineering”, New Age International Publishers, 2007.

Reference Books:

1. E. Kuffel, W. S. Zaengl and J. Kuffel, “High Voltage Engineering Fundamentals”, Newnes Publication, 2000.
2. An Introduction to High Voltage Engineering by Subir Ray, PHI

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B.Tech. in Electrical and Electronics Engineering
VII Semester Syllabus
EE712PE: Linear System Analysis (PE – III)

Prerequisites: Electrical Circuits and Control Systems

Course Objectives

1. To understand the representation of non-electrical systems using electrical networks.
2. To learn how to develop state model and analyse the same using state variable approach.
3. To represent non sinusoidal periodic and non-periodic signal using Fourier series and Fourier transform and analyse the electrical networks with such signals.
4. To analyse simple electrical networks using Laplace transforms.
5. To test if a transfer function is realizable and synthesize using different methods into an electrical network.

Course Outcomes

After completion of this course, the student will be able to

1. To represent non electrical systems with equivalent electrical network.
2. To analyse simple electrical networks using state variable approach.
3. To use the Fourier series and Fourier transforms to analyse electrical networks with non-sinusoidal signals.
4. To use the Laplace transform principles for analysing the electrical networks.
5. To test if a transfer function can be realized and synthesize the electrical network.

Unit-I: Analogous Systems

Analogous systems, Classification of systems, Linear, non-linear, dynamic and static. Time invariant systems. Mechanical Translational and Rotational Systems, D'Alemberts Principle, Force Voltage Analogy, Force Current Analogy. Mechanical coupling devices - gears - mathematical Representation, Simple Problems

Unit-II: State Variable Analysis of Electrical Networks

Choice of state variables in electrical networks. Formulation of State Equations for electrical networks. Equivalent source method. Network Topological method. Solution of the state equation. Analysis of simple networks with state variable approach

Unit-III: Applications of Fourier Series and Fourier Transform

Applications of Fourier Series: RMS, Average value of a non-sinusoidal periodic waveform. Expression for power with non-sinusoidal voltage and current. Power Factor - Effect of harmonics. Analysis of simple circuits with non-sinusoidal inputs. **Application of Fourier**

Transform: Representation of non-periodic functions, Fourier integral and Fourier transform. Graphical representation, properties of Fourier transform. Persaval's theorem, Fourier Transform of constant, unit step, unit impulse, unit ramp signals and exponential functions. Relationship with Laplace transform

Unit-IV: Application of Laplace transform to Electrical Networks

Response of RL, RC and RLC networks to step, ramp, pulse and impulse functions. Shifting and scaling theorems. Laplace transform of periodic functions. Convolution theorem, Convolution integral and applications

Unit-V: Network Synthesis

Testing of Polynomials: Elements of realizability, Hurwitz Polynomials. positive real functions - properties, testing, Sturm's Test Synthesis of One port LC Networks - Foster and Cauer methods. Synthesis of One port RL and RC Networks - Foster and Cauer methods

Suggested Readings:

1. Engineering Network Analysis and Filter Design – Gopal G Bhise, Prem R Chadha, Umesh. Durgesh C Kulshreshta, Umesh Publications
2. Analysis of Linear Systems – A Chang

Reference Books:

1. Networks and Systems – D. Roy Choudary, New Age International
2. Linear Systems Analysis – A. N. Sripathi, New Age International
3. Analysis of Linear Systems – R. L. Narsimham
4. Network Analysis and Synthesis – Franklin F Kuo, Wiley India

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B.Tech. in Electrical and Electronics Engineering
VII Semester Syllabus
EE713PE: Electrical and Hybrid Vehicles (PE – III)

Prerequisites: Power Semiconductor Drives, Electrical Drives and Control, Utilization of Electrical Energy

Course Objectives

1. To understand the fundamental concepts of vehicle performance.
2. To understand principles, analysis of hybrid and electricvehicles.
3. To know the various aspects of hybrid and electric drive train such as their configuration, types of electric machines.
4. To understand the energy storage devices.
5. To understand different energy management strategies.

Course Outcomes

After completion of this course, the student will be able to

1. Understand the models to describe vehicles and their performance.
2. Understand the concepts of hybrid electric vehicle and electric drive trains.
3. Understand the types of electric machines used for drive train.
4. Understand the different strategies related to energy storage systems.
5. Understand the concepts of energy management strategies.

Unit-I: Introduction to Vehicle Performance

Introduction: Conventional Vehicles, vehicle resistances, rolling resistance, aerodynamic drag, grading resistance. Dynamic equation, power train tractive effort and vehicle speed.

Vehicle power plant and transmission characteristics, basics of vehicle performance, vehicle power source characterization, transmission characteristics and mathematical models to describe vehicle performance.

Unit-II: Introduction to Hybrid Electric Vehicles

History of hybrid and electric vehicles, social and environmental importance of hybrid and electric vehicles, impact of modern drive-trains on energy supplies. **Hybrid Electric** Drive-Trains: Basic concept of hybrid traction, introduction to various hybrid drive-train topologies, power flow control in hybrid drive-train topologies, fuel efficiency analysis.

Unit-III: Electric Trains and Electric Propulsion Unit

Electric Trains: Electric Drive-trains: Basic concept of electric traction, introduction to various electric drive train topologies, power flow control in electric drive-train topologies, fuel efficiency analysis. **Electric Propulsion Unit:** Introduction to electric components used in hybrid and electric vehicles, Configuration and control of DC Motor drives, Configuration and control of Induction Motor drives, configuration and control of Permanent Magnet Motor drives, Configuration and control of Switch Reluctance Motor drives, drive system efficiency.

Unit-IV: Energy Storage

Energy Storage: Introduction to Energy Storage Requirements in Hybrid and Electric Vehicles, Battery based energy storage and its analysis, Fuel Cell based energy storage and its analysis, Super Capacitor based energy storage and its analysis, Flywheel based energy storage and its analysis, Hybridization of different energy storage devices. Sizing the drive system: Matching the electric machine and the internal combustion engine (ICE), Sizing the propulsion motor, sizing the power electronics, selecting the energy storage technology, Communications, supporting subsystems

Unit-V: Energy Management Strategies

Energy Management Strategies: Introduction to energy management strategies used in hybrid and electric vehicles, classification of different energy management strategies, comparison of different energy management strategies, implementation issues of energy management strategies. **Case Studies:** Design of a Hybrid Electric Vehicle (HEV), Design of a Battery Electric Vehicle (BEV).

Suggested Readings:

1. C. Mi, M. A. Masrur and D. W. Gao, “Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives”, John Wiley & Sons, 2011.
2. S. Onori, L. Serrao and G. Rizzoni, “Hybrid Electric Vehicles: Energy Management Strategies”,Springer, 2015.

Reference Books:

1. M. Ehsani, Y. Gao, S. E. Gay and A. Emadi, “Modern Electric, Hybrid Electric, and Fuel CellVehicles: Fundamentals, Theory, and Design”, CRC Press, 2004.
2. T. Denton, “Electric and Hybrid Vehicles”, Routledge, 2016.

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B.Tech. in Electrical and Electronics Engineering
VII Semester Syllabus
EE714PE: Power Quality and FACTS (PE-IV)

Prerequisites: Power Electronics, Power System Operation and Control, HVDC Transmission

Course Objectives

1. To understand definition of power quality and different terms of power quality.
2. To understand the analysis of uncompensated AC transmission lines.
3. To understand the objectives of static shunt compensation.
4. To understand the objectives of static series compensation.
5. To understand the objectives of unified power flow controller.

Course Outcomes

After completion of this course, the student will be able to

1. Understand definition of power quality and different terms of power quality.
2. Understand the performance of uncompensated AC transmission lines.
3. Understand the objectives of static shunt compensation.
4. Understand the objectives of static series compensation.
5. Understand the power and control circuits of series controller, GCSC, TSSC and TCSC.

Unit-I: Power Quality Problems in Distribution Systems

Power Quality problems in distribution systems: Transient and Steady state variations in voltage and frequency. Unbalance, Sags, Swells, Interruptions, Wave-form Distortions: harmonics, noise, notching, dc-offsets, fluctuations, Flicker and its measurement.

Unit-II: Transmission Lines and Series/Shunt Reactive Power Compensation

Basics of AC Transmission, Analysis of uncompensated AC transmission lines, Passive Reactive Power Compensation. Shunt and series compensation at the mid-point of an AC line, comparison of series and shunt compensation.

Unit-III: Static Shunt Compensators

Objectives of shunt compensation, Methods of controllable VAR generation, Static Var Compensator, its characteristics, TCR, TSC, FC-TCR configurations, STATCOM, basic operating principle, control approaches and characteristics

Unit-IV: Static Series Compensators

Objectives of series compensator, variable impedance type of series compensators, TCSC, TSSC- operating principles and control schemes, SSSC, Power Angle characteristics, Control range and VAR rating, Capability to provide reactive power compensation, external control

Unit-V: Combined Compensators

Introduction to Unified Power Flow Controller, Basic operating principles, Conventional control capabilities, Independent control of real and reactive power.

Suggested Readings:

1. Electrical Power Systems Quality, Dugan Roger C, Santoso Surya, Mc Granaghan, Marks F.Beaty and H. Wayre, Mc Graw Hill
2. Power Systems Quality Assessment, J. Arillaga, N.R. Watson, S.Clon, John Wiley.

Reference Books:

1. Power Quality, C.Sankaran, CRC Press 4. Understanding power quality problems, Math H.Bollen, IEEE press.
2. Understanding FACTS –Concepts and Technology of Flexible AC Transmission Systems”Narain G.Honorani, Laszlo Gyugyi

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B.Tech. in Electrical and Electronics Engineering
VII Semester Syllabus
EE715PE: Power System Reliability (PE - IV)

Prerequisites: Reliability Engineering, Power System - I, Power System - II, Power System Operation and Control

Course Objectives

1. To describe the generation system model and recursive relation for capacitive model building.
2. To explain the equivalent transitional rates, cumulative probability and cumulative frequency.
3. To develop the understanding of risk, system and load point reliability indices.
4. To explain the basic and performance reliability indices.
5. To explain about outages of various components.

Course Outcomes

After completion of this course, the student will be able to

1. Estimate loss of load and energy indices for generation systems model.
2. Describe merging generation and load models.
3. Apply various indices for distribution systems.
4. Evaluate reliability of interconnected systems.
5. Learn effect of outages of components.

Unit-I: Basic Probability Theory and Reliability

Basic Probability Theory: Elements of probability, probability distributions, Random variables, Density and Distribution functions- Binomial distribution- Expected value and standard deviation, Binomial distribution, Poisson distribution, normal distribution, exponential distribution, Weibull distribution. **Definition of Reliability:** Definition of terms used in reliability, Component reliability, Hazard rate, derivation of the reliability function in terms of the hazard rate. Hazard models, Bath tub curve, Effect of preventive maintenance. Measures of reliability: Mean Time to Failure and Mean Time between Failures.

Unit-II: Generating System Reliability Analysis

Generation system model, capacity outage probability tables, Recursive relation for capacitive model building, sequential addition method, unit removal, Evaluation of loss of load and energy indices, Examples. Frequency and Duration methods, Evaluation of equivalent transitional rates of identical and non-identical units, Evaluation of cumulative probability and

cumulative frequency of non-identical generating units, 2-level daily load representation, merging generation and load models, Examples.

Unit-III: Reliability Evaluation and analysis

Operating Reserve Evaluation: Basic concepts, risk indices, PJM methods, security function approach, rapid start and hot reserve units, Modeling using STPM approach. **Bulk Power System Reliability Evaluation:** Basic configuration, conditional probability approach, system and load point reliability indices, weather effects on transmission lines, Weighted average rate and Markov model, Common mode failures. **Inter Connected System Reliability Analysis:** Probability array method, Two inter connected systems with independent loads, effects of limited and unlimited tie capacity, imperfect tie, Two connected Systems with correlated loads, Expression for cumulative probability and cumulative frequency.

Unit-IV: Distribution System Reliability Analysis:

Basic Techniques, Radial networks, Evaluation of Basic reliability indices, performance indices, load point and system reliability indices, customer oriented, loss and energy oriented indices, Examples. Basic concepts of parallel distribution system reliability

Unit-V: Substations and Switching Stations

Effects of short-circuits, breaker operation, Open and Short- circuit failures, Active and Passive failures, switching after faults, circuit breaker model, preventive maintenance, exponential maintenance times.

Suggested Readings:

1. Reliability Evaluation of Power systems by R. Billinton, R.N. Allan, BS Publications, 2007.
2. Reliability Modeling in Electric Power Systems by J. Endrenyi, John Wiley and Sons, 1978

Reference Books:

1. Reliability Engineering: Theory and Practice by Alessandro Birolini, Springer Publications.
2. An Introduction to Reliability and Maintainability Engineering by Charles Ebeling, TMHPublications.
3. Reliability Engineering by E. Balaguruswamy, TMH Publications.
4. Reliability Engineering by Elsayed A. Elsayed, Prentice Hall Publications.

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B.Tech. in Electrical and Electronics Engineering
VII Semester Syllabus
EE716PE: Advanced Electrical Drives (PE-IV)

Prerequisites: Power Electronics and Power Semiconductor Drives

Course Objectives

1. To understand the dynamics of electric drives.
2. To understand the closed loop control of induction motor drives.
3. To analyse the performance of Switched Reluctance Motor Drives.
4. To analyse the performance of Brushless DC Motor Drives.
5. To understand the concepts of Solar and Battery powered Drives.

Course Outcomes

After completion of this course, the student will be able to

1. Understand the Dynamics of an electric drives.
2. Understand the closed loop control of induction motor drives.
3. Understand the performance and operation of Switched Reluctance Motor Drives.
4. Understand the performance and operation of Brushless DC Motor Drives.
5. Understand the concepts of solar and battery powered drives.

Unit-I: Dynamics of Electrical Drives

Introduction, choice of electric drives, Fundamental torque equation, speed-torque sign conventions, Multi quadrant operation of Electric drive, Component of load torque, Nature and Classification of load Torque, steady state stability, closed loop control of Drives.

Unit-II: Induction Motor Drives

Introduction to scalar and vector control, Open loop volts/Hz control of induction motor using voltage source inverter, Closed loop adjustable speed of induction motor, Speed control of induction motor with slip regulation, closed loop control of induction motor with volts/Hz and slip regulation.

Unit-III: Switched Reluctance Motor Drives

Introduction to variable reluctance motor, Construction, Types of Switched Reluctance Motors, performance characteristics, operation and control requirements, Converter circuits, Modes of operation, applications and closed Loop operation of switched Reluctance motor drive.

Unit-IV: Brushless DC Motor Drives

Brushless DC motor: construction, operation performance, Characteristics, Control of Brushless DC motor, Comparison of BLDC motor with brushed DC motor, Comparison of BLDC motor with Induction Motor, applications and important features, Voltage source Inverter fed BLDC motor Drive.

Unit-V: Solar and Battery Powered Drives

Introduction to Solar and Battery powered drives, Solar Panels or Photovoltaic Panels, Characteristics of Solar Panels, Motors suitable for pump drives, Solar powered pump drive, Characteristics, Block diagram of Solar powered drive with MPPT, Battery powered vehicles, Battery Powered drive with Voltage Source Inverter.

Suggested Readings:

1. G K Dubey, Fundamentals of Electric Drives, CRC Press, 2002.
2. G K Dubey, Power Semiconductor Controlled Drives, Prentice Hall International Edition, 1989.
3. B. K. Bose", Modern Power Electronics, and AC Drives, Pearson 2015.
4. R. Krishnan, "Permanent Magnet Synchronous and Brushless DC motor Drives", CRC Press,2009.

Reference Books:

1. Miller T.J.E, " Brushless Permanent Magnet and Reluctance motor drives, Oxford Science, 1988
2. Ned Mohan, "Advanced Electric Drives: Analysis, Control and Modelling using MATLAB/Simulink, John Wiley and Sons Inc

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B.Tech. in Electrical and Electronics Engineering
VII Semester Syllabus
EE751PC: Power Engineering Simulation Lab

Prerequisites: Electrical and Electronic circuits, Power System Analysis and Power Electronics

Course Objectives

1. To evaluate the performance of transmission lines.
2. To analyse various faults in power systems.
3. To analyse performance of feedback and load frequency control of the systems.
4. To analyse the performance of different power electronic converters.
5. To analyse the performance characteristics of various electrical machines.

Course Outcomes

After completion of this course, the student will be able to

1. Design and analyse electrical systems in time and frequency domain.
2. Analyse various transmission lines and perform fault analysis.
3. Model Load frequency control of Power Systems.
4. Model different power electronic converters.
5. Model different types of electrical machines and analyse their performance characteristics.

Any Ten experiments are required to be conducted from the following list of experiments.

1. Symmetrical component analysis using Simulink.
2. Transmission Line Fault Analysis using Simulink.
3. Transient analysis of open-ended line and short-circuited line using Simulink.
4. Short Circuit Analysis of Power system models using Simulink.
5. Load frequency control of single area and two area power system using Simulink.
6. Economic Dispatch of Thermal Units using MATLAB.
7. Simulation of single-phase Dual converter.
8. Simulation of Buck-Boost Chopper.
9. Simulation of Sinusoidal pulse width modulation based single Phase inverter.
10. Simulation of speed control of Chopper fed DC Motor.
11. Simulation of speed control of single-phase fully Controlled Rectifier fed DC Motor.
12. Simulation of speed control of Induction Motor.
13. Performance characteristics of Synchronous Motor using Simulink.

Suggested Readings:

1. C.L. Wadhwa: Electrical Power Systems –Third Edition, New Age International Pub. Co., 2001.
2. Hadi Sadat: Power System Analysis –Tata Mc Graw Hill Pub. Co. 2002.
3. Agam Kumar Tyagi, MATLAB and SIMULINK for engineers, November 2011
4. L. Ashok Kumar, A. Kalaiarasi, Y. Uma Maheswari, Power Electronics with MATLAB, Cambridge University Press, 2017

Reference Books:

1. D. P. Kothari: Modern Power System Analysis-Tata Mc Graw Hill Pub. Co. 2003.
2. Weidong Xiao, Power Electronics Step-by-Step: Design, Modeling, Simulation, and Control, 1st Edition

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B.Tech. in Electrical and Electronics Engineering
VII Semester Syllabus
EE752PC: Electrical and Electronics Design Lab

Prerequisites: Basics of Electrical Engineering

Course Objectives

1. To develop hardware skills such as soldering, winding etc.
2. To increase ability for analysis and testing of circuits.
3. To give an exposure to market survey for available components.
4. To develop an ability for proper documentation of experimentation.
5. To prepare students for working on different hardware projects.

Course Outcomes

After completion of the course, student will be able to:

1. Get practical knowledge related to different electrical components/devices.
2. Fabricate basic electrical circuit elements/networks.
3. Trouble shoot the electrical circuits.
4. Design filter circuit for application.
5. Get hardware skills such as soldering, winding etc.

Any Ten experiments are required to be conducted from the following list of experiments.

1. Design and fabrication of reactor/ electromagnet for different inductance values
2. Design and fabrication of single-phase Induction/three phase motor stator.
3. Start delta starter wiring for automatic and manual operation.
4. Wiring of distribution box with MCB, ELCB, RCCB and MCCB.
5. Wiring of 40 W tube, T-5, LED, Metal Halide lamps and available latest luminaries.
6. Assembly of various types of contactors with wiring.
7. Assembly of DOL and 3-point starter with NVC connections and overload operation.
8. Design and development of 5 V regulated power supply.
9. Microcontroller Interface circuit for temperature/level/speed/current/voltage measurement.
10. Peak detector using op-amplifiers.
11. Zero crossing detector using op-amplifiers.
12. Design and development of precision rectifier.

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B.Tech. in Electrical and Electronics Engineering
VIII Semester Syllabus
MS804HS: Fundamentals of Management for Engineers
(Common to EEE, ME, MME & MCT)

Course Objectives

1. To enable the students, understand the evolution and functions of Management.
2. To make the students learn planning process and decision making in the organization.
3. To enable the students to learn the application of the principles in an organization.
4. To learn the ability of directing and leading the organization.
5. To study the system and process of effective controlling in the organization.

Course Outcomes

After completion of this course, the student will be able to

1. Understand the significance of Management and its functions.
2. Analyze the planning process in the organization.
3. Comprehend the concept of organization.
4. Demonstrate the ability to direct and exhibit leadership qualities effectively.
5. Formulate best control methods for effective management.

UNIT- I: Introduction to Management

Definition, Nature and Scope of Management, Functions of management, Managerial Roles, Levels of Management, Managerial Skills, Challenges of Management. Evolution of Management- Classical Approach- Scientific and Administrative Management; The Behavioral Approach; The Quantitative Approach; The Systems Approach; Contingency Approach, IT Approach.

UNIT- II: Planning and Decision Making

Planning- Concept, Definition, Types of Plans, Planning Process, Importance of Planning, Management by Objectives; Production Planning and Control. **Decision making and Problem Solving -** Concept, Types of Decisions-Programmed and Non-Programmed Decisions, Decision making Process, Bounded Rationality and Influence on Decision Making; Group Problem Solving and Decision Making,

UNIT- III: Organization and HRM

Organization: Definition, Principles of Organizations, Formal and informal organizations, Importance, Organizational Design & Organizational Structures- mechanistic and organic

structures; Departmentalization, Delegation of authority; Empowerment, Centralization, Decentralization, Recentralization; Span of Control.

Human Resource Management & Business Strategy: Job Analysis, Recruitment- sources, process, Selection process; Training and Development- importance, on-the-job and off-the job training methods; Performance Appraisal-meaning, methods. Job Satisfaction, Job Enrichment, Job Enlargement,

UNIT- IV: Leading and Motivation

Leading: Definition, Elements of Leading, importance and characteristics of Leading, Leadership, Power and Authority, Leadership Styles- Behavioural Leadership, Situational Leadership, Leadership Skills, Leader as Mentor and Coach, Leadership during adversity and Crisis; Handling Employee and Customer Grievances, Team Leadership.

Motivation-Definition, importance, Types of Motivation; Content Motivational Theories-Needs Hierarchy Theory, Two Factor Theory, Theory X and Theory Y. Relationship between Motivation, Performance and Engagement.

UNIT-V: Controlling

Definitions, Importance, Limitations, characteristics, Control Process, Types and Strategies for Control, Establishing control systems, Elements of good Control system, Control frequency and Methods, Budgetary and Non-Budgetary Controls.

Suggested Readings:

1. Andrew DuBrin, Management Essentials, 9th Edition, CengageLearning,2012.
2. Stephen P. Robbins, Fundamentals of Management, Pearson Education,2009.
3. R. Satyaraju, A.Parthasarthy, Management: Texts and Cases, 2nd Edition,PHI Learning Pvt. Ltd, 2009.

Reference Books:

1. Harold Koontz, Heinz Weihrich, Essentials of Management, Tata McGraw-Hill.
2. Robert N Lussier, Management Fundamentals,5th EditionCengageLearning,2013.
3. T.R.Banga,S.C.Sharma, Industrial Engineering and Management: Including Production Management, Khanna Publishers.

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B.Tech. in Electrical and Electronics Engineering
VIII Semester Syllabus
EE811PE: HVDC Transmission (PE - V)

Prerequisites: Power Systems-I, Power Systems-II, Power System Protection, Power System Operation and Control, Power Electronics

Course Objectives

1. To compare EHV AC and HVDC systems and analyse Graetz circuit.
2. To control HVDC systems using various methods.
3. To perform power flow analysis in AC/DC systems.
4. To describe various protection methods for HVDC systems.
5. To describe various Harmonics and Filters.

Course Outcomes

After completion of this course, the student will be able to

1. Compare EHV AC and HVDC system and analyse Graetz circuit for rectifier and inverter mode of operation.
2. Describe various methods to control the HVDC systems.
3. Perform power flow analysis in AC/DC systems.
4. Describe various protection methods for HVDC systems.
5. Classify harmonics and design different types of filters.

Unit-I: Basic Concepts and Analysis of HVDC Converters

Basic Concepts: Necessity of HVDC systems, Comparison of AC and DC Transmission, Applications of DC Transmission System, Types of HVDC Links, Apparatus Required for HVDC Systems. **Analysis of HVDC Converters:** Characteristics of 6 Pulse Converter, Choice of Converter Configuration, Analysis of Graetz circuit without Overlap and with Overlap less than 60 degrees, Inverter Operation, Equivalent Circuit of HVDC Link.

Unit-II: Converter and HVDC System Control

Converter and HVDC System Control: Principle of DC Link Control, Converters Control Characteristics, System Control Hierarchy, Firing Angle Control, Current and Extinction Angle Control, Starting and Stopping of DC Link.

Unit-III: Reactive Power Control in HVDC and Power Flow Analysis in AC/DC Systems

Reactive Power Control in HVDC: Introduction, Reactive Power Requirements in Steady State, Sources of Reactive Power, reactive power control using FACTS devices, **Power Flow**

Analysis in AC/DC Systems: Solution of AC-DC Power flow-Simultaneous Method-Sequential Method, Modelling of DC Links, DC Network, DC Converter, Controller Equations, Solution of DC Load Flow, P.U. System for DC Quantities.

Unit-IV: Converter Faults and Protection

Converter Faults-Arc Back, Arc Through, Quenching, Misfire, Commutation Failure, Protection Against Over Currents in Converter Station, Overvoltages in Converter Station, Protection Against Overvoltages in Converter Station, Smoothing Reactors, DC Breakers, Corona Loss, Radio Interference, Audible Noise, Space Charge Field.

Unit-V: Harmonics and Filters

Harmonics: Generation of Harmonics, Characteristic Harmonics, Calculation of AC Harmonics, Non-characteristic Harmonics, Calculation of Voltage and Current Harmonics, Adverse Effects of Harmonics. **Filters:** Types of AC Filters, Design of Single Tuned Filters – Design of High Pass Filters.

Suggested Readings:

1. K. R. Padiyar, HVDC Power Transmission Systems, New Age International (P) Limited, Publishers, 1990.
2. S K Kamakshaiah, V Kamaraju", HVDC Transmission, TMH Publishers, 2011.

Reference Books:

1. S. Rao, EHVAC and HVDC Transmission Engineering and Practice, Khanna publications, 3rd Edition 1999.
2. Jos Arrillaga, HVDC Transmission, The institution of Electrical Engineers, IEE Power & Energy series 29, 2nd Edition 1998.
3. E. W. Kimbark, Direct Current Transmission, John Wiley and Sons, Volume 1, 1971.
4. E. Uhlmann, Power Transmission by Direct Current, B. S. Publications, 2009.

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B.Tech. in Electrical and Electronics Engineering
VIII Semester Syllabus
EE812PE: Control Systems Design (PE-V)

Prerequisites: Control Systems

Course Objectives

1. To know the time and frequency domain design problem specifications.
2. To understand the design of classical control systems in time-domain.
3. To analyse the design aspects of classical control systems in frequency-domain.
4. To know the design of various compensator controllers.
5. To identify the performance of the systems by designing them in state-space and the effects of nonlinearities on various systems performance.

Course Outcomes

After completion of this course, the student will be able to

1. Understand various design specifications.
2. Understand the design of classical system in time domain.
3. Understand the design of classical system in frequency domain.
4. Design controllers to satisfy the desired design specifications using simple controller structures (P, PI, PID, compensators).
5. Design controllers using the state-space approach.

Unit-I: Design Specifications

Introduction to design problem and philosophy. Introduction to time domain and frequency domain design specification and its physical relevance. Effect of gain on transient and steady state response. Effect of addition of pole on system performance. Effect of addition of zero on system response

Unit-II: Design of Classical Control System in The Time Domain

Introduction to compensator. Design of Lag, lead lag-lead compensator in time domain. Feedback and Feed forward compensator design. Feedback compensation. Realization of compensators.

Unit-III: Design of Classical Control System in Frequency Domain

Compensator design in frequency domain to improve steady state and transient response. Feedback and Feed forward compensator design using bode diagram.

Unit-IV: Design of PID Controllers

Design of P, PI, PD and PID controllers in time domain and frequency domain for first, second and third order systems. Control loop with auxiliary feedback – Feed forward control.

Unit-V: Control System Design in State Space

Review of state space representation. Concept of controllability & observability, effect of pole zero cancellation on the controllability & observability of the system, pole placement design through state feedback. Ackerman's Formula for feedback gain design, Design of Observer. Reduced order observer, Separation Principle. **Non-linearities and Its Effect on System Performance:** Various types of non-linearities, Effect of various non-linearities on system performance, Singular points, Phase plot analysis.

Suggested Readings:

1. N. Nise, "Control system engineering", John Wiley, 2000.
2. I. J. Nagrath and M. Gopal, "Control system engineering", Wiley, 2000

Reference Books:

1. M. Gopal, "Digital Control Engineering", Wiley Eastern, 1988.
2. K. Ogata, "Modern Control Engineering", Prentice Hall, 2010.
3. B. C. Kuo, "Automatic Control system", Prentice Hall, 1995.
4. J. J. D'Azzo and C. H. Houpis, "Linear control system analysis and design (conventional andmodern)", McGraw Hill, 1995.
5. R. T. Stefani and G. H. Hostetter, "Design of feedback Control Systems", Saunders CollegePub, 1994.

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B.Tech. in Electrical and Electronics Engineering
VIII Semester Syllabus
EE813PE: AI Techniques in Electrical Engineering (PE-V)

Prerequisites: Power System Operation and Control

Course Objectives

1. To locate soft commanding methodologies, such as artificial neural networks, Fuzzy logic and Genetic Algorithms.
2. To observe the concepts of feed forward neural networks and about feedback neural networks.
3. To practice the concept of fuzziness involved in various systems and comprehensive knowledge of fuzzy logic control and to design the fuzzy control.
4. To analyse genetic algorithm, genetic operations and genetic mutations.
5. To analyse the application of AI to Electrical Engineering.

Course Outcomes

After completion of this course, the student will be able to

1. Understand feed forward neural networks, feedback neural networks and learning techniques.
2. Understand artificial Neural Network Paradigms.
3. Understand fuzziness involved in various systems and fuzzy set theory.
4. Develop genetic algorithm for applications in electrical engineering.
5. Develop Neural Network and fuzzy logic control applications in electrical engineering.

Unit-I: Artificial Neural Networks

Introduction, Models of Neuron Network, Architectures, Knowledge representation, Artificial Intelligence and Neural networks, Learning process, Error correction learning, Hebbian learning, Competitive learning, Boltzman learning, supervised learning-Unsupervised learning, Reinforcement learning, Learning tasks.

Unit-II: ANN Paradigms

Multi-layer perceptron using Back propagation Algorithm (BPA), Self-Organizing Map (SOM), Radial Basis Function Network-Functional Link Network (FLN), Hopfield Network.

Unit-III: Fuzzy Logic

Introduction, Fuzzy versus crisp, Fuzzy sets, Membership function, Basic Fuzzy set operations, Properties of Fuzzy sets, Fuzzy Cartesian Product, Operations on Fuzzy relations,

Fuzzy logic, Fuzzy Quantifiers, Fuzzy Inference, Fuzzy Rule based system, Defuzzification methods.

Unit-IV: Genetic Algorithms

Introduction, Encoding, Fitness Function, Reproduction operators, Genetic Modeling, Genetic operators, Cross over-Single site cross over, Two point cross over, Multi point cross over Uniform cross over, Matrix cross over, Cross over Rate, Inversion & Deletion, Mutation operator, Mutation, Mutation Rate, Bit-wise operators, Generational cycle, convergence of Genetic Algorithm.

Unit-V: Applications of AI Techniques

Load forecasting, Load flow studies, Economic load dispatch, Load frequency control, Single area system and two area system, Reactive power control, Speed control of DC and AC Motors.

Suggested Readings:

1. S. Rajasekaran and G.A.V. Pai Neural Networks, Fuzzy Logic & Genetic Algorithms, PHI, NewDelhi, 2003.
2. Rober J. Schalkoff, Artificial Neural Networks, Tata McGraw Hill Edition, 2011.

Reference Books:

1. P.D. Wasserman; Neural Computing Theory & Practice, Van Nostrand Reinhold, New York,1989.
2. Bart Kosko; Neural Network & Fuzzy System, Prentice Hall, 1992
3. D.E. Goldberg, Genetic Algorithms, Addison-Wesley 1999.

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B.Tech. in Electrical and Electronics Engineering
VIII Semester Syllabus
EE814PE: Smart Grid Technologies (PE-VI)

Prerequisites: Power Systems

Course Objectives

1. To group various aspects of the smart grid.
2. To defend smart grid design to meet the needs of a utility.
3. To select issues and challenges that remains to be solved.
4. To analyse basics of electricity, electricity generation, economics of supply and demand.
5. To know the various aspects of electricity market operations in both regulated and deregulated environment.

Course Outcomes

After completion of this course, the student will be able to

1. Understand the features of small grid in the context of Indian grid.
2. Understand the role of automation in transmission and distribution.
3. Apply evolutionary algorithms for smart grid.
4. Understand operation and maintenance of PMUs, PDCs and WAMs.
5. Understand the voltage and frequency control in micro grid.

Unit-I: Introduction to Smart Grid

Introduction to Smart Grid, Working definitions of Smart Grid and Associated Concepts, Smart grid Functions, Traditional Power Grid and Smart Grid, New Technologies for Smart Grid, Advantages, Indian Smart Grid, Key Challenges for Smart Grid.

Unit-II: Smart Grid Architecture

Components and Architecture of smart grid design, Review of the proposed architectures for Smart Grid, the fundamental components of Smart Grid designs, Transmission Automation, Distribution Automation, Renewable Integration.

Unit-III: Tools and Techniques for Smart Grid

Computational techniques, static and dynamic Optimization Techniques, Computational Intelligence Techniques, Evolutionary Algorithms, Artificial Intelligence techniques.

Unit-IV: Distribution Generation Technologies and Smart Grid

Introduction to Renewable Energy Technologies, Micro grids, Storage Technologies, Electric Vehicles and plug-in hybrids, Environmental impact and Climate Change, Economic Issues.

Communication Technologies and Smart Grid: Introduction to Communication Technology, Synchro-Phasor Measurement Units (PMUs), Wide Area Measurement Systems (WAMS).

Unit-V: Control of Smart Power Grid System

Load Frequency Control (LFC) in Micro Grid System, Voltage Control in Micro Grid System, Reactive Power Control in Smart Grid. Case studies and test beds forthe Smart Grids.

Suggested Readings:

1. Stuart Borlase, Smart Grids, Infrastructure, Technology and Solutions, CRC Press, 2013
2. Gil Masters, Renewable and Efficient Electric Power System, Wiley-IEEE Press, 2004.

Reference Books:

1. A.G. Phadke and J.S. Thorp, "Synchronized Phasor Measurements and their Applications",Springer Edition, 2010.
2. T. Ackermann, Wind Power in Power Systems, Hoboken, NJ, USA, John Wiley, 2005.

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B.Tech. in Electrical and Electronics Engineering
VIII Semester Syllabus
EE815PE: Electrical Distribution Systems (PE-VI)

Prerequisites: Power Systems – I, Power Systems – II and Switchgear & Protection

Course Objectives

1. To distinguish between transmission and distribution systems.
2. To understand design considerations of feeders.
3. To compute voltage drop and power loss in feeders.
4. To understand protection of distribution systems.
5. To examine the power factor improvement and voltage control.

Course Outcomes

After completion of this course, the student will be able to
1. Distinguish between transmission and distribution lines
2. Compute power loss and voltage drop of the feeders.
3. Design protection of distribution systems.
4. Understand the importance of power factor improvement.
5. Understand the voltage control methods.

UNIT – I: General Concepts and Distribution Feeders

General Concepts: Introduction to distribution system, Distribution system planning, Factors effecting the Distribution system planning, Load modelling and characteristics. Coincidence factor - contribution factor - Loss factor - Relationship between the load factor and loss factor. Load growth, Classification of loads (Residential, commercial, Agricultural and Industrial) and their characteristics.

Distribution Feeders: Design Considerations of Distribution Feeders: Radial, loop and network types of primary feeders, voltage levels, Factors effecting the feeder voltage level, feeder loading, basic design practice of the secondary distribution system, secondary banking, secondary network types, secondary mains.

UNIT – II: Substations and System Analysis

Substations: Location of Substations: Rating of distribution substation, service area with 'n' primary feeders. Benefits derived through optimal location of substations. Optimal location of Substations (Perpendicular bisector rule and X, Y co-ordinate method).

System Analysis: Voltage drop and power-loss calculations: Derivation for voltage drop and power loss in lines, manual methods of solution for radial networks, three phase balanced primary lines, analysis of non-three phase systems.

UNIT – III: Protection and Coordination

Protection: Objectives of distribution system protection, over current Protective Devices: Principle of operation of Fuses, Auto-Circuit Recloser - and Auto-line sectionalizes

Coordination: Coordination of Protective Devices: Objectives of protection co-ordination, general coordination procedure, Types of protection coordination: Fuse to Fuse, Auto-Recloser to Fuse, Circuit breaker to Fuse, Circuit breaker to Auto-Recloser.

UNIT - IV: Compensation for Power Factor Improvement

Different types of power capacitors, shunt and series capacitors, effect of shunt capacitors (Fixed and switched), effect of series capacitors, difference between shunt and series capacitors, Calculation of power factor correction, capacitor allocation - Economic justification of capacitors - Procedure to determine the best capacitor location.

UNIT – V: Voltage Control

Voltage Control: Importance of voltage control, methods of voltage control, Equipment for voltage control, effect of shunt capacitors, effect of series capacitors, effect of AVB/AVR on voltage control, line drop compensation, voltage fluctuations.

Suggested Readings:

1. Turan Gonen, Electric Power Distribution System Engineering, CRC Press, 3rd Edition 2014.
2. V. Kamaraju, Electrical Power Distribution Systems, Tata Mc Graw Hill Publishing Company, 2nd edition, 2010.

Reference Books:

1. G. Ram Murthy, Electrical Power Distribution handbook, 2nd edition, University press 2004.
2. A.S. Pabla, Electric Power Distribution, Tata McGraw Hill Publishing company, 6th edition, 2013.

Online Resources:

1. https://nptel.ac.in/courses/108107112

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B.Tech. in Electrical and Electronics Engineering
VIII Semester Syllabus
EE816PE: Utilization of Electrical Energy (PE-VI)

Prerequisites: Electrical Machines-I, Electrical Machines-II and Power Electronics

Course Objectives

1. To understand the fundamentals of illumination and good lighting practices.
2. To understand the methods of electric heating and welding.
3. To understand the concepts of electric drives and their applications.
4. To study the basic principles of Light control and types of lighting schemes.
5. To impart design of indoor and outdoor lighting.

Course Outcomes

After completion of this course, the student will be able to

1. Acquire knowledge on, electric drives characteristics and their applicability in industry based on the nature of different types of loads and their characteristics.
2. Understands the concepts and methods of electric heating, welding, illumination and electric traction.
3. Apply the above concepts to real-world electrical and electronics problems and applications.
4. Illustrate working principle of electric power utilization and their applications in real life.
5. Examine various applications in indoor and outdoor areas where use of light sources are essential.

Unit-I: Electric Drives

Type of electric drives, choice of motor, starting and running characteristics, speed control, temperature rise, particular applications of electric drives, types of industrial loads, continuous, intermittent and variable loads, load equalization.

Unit-II: Electric Heating and Electric Welding

Electric Heating: Electric heating, advantages, methods of electric heating, resistance heating, induction heating and dielectric heating. **Electric Welding:** Electric welding, resistance and arc welding, electric welding equipment, comparison between A.C. and D.C. Welding.

Unit-III: Illumination Systems

Illumination: Introduction, terms used in illumination, laws of illumination, polar curves, Photometry, integrating sphere, sources of light. **Various Illumination Methods:** Discharge lamps, MV and SV lamps, comparison between tungsten filament lamps and fluorescent tubes, Basic principles of light control, Types and design of lighting and flood lighting.

Unit-IV: Electric Traction - I

System of electric traction and track electrification. Review of existing electric traction systems in India, Special features of traction motor, methods of electric braking, plugging, rheostat braking and regenerative braking, Mechanics of train movement, Speed-time curves for different services, trapezoidal and quadrilateral speed time curves.

Unit-V: Electric Traction - II

Calculations of tractive effort, power, specific energy consumption for given run, effect of varying acceleration and braking retardation, adhesive weight and coefficient of adhesion.

Suggested Readings:

1. E. Openshaw Taylor, Utilisation of Electric Energy – by University press, 1961.
2. Partab, H., 'Art and Science of Utilisation of Electrical Energy', Dhanpat Rai and Sons, New Delhi, 1986.

Reference Books:

1. N. V. Suryanarayana, Utilization of Electrical Power including Electric drives and Electric traction, New Age International (P) Limited, Publishers, 1996.
2. C. L. Wadhwa, Generation, Distribution and Utilization of electrical Energy, New Age International (P) Limited, Publishers, 1997.
3. Tripathy, S.C., 'Electric Energy Utilisation and Conservation', Tata McGraw Hill Publishing Company Ltd. New Delhi, 1991.

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Open Elective offered by EEE Department
V Semester Syllabus
EE521OE: Electrical Engineering Materials (OE-I)

Prerequisites: Engineering Physics, Engineering Chemistry, Basic Electrical Engineering.

Course Objectives

1. To introduce the fundamental concepts of engineering materials, their properties and applications.
2. To understand the concept of dielectric materials.
3. To describe the various magnetic materials available.
4. To introduce the concept of semiconductor materials.
5. To understand materials used for electric applications.

Course Outcomes

After completion of this course, the student will be able to

1. Compare and contrast different materials used in the field of engineering.
2. Select the dielectric materials appropriate to the system and field of application.
3. Apply the knowledge of magnetic materials to engineering applications.
4. Understand the use of semiconductor materials.
5. Understand the introductory concepts of materials used in electric applications.

UNIT - I: Introduction to Engineering Materials

Historical perspective of materials, Classification of materials, Properties of materials - Physical, Mechanical, Electrical, Magnetic, and Chemical properties, Bases of materials, Selection of materials, Manufacturing processes

UNIT – II: Dielectric Materials

Dielectric as electric field medium, leakage currents, dielectric loss, dielectric strength breakdown voltage, electric conductivity in solids, liquids and gaseous dielectrics

UNIT- III: Magnetic Materials

Introduction, terms connected with magnetic materials, magnetic parameters, classification of magnetic materials – diamagnetic, paramagnetic and ferromagnetic materials, properties of ferromagnetic materials, magnetically soft materials, magnetically hard materials**,** B-H curves of soft and hard magnetic materials, Losses in magnetic materials, factors affecting permeability and hysteresis loss

UNIT - IV: Semiconductor Materials

Introduction to semiconductors, characteristics of semiconductors, atomic structure, intrinsic and extrinsic semiconductors, energy band diagrams, preparation of semiconductor materials,

production of p-type and n-type crystals, thermal conductivity of semiconductors, electrical characteristics of semiconductors

UNIT-V: Materials for Electric Applications

Conductor, general properties of conductors, specific resistance, factors affecting resistivity of electric materials, materials for lamp filaments, materials used for transmission lines, bimetals electrical contact materials

Suggested Readings:

1. R. K. Rajput, Electrical Engineering Materials, University Science / Laxmi Publications Press 2009.
2. C.S. Indulkar. S Thiruvengadam An Introduction To Electrical Engineering Materials, S Chand, 2006

Reference Books:

1. A. J. Dekker, Electrical engineering materials, PHI, 1970

Online Resources:

1. https://nptel.ac.in/courses/113102080
2. https://nptel.ac.in/courses/112108150

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Open Elective offered by EEE Department
V Semester Syllabus
EE522OE: Non - Conventional Power Generation (OE-I)

Prerequisites: None

Course Objectives

1. To introduce various types of renewable energy technologies.
2. To understand solar electric power generation and tracking.
3. To understand the wind energy conversion and the components of wind turbine.
4. To discuss the concepts of biomass energy conversion.
5. To understand the principles of OTEC and Fuel cells.

Course Outcomes

After completion of this course, the student will be able to

1. Analyze solar energy radiation and collection
2. Analyze solar thermal and photovoltaic systems and related technologies for energy conversion.
3. Understand Wind energy conversion and devices available for it.
4. Understand Biomass conversion technologies, Geo thermal resources and energy conversion principles and technologies.
5. To gain knowledge about power generation from oceans and fundamentals of fuel cells.

Unit-I: Introduction to Solar Energy and Thermal Conversion Systems

Solar Radiation on Earth's surface-Solar radiation geometry, solar radiation measurements, Solar radiation data, Solar radiation on horizontal and tilted surfaces, solar Thermal conversion, Flat plate collectors, concentrated collectors, solar applications - Solar ponds.

Unit-II: Solar Electric power Generation

Solar-Electric Power generation, Photovoltaic cells, Equivalent circuit, V-I Characteristics, Photovoltaic modules, constructional details, design considerations, Tracking, Solar Thermo electric conversion.

Unit-III: Harnessing Wind Energy

Wind Energy, Fundamentals of wind energy-power available in wind, Betz Limit, Aerodynamics of wind turbine, Wind turbines, Horizontal and vertical axis turbines, their configurations, Wind Energy conversion systems.

Unit-IV: Biomass

Energy from Bio Mass, Various fuels, Sources-Conversion technologies, Wet Processes, Dry Processes, Bio Gas generation, Aerobic and anaerobic digestion, Factors affecting generation of bio gas, Classification of bio gas plants, Different Indian digesters, Digester design

considerations, Gasification process, Gasifiers, Applications. Geothermal Energy, sources.

Unit-V: Ocean Energy and Fuel Cells

OTEC Systems, Principle of operation, Open and closed cycles, Energy from Tides, Principle of Tidal Power, Components of tidal Power plants, Operation Methods, Estimation of Energy in Single and double basin systems, Energy and Power from Waves, Wave energy conversion devices, Fuel Cells, Design and Principle of operation, Types of Fuel Cells, Advantages and disadvantages, Types of Electrodes, Applications.

Suggested Readings:

1. John Twidell & Wier, "Renewable Energy Resources", CRC Press, 2009.
2. G. D. Rai, "Non-Conventional Energy sources", Khanna publishers, 2004

Reference Books:

1. D. P .Kothari, Singal, Rakesh and Ranjan, "Renewable Energy sources and Emerging Technologies", PHI, 2009.
2. F. C. Treble, Generating Electricity from Sun, Pergamon Press, 1st Edition 1991
3. C. S. Solanki, "Solar Photovoltaics - Fundamentals- Principles and Applications", PHI, 2009
4. S. P. Sukhatme, "Solar Energy Principles and Application", TMH, 2009.

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Open Elective offered by EEE Department
VI Semester Syllabus
EE621OE: Energy Conservation and Green Building (OE-II)

Prerequisites: Fundamentals of Electrical Energy and Electrical Power

Course Objectives

1. To understand different forms and types of energy sources
2. To understand the concept of environmental audit and energy audit
3. To understand the significance of energy efficiency and need for conservation
4. To understand the basic concepts of green buildings
5. To understand the various rating systems of green buildings

Course Outcomes

After completion of this course, the student will be able to

1. Can differentiate between renewable and non- renewable energy sources
2. Will be familiar with the concepts of environmental audit and energy audit
3. Can understand the need for energy efficiency and conservation
4. Will get awareness on the concept of green buildings and its advantages
5. Get acquainted with the various rating systems of green buildings

UNIT-I: Energy - Renewable & Non-Renewable

Renewable Energy sources – Solar, wind Ocean, Hydro, Biomass
Non-Renewable Energy sources – Coal, Petroleum, Natural Gas, Nuclear Energy, Chemical sources, Hydrogen fuel cells.

UNIT-II: Environmental Audit & Energy Audit

Environmental Audit – Meaning, necessity, norms. Types - Liabilities audit, Management audit, Activities audit, Energy Audit – Definition, need & Types of energy audit, Energy management approach – understanding energy costs.

UNIT III: Energy Efficiency & Conservation

Growing need for energy, need for energy efficiency & Conservation, Energy Efficiency, Bureau of Energy Efficiency (BEE) Ratings, Leadership in Energy & Environmental Design (LEED) ratings, functions of Government Organizations working for Energy conservation & Audit.

UNIT-IV: Green Building

Definition, Benefits, Principles of Green buildings, Salient features of Green buildings, planning concepts for green buildings – Maximize comfort, day lighting, ventilation, materials.

UNIT-V: Rating Systems for Green Building

Indian Green Building Council (IGBC) ratings, Green Rating for Integrated Habit Assessment (GRIHA), HVAC in Green Buildings, Comparison of different Rating systems.

Suggested Readings:

1. Dr. Dinesh Kumar Gupta, Vaibhao K Sonarkar : Energy Conservation and Green Buildings, Nirali Prakashan 1st Edition, 2019, ISBN : 9789389108316
2. Michael Montoya - Green Building Fundamentals: A Practical Guide to Understanding and Applying Fundamental Sustainalbe Construction Practice and the Leed Green Building Rating System, Prentice Hall, 1st Edition

Reference Books:

1. Matilda Schmidt - Green Building and Energy Efficiency, Syrawood Publishing House
2. IGBC Green Homes Rating Systems – Version 3.0
3. A Handbook of energy efficiency in buildings – A life cycle approach, Elseiver
4. Energy Conservation Building Code 2017 – Bureau of Energy Efficiency Publications

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Open Elective offered by EEE Department
VI Semester Syllabus
EE622OE: Conventional Power Generation (OE-II)

Prerequisites: Fundamental Physics and Elementary Chemistry

Course Objectives

1. To understand the Operation of Hydro Power stations.
2. To know the working of Thermal Power stations.
3. To understand the Operation of Nuclear Power stations.
4. To know the working of Gas Power stations.
5. To illustrate the economic aspects of power generation.

Course Outcomes

After completion of this course, the student will be able to

1. Draw the layout of hydro power plant, and explain the various components used.
2. Draw the layout of steam power plant, and explain various equipment used in the plant.
3. Draw the layout of nuclear power plant, and explain the operation of nuclear reactor.
4. Draw the layout of gas power plant, and explain its operation.
5. Illustrate various economic aspects of the power plant erection, operation.

Unit-I: Hydroelectric Power Stations

Introduction, Elements of hydro electric power station-types-concept of pumped storage plants-storage requirements, estimation of power developed from a given catchment area; heads and efficiencies.

Unit-II: Thermal Power Stations

Introduction, Line diagram of Thermal Power Station (TPS) showing paths of coal, steam, water, air, ash and flue gasses, Brief description of TPS components: Economizers, Boilers, Super heaters, Turbines, Condensers, Chimney and cooling towers

Unit-III: Nuclear Power Stations

Introduction, Nuclear Fission and Chain reaction, nuclear fuels, Principle of operation of Nuclear reactor, Reactor Components: Moderators, Control rods, Reflectors and Coolants.

Unit-IV: Gas Power Stations

Introduction, Principle of Operation and Components (Block Diagram Approach Only), Advantages of Gas power plants, Disadvantages of gas power plants, Comparison of different power plants

Unit-V: Economic Aspects of Power Generation

Importance of Economic Aspects of Power Generation, Load curve, load duration and integrated load duration curves-load, demand, diversity, capacity, utilization and plant use factors- Numerical Problems.

Suggested Readings:

1. J. B. Gupta, A Course in Power Systems, S.K. Kataria & Sons Publishers, 2013
2. C. L. Wadhawa, Generation and utilization of Electrical Energy, New age International (P) Limited, Publishers 1997.
3. V.K Mehta and Rohit Mehta, Principles of Power Systems, S. Chand& Company Ltd, New Delhi, 2004.

Reference Books:

1. M.V. Deshpande, Elements of Power Station design and practice , Wheeler Publishing, 3rd Edition 1999.
2. S. N. Singh, Electrical Power Generation, Transmission and Distribution, PHI, 2003.

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Open Elective offered by EEE Department
VII Semester Syllabus
EE721OE: Energy Storage Systems (OE-III)

Prerequisites: Electro chemistry

Course Objectives

1. To understand the basics of electrical systems and energy storage.
2. To enable the student to understand the need for energy storage devices.
3. To enable the student to understand the classifications of ESS.
4. To understand different types of ESS.
5. To enable the student to understand various technologies available and their applications.

Course Outcomes

After completion of this course, the student will be able to

1. Analyze the characteristics of energy from various sources.
2. Analyze the need for storage of energy.
3. Classify various types of energy storage and various devices used for the purpose.
4. Identify different types of ESS.
5. Identify various real time applications.

Unit-I: Basics of Electrical Systems and Energy Storage

Characteristics of electricity, Electricity and the roles of EES, High generation cost during peak-demand periods, Need for continuous and flexible supply, Long distance between generation and consumption, Congestion in power grids, Transmission by cable.

Unit-II: Need for Electrical Energy Storage

Emerging needs for EES, More renewable energy, less fossil fuel, Smart Grid uses, The roles of electrical energy storage technologies, The roles from the viewpoint of a utility, The roles from the viewpoint of consumers, The roles from the viewpoint of generators of renewable energy.

Unit-III: Classification of Energy Storage Systems

Classification of EES systems , Mechanical storage systems, Pumped hydro storage (PHS), Compressed air energy storage (CAES), Flywheel energy storage (FES), Electrochemical storage systems, Secondary batteries, Flow batteries, Chemical energy storage, Hydrogen (H2), Synthetic natural gas (SNG).

Unit-IV: Types of Electrical Energy Storage systems

Electrical storage systems, Double-layer capacitors (DLC), Superconducting magnetic energy storage (SMES), Thermal storage systems, Standards for EES, Technical comparison of EES technologies.

Unit-V: Applications of Energy Storage Systems

Present status of applications, Utility use (conventional power generation, grid operation & service), Consumer use (uninterruptable power supply for large consumers), New trends in applications, Renewable energy generation, Smart Grid, Smart Micro grid, Smart House, Electric vehicles, Management and control hierarchy of storage systems, Internal configuration of battery storage systems, External connection of EES systems , Aggregating EES systems and distributed generation (Virtual Power Plant), Battery SCADA - aggregation of many dispersed batteries.

Suggested Readings:

1. The Electrical Energy Storage by IEC Market Strategy Board.
2. James M. Eyer, Joseph J. Iannucci and Garth P. Corey, "Energy Storage Benefits and Market Analysis", Sandia National Laboratories, 2004.

Reference Books:

1. Jim Eyer, Garth Corey, Energy Storage for the Electricity Grid: Benefits and Market Potential Assessment Guide, Report, Sandia National Laboratories, Feb 2010.

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Open Elective offered by EEE Department
VII Semester Syllabus
EE722OE: Electrical Systems and Safety (OE-III)

Prerequisites: Basic Electrical Engineering and Engineering Physics

Course Objectives

1. To understand the electrical wiring systems.
2. To Understand the Electrical safety.
3. To understand the types of Substations.
4. To understand Electrical billing and tariff.
5. To understand the concepts of Illumination schemes.

Course Outcomes

After Completion of this course, the student will be able to

1. Know about the wiring systems and accessories.
2. Know about the Electrical Safety Measures.
3. Get acquainted with different types of Substations.
4. Know about the Electrical billing and different types of tariff.
5. Get familiarised with different Illumination schemes.

Unit-I: Electrical Wiring Systems

Types of wires, specifications, types of wiring systems, selection of wire, wiring accessories and protective devices, IE rules for domestic and industrial wiring, types of electrical distribution systems – Radial, Ring / Loop and Interconnected Distributed System, Introduction to UG cables, Types of UG cables and construction of UG cables.

Unit-II: Electrical Safety

Electricity, its usefulness and Hazards, statutory provisions, Indian standards, effects of electrical parameters on human body, safety measures for electric shock, purpose of Earthing, Types of Earthing.

UNIT-III: Substations

Introduction, types of Substations, Line diagram of substation, outdoor substation - pole mounted type, Description of components, Indoor substation - floor mounted type, Description of components.

Unit-IV: Electrical Billing and Tariff

Desirable characteristics of tariff, Objectives of tariff, types of tariff - flat rate, block rate, two part tariff, three part tariff and Power Factor tariff.

Unit-V: Illumination

Introduction, terminology in Illumination, laws of Illumination, various types of light sources, practical lighting schemes.

Suggested Readings:

1. J.B.Gupta, “A course in Electrical Technology”, S.K. Kataria & Sons, 2012
2. V.K.Mehta, Rohit Mehta, “Principles of Power System”, S.Chand Publisher, 3rd edition March 2005
3. Dr.S.L.Uppal and G.C. Garg, “Electrical Wiring Estimating and Costing”, Khanna Publishers.

Reference Books:

1. Dr.Sanjeev Singh, Umesh Rathore, “Energy management”, Second Edition, S.K.Kataria and Sons, 2014.
2. S.Sivanagaraju, M.Balasubba Reddy, D.Srilatha, “Generation and Utilisation of Electrical Energy”, Pearson publishers, 2010