NATIONAL ENGINEERING COLLEGE

(An Autonomous Institution – Affiliated to Anna University Chennai)

K.R.NAGAR, KOVILPATTI – 628 503

www.nec.edu.in

REGULATIONS - 2019

DEPARTMENT OF

ELECTRICAL AND ELECTRONICS ENGINEERING

CURRICULUM AND SYLLABI OF

M.E. – HIGH VOLTAGE ENGINEERING

SEMESTER – I

S. No.	Course Category	Course Code	Course Title	L	T	P	C	QP
THEORY								
1	SFC	19HE11C	Mathematical Foundations of High Voltage Engineering	3	0	0	3	A
2	PCC	19HE12C	High Voltage Engineering and its Application	3	0	0	3	A
3	PCC	19HE13C	Research Methodology and IPR	2	0	0	2	B
4	PEC		Elective – I	3	0	0	3	A
5	PEC		Elective – II	3	0	0	3	A
6.	AC		Audit Course - I	2	0	0	0	D
PRACTICAL								
7	PCC	19HE14C	High Voltage Laboratory – I	0	0	4	2	-
8	PEC		Elective - I Laboratory	0	0	4	2	-
			TOTAL	**16**	**0**	**8**	**18**	

SEMESTER – II

S. No.	Course Category	Course Code	Course Title	L	T	P	C	QP
THEORY								
1	PCC	19HE21C	Insulation Technology	3	0	0	3	A
2	PCC	19HE22C	High Voltage Testing Techniques	3	0	0	3	A
3	PEC		Elective – III	3	0	0	3	A
4	PEC		Elective – IV	3	0	0	3	A
5	AC		Audit Course – II	2	0	0	0	D
PRACTICAL								
6	PCC	19HE23C	High Voltage Laboratory - II	0	0	4	2	-
7	PCC	19HE24C	Mini project with Seminar	0	0	4	2	
8	PEC		Elective – II Laboratory	0	0	4	2	-
			TOTAL	**14**	**0**	**12**	**18**	

SEMESTER – III

S. No.	Course Category	Course Code	Course Title	L	T	P	C	QP
THEORY COURSES								
1	PEC		Elective – V	3	0	0	3	A
2	OEC		Elective – VI (Open Elective)	3	0	0	3	A
3	PEC		Elective – VII	3	0	0	3	A
PRACTICAL								
4	PCC	19HE31C	Project Work - I	0	0	20	10	-
TOTAL				**9**	**0**	**20**	**19**	**-**

SEMESTER – IV

S. No.	Course Category	Course Code	Course Title	L	T	P	C	QP
PRACTICAL								
1	PCC	19HE41C	Project Work – II	0	0	32	16	-
TOTAL				**0**	**0**	**32**	**16**	**-**

TOTAL CREDITS : 71

ELECTIVE COURSES

S. No	Course Code	COURSE TITLE	L	T	P	C	QP
1.	19HE01E	Field Computation and Modeling of Electrical Apparatus	3	0	0	3	A
2.	19HE02E	Advanced Electromagnetic Field	3	0	0	3	A
3.	19HE03E	High Voltage Equipments	3	0	0	3	A
4.	19HE04E	Design of Insulation for High Voltage Apparatus	3	0	0	3	A
5.	19HE05E	EHV AC Power Transmission	3	0	0	3	A
6.	19HE06E	Advanced Topics in High Voltage Engineering	3	0	0	3	A
7.	19HE07E	Pollution Performance of Power Apparatus and Systems	3	0	0	3	A
8.	19HE08E	Condition Monitoring of High Voltage Power Apparatus	3	0	0	3	A
9.	19HE09E	Electrical Transients in Power System	3	0	0	3	A
10.	19HE10E	High Voltage Protection and Switchgear	3	0	0	3	A

11.	19HE11E	Electromagnetic Interference and Electromagnetic Compatibility	3	0	0	3	A
12.	19HE12E	Pulse Power Engineering	3	0	0	3	A
13.	19HE13E	High Voltage DC Transmission	3	0	0	3	A
14.	19HE14E	Flexible AC Transmission Systems	3	0	0	3	A
15.	19HE15E	Power Quality	3	0	0	3	A
16.	19HE16E	Restructured Power Systems	3	0	0	3	A
17.	19HE17E	Power System Planning and Reliability	3	0	0	3	A
18.	19HE18E	Smart Grid	3	0	0	3	A
19.	19HE19E	Power Electronics in Power Systems	3	0	0	3	A
20.	19HE20E	Control of Electric Drives	3	0	0	3	A
21.	19HE21E	Advanced Electrical Drives	3	0	0	3	A
22.	19HE22E	Soft Computing Techniques	3	0	0	3	A
23.	19HE23E	Evolutionary Computing	3	0	0	3	A
24.	19HE24E	Optimization Techniques	3	0	0	3	A
25.	19HE25E	Energy management	3	0	0	3	A
26.	19HE26E	Nano Technology	3	0	0	3	A
27.	19HE27E	Optimal control and Filtering	3	0	0	3	A
28.	19HE28E	Digital Control System	3	0	0	3	A
29.	19HE29E	Robotics and Industrial Automation	3	0	0	3	A
30.	19HE30E	Field Computation Laboratory	0	0	4	2	-
31.	19HE31E	Power System Simulation Laboratory	0	0	4	2	-
32.	19HE32E	Protection and Switchgear Laboratory	0	0	4	2	-
33.	19HE33E	Soft computing Laboratory	0	0	4	2	-
34.	19GD01E	Business Analytics	3	0	0	3	A
35.	19GD02E	Industrial Safety	3	0	0	3	A
36.	19GD03E	Operations Research	3	0	0	3	A
37.	19GD04E	Cost Management of Engineering Projects	3	0	0	3	A
38.	19GD05E	Composite Materials	3	0	0	3	A
39.	19GD06E	Waste to Energy	3	0	0	3	A

AUDIT COURSES 1 & 2

S. No	Course Category	Course Code	COURSE TITLE	L	T	P	C	QP
1.	AC	19AC01E	English for Research Paper Writing	2	0	0	0	D
2.	AC	19AC02E	Disaster Management	2	0	0	0	D
3.	AC	19AC03E	Sanskrit for Technical Knowledge	2	0	0	0	D
4.	AC	19AC04E	Value Education	2	0	0	0	D
5.	AC	19AC05E	Constitution of India	2	0	0	0	D
6.	AC	19AC06E	Pedagogy Studies	2	0	0	0	D
7.	AC	19AC07E	Stress Management by Yoga	2	0	0	0	D
8.	AC	19AC08E	Personality Development through Life Enlightenment Skills	2	0	0	0	D

19HE11C MATHEMATICAL FOUNDATIONS OF HIGH VOLTAGE ENGINEERING **LT P C QP 3 0 0 3 A**

COURSE OUTCOMES

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

CO1: learn the concepts of matrix theory. (K1)

CO2: understand simplex method, two phase method and graphical solution in linear programming. (K2)

CO3: learn moment generating functions and one dimensional random variables. (K1)

CO4: understand queueing models and computation methods in engineering. (K2)

CO5: apply appropriate mathematical transform techniques in signal processing and wavelet. (K3)

UNIT I ADVANCED MATRIX THEORY **9**

Eigen-values using QR transformations – Generalized eigen vectors – Canonical forms – Singular value decomposition and applications – Pseudo inverse – Least square approximations.

UNIT II LINEAR PROGRAMMING **9**

Formulation – Graphical Solution – Simplex Method – Two Phase Method – Transportation and Assignment Problems.

UNIT III ONE DIMENSIONAL RANDOM VARIABLES **9**

Random variables - Probability function – moments – moment generating functions and their properties – Binomial, Poisson, Geometric, Uniform, Exponential, Gamma and Normal distributions.

UNIT IV QUEUEING MODELS **9**

Poisson Process – Markovian queues – Single and Multi Server Models – Little's formula – Machine Interference Model – Steady State analysis – Self Service queue.

UNIT V COMPUTATIONAL METHODS IN ENGINEERING **9**

Boundary value problems for ODE – Finite difference methods – Numerical solution of PDE – Solution of Laplace and Poisson equations – Liebmann's iteration process – Solution of heat conduction equation by Schmidt explicit formula and Crank - Nicolson implicit scheme – Solution of wave equation.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Bronson,R., "Matrix Operation, Schaum's outline series", McGraw Hill, New York, 1989.
2. Taha, H. A., "Operations Research: An Introduction", 7th Edition, Pearson Education Edition, Asia, New Delhi, 2002.
3. R. E. Walpole, R. H. Myers, S. L. Myers, and K. Ye, "Probability and Statistics for Engineers & Scientists", 8th Edition, Asia, 2007.
4. Donald Gross and Carl M. Harris, "Fundamentals of Queueing theory", 2nd Edition, John Wiley and Sons, New York 1985.
5. Grewal, B.S., "Numerical methods in Engineering and Science", 7th Edition, Khanna Publishers, 2000.

19HE12C HIGH VOLTAGE ENGINEERING AND ITS APPLICATION L T P C QP
3 0 0 3 A

COURSE OUTCOMES

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

CO 1: Summarize the basics of high voltage and insulation engineering. (K2)
CO 2: explain the generation methods of HVAC, HVDC, Impulse voltage and Current. (K2)
CO 3: describe the measurement techniques of HVAC, HVDC, impulse voltages and currents. (K2)
CO 4: explain the breakdown phenomena of various dielectric medium. (K2)
CO 5: outline the application areas of high voltage engineering. (K2)

UNIT I INTRODUCTION 9

Need for generating high voltages – Role of the insulation in power apparatus and systems – Essential properties of dielectrics – Insulating materials commonly used in power system equipment – Principles of insulation coordination – Electric fields – Need for generating high voltages in laboratory.

UNIT II GENERATION OF HIGH VOLTAGE AND CURRENTS 9

Generation of high direct current voltages – Generation of high alternating voltages – Generation of impulse voltages – Generation of impulse currents – Tripping and control of impulse generators.

UNIT III MEASUREMENTS OF HIGH VOLTAGE AND CURRENTS 9

Measurement of high direct current voltages – Measurement of high alternating voltages – Measurement of high impulse voltages – Measurement of high direct currents – Measurement of high alternating and Impulse currents – Oscilloscope measurements for high voltages and currents.

UNIT VI BREAKDOWN MECHANISMS IN SOLID, GAS AND LIQUID DIELECTRICS 9

Behavior of gaseous dielectrics in electric fields – Townsend's theory and Streamer theory – Paschen's law – Breakdown in vacuum insulation – Conduction and breakdown in pure and commercial liquid – Breakdown Mechanisms of Solid and Composite Dielectrics.

UNIT V APPLICATIONS OF HIGH VOLTAGE ENGINEERING 9

Lightning Protection – Pulsed Power Technology – Light Technology and Laser Technology – X-ray Technology – Electrostatic Particle Precipitation.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Andreas Küchler, "High Voltage Engineering: Fundamentals – Technology – Applications", 5th Edition, Springer Vieweg, 2018.
2. Naidu. M.S, and Kamaraju. V, "High Voltage Engineering", 5th Edition, Tata McGraw Hill Private Limited, 2013.
3. Kuffel. E, Zaengl. W.S and Kuffel. J, "High Voltage Engineering: Fundamentals", 2nd Edition, Elsevier, 2000.
4. Alston. L. L, "High Voltage Technology", 1st Indian Edition, Oxford University Press, New Delhi, 2006

19HE13C RESEARCH METHODOLOGY AND IPR L T P C QP
2 0 0 2 B

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Understand research problem formulation. (K2)
CO2: Analyze research related information. (K4)
CO3: Understand the research ethics. (K2)
CO4: Understanding that when IPR would take such important place in growth of individuals & Nation. (K2)
CO5: Recognize the importance of Report writing. (K2)

UNIT I RESEARCH FORMULATION AND DESIGN 6

Defining and formulating the research problem, selecting the problem, necessity of defining the problem, importance of literature review in defining a problem, literature review - primary and secondary sources, reviews, monograph, patents, research databases, web as a source, searching the web, critical literature review, identifying gap areas from literature and research database, development of working hypothesis.

UNIT II DATA COLLECTION AND ANALYSIS 6

Method validation, observation and collection of data, methods of data collection, sampling methods, data processing and analysis strategies and tools, data analysis with statistical package (Sigma STAT,SPSS for student t-test, ANOVA, etc.), hypothesis testing.

UNIT III RESEARCH ETHICS, IPR AND SCHOLARY PUBLISHING 6

Ethics - ethical issues, ethical committees (human & animal); IPR- intellectual property rights and patent law, commercialization, copy right, royalty, trade related aspects of intellectual Property rights (TRIPS); scholarly publishing - IMRAD concept and design of research paper, citation and acknowledgement, plagiarism, reproducibility and accountability.

UNIT IV CONTEMPORARY ISSUES IN IPR 6

Interface between IPR and Human Rights -Interface between IPR and Competition Law -IPR and sustainable development – Impact of Internet on IPR - IPR of Biological systems & E-Commerce.

UNIT V INTERPRETATION AND REPORT WRITING 6

Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.

L: 30; TOTAL: 30 PERIODS

REFERENCES

1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., “An introduction to Research Methodology”, RBSA Publishers, 2015.
2. Kothari, C.R., “Research Methodology: Methods and Techniques”, New Age International, 2018.
3. Wadehra, B.L. “Law relating to patents, trademarks, copyright designs and geographical indications”. Universal Law Publishing, Reprint, 2011.
4. Anthony, M., Graziano, A.M. and Raulin, M.L.. Research Methods: A Process of Inquiry, Allyn and Bacon 2012.
5. Carlos, C.M., Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York, 2000.

19HE14C HIGH VOLTAGE LABORATORY - I L T P C
0 0 4 2

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: demonstrate the generation methods of high AC, DC and impulse voltages. (K2)

CO 2: interpret the dielectric characteristics of air and liquid mediums. (K2)

CO 3: estimate the resistivity of soil under dry and wet conditions. (K2)

LIST OF EXPERIMENTS

1. Study of Insulations used in High Voltage Equipments
2. Generation of High AC Voltage and of High DC Voltage
3. Generation of Impulse Voltage with various gap spacing and Positive and Negative Polarity
4. Simulation of Lightning and Switching Impulse
5. Measurement of breakdown strength of air medium with high AC and DC voltage under uniform and non uniform field
6. Study of Different Discharge Phenomenon in air
7. Measurement of breakdown strength of solid dielectric medium
8. Measurement breakdown strength of liquid dielectric medium
9. Temperature Effects on Breakdown Strength of liquid dielectric medium
10. Measurement of soil resistivity

P : 60; TOTAL : 60 PERIODS

19HE21C INSULATION TECHNOLOGY L T P C QP
3 0 0 3 A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: summarize the general properties of dielectric materials (K2)
CO 2 : dissect the different breakdown mechanism in gaseous dielectrics (K2)
CO 3: perceive the various breakdown mechanisms in solid dielectrics (K2)
CO 4: appraise the conduction and breakdown mechanism in liquid dielectrics (K2)
CO 5 : select the different dielectric materials in electrical equipments applications (K2)

UNIT I INTRODUCTION 9

Properties of dielectric material – Electric stress and electric strength – Estimation and control of electric stress – Brief overview of breakdown mechanisms – Polarisation mechanism – Dependence of permittivity on temperature, pressure, humidity and voltage – Permittivity of mixtures – Practical importance of permittivity.

UNIT II BREAKDOWN IN GASES AND VACCUM 9

Basic ionization process – Townsend current growth equations – Townsend criterion for spark breakdown – Streamer mechanisms –– Paschen's law – Breakdown in non-uniform fields – Vacuum: Pre-breakdown conduction – Factors affecting the breakdown voltage.

UNIT III BREAKDOWN IN SOLIDS 9

Intrinsic breakdown – Electromechanical breakdown – Thermal breakdown – Chemical and electrochemical deterioration – Breakdown due to tracking and treeing – Partial discharges.

UNIT IV ELECTRICAL CONDUCTION AND BREAKDOWN IN LIQUIDS 9

Pure liquids and commercial liquids – Purification – Natural conduction – Induced conduction – Process of conduction – Breakdown phenomena and electric strength of pure liquids – Breakdown of commercial liquids.

UNIT V APPLICATION OF DIELECTRIC MATERIALS 9

Classification based on insulating materials and application – Application of insulating materials in transformers, rotating machines, circuit breakers, cables, power capacitors and bushings.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Adrinaus, Dekker J., "Electrical Engineering Materials", Prentice Hall of India Pvt. Ltd., New Delhi, 1979.
2. Alston L.L, "High Voltage Technology", Oxford University Press, London, 1968 (B.S.Publications, First Indian Edition 2006).
3. Kuffel E., Zaengl W.S. and Kuffel J., "High Voltage Engineering Fundamentals", Elsvier India Pvt. Ltd, 2008.
4. Dieter Kind and Hermann Karner, "High Voltage Insulation Technology", (Translated from German by NarayanaRao Y., Friedr. Vieweg&Sohn, Braunschweig), 1985.
5. Naidu M.S. and Kamaraju V., "High Voltage Engineering", Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2013.
6. Ushakov V.Y., "Insulation of High Voltage Equipment", Springer, ISBN.3-540- 20729- 5, 2004.

19HE22C HIGH VOLTAGE TESTING TECHNIQUES L T P C QP
3 0 0 3 A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: explain different types of testing and measurement techniques. (K2)
CO 2: describe pre-testing procedures by statistical evaluation methods (K3)
CO 3: discuss the tests and the procedures for various high voltage power apparatus as per Indian and international standards. (K2)
CO 4: explain non-destructive insulation test techniques (K2)
CO 5: describe artificial pollution test and design a high voltage laboratory with fencing, earthing and shielding (K3)

UNIT I INTRODUCTION 9

Objectives of high voltage testing - classification of testing methods- self restoration and non-self restoration systems-standards and specifications, measurement techniques, Diagnostic testing, online measurement.

UNIT II STATISTICAL EVALUTION OF MEASURED RESULTS 9

Determination of probability values, Distribution function of a measured quantity, confidence limits of the mean values of disruptive discharges - 'Up and Down' method for determining the 50% disruptive discharge voltage - multi stress ageing - life data analysis

UNIT III TESTING TECHNIQUES FOR ELECTRICAL EQUIPMENT 9

Testing of insulators, bushings, surge arresters, power transformer: influences and correction of ambient conditions - testing methodology (various type tests, sample tests, routine tests to be conducted on insulators, bushings and surge arresters, transformer) - recording of oscillograms - interpretation of test results.

UNIT IV NON-DESTRUCTIVE INSULATION TEST TECHNIQUES 9

Dynamic properties of dielectrics-dielectric loss and capacitance measurement-partial discharge measurements-basic partial discharge (PD) circuit – PD currents- PD quantities -Digital PD instruments and measurements, acoustic emission technique and UHF Techniques for PD identification, Corona and RIV measurements on line hardware.

UNIT V POLLUTION TESTS AND DESIGN OF HIGH VOLTAGE LAB 9

Artificial Pollution tests- salt-fog method, solid layer method, Dimensions of High voltage laboratory, equipment- fencing, earthing and shielding, circuits for high voltage experiments.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Dieter Kind, Kurt Feser, "High voltage test techniques", SBA Electrical Engineering Series, New Delhi,1999.
2. Naidu M.S. and Kamaraju V., "High voltage Engineering", Tata McGraw Hill Publishing Company Ltd., New Delhi, 2004.
3. Kuffel, E., Zaengl, W.S. and Kuffel J., "High Voltage Engineering Fundamentals", Elsvier India P Ltd, 2005
4. Gallagher, T.J., and Pearmain A., "High Voltage Measurements, Testing and Design", John Willey & Sons, New York, 1983.
5. IS, IEC and IEEE standards for "Dielectric Testing of High Voltage Apparatus"
6. W.Kennedy, "Recommended Dielectric Tests and Test Procedures for Converter Transformer and Smoothing Reactors", IEEE Transactions on Power Delivery, Vol.1, No.3, pp 161-166, 1986.

19HE23C **HIGH VOLTAGE LABORATORY – II** **L T P C**
0 0 4 2

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: infer the conditions of different insulating material using various non-destructive test techniques. (K2)

CO 2: interpret the quality of high voltage insulators and cables. (K2)

CO 3: evaluate the performance of liquid dielectric medium. (K2)

LIST OF EXPERIMENTS

1. Measurement of Partial Discharge in dielectric using Partial Discharge Meter
2. Measurement of Capacitance and Loss tangent of dielectric medium
3. Determination of AC flash over voltage of a Pin Type Insulator and Disc Insulator
4. Determination of 50% critical impulse flash over voltages on 11 kV insulator with Positive and Negative Polarity
5. Power frequency testing on Cables
6. Determination of Flash point and Fire Point of Liquid Dielectric Medium
7. Determination of Viscosity of Liquid Dielectric Medium
8. Determination of Pour Point of Liquid Dielectric Medium
9. Determination of Moisture Content of Liquid Dielectric Medium
10. Measurement of harmonics with harmonic analyzer

P: 60; TOTAL: 60 PERIODS

19HE24C **MINI PROJECT WITH SEMINAR** **L T P C**
0 0 4 2

During the seminar session, each student is expected to prepare and present a topic on High voltage Engineering / technology, for duration of about 15 to 20 minutes. Each student is expected to present atleast twice during the semester and the student is evaluated based on the presentation skill, concept and Query clarification. At the end of the semester, he / she can submit a report on his / her topic of seminar and marks are given based on the report. A Faculty is to be allotted and he / she will guide and monitor the progress of the student and maintain the attendance also. The seminar will be assessed by a committee appointed by the COE.

P: 60; TOTAL: 60 PERIODS

19HE01E FIELD COMPUTATION AND MODELING OF ELECTRICAL APPARATUS

L	T	P	C	QP
3	0	0	3	A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: recall the basic concepts in electric and magnetic fields. (K2)
CO 2: choose the new techniques to find the solutions of electro static boundary value problems. (K2)
CO 3: improve the new techniques to achieve the accurate results. (K2)
CO 4: determine and find the various parameters of field configurations. (K2)
CO 5: model the various electrical apparatus. (K2)

UNIT I ELECTRIC & MAGNETIC FIELD – INTRODUCTION 9

Electric field –Coulomb s law – Gauss Law –Electric Dipole - Electric fields in material space – Polarization – Magnetic field – Amperes Law – Faradays Law – Maxwell's equation

UNIT II SOLUTIONS OF FIELD EQUATIONS – ANALYTICAL METHODS 9

Limitations of the conventional design procedure need for the field analysis based design - Problem definition and solution by analytical methods - Direct integration method – Method of images

UNIT III SOLUTIONS OF FIELD EQUATIONS – NUMERICAL METHODS 9

Field Plotting Finite element method (FEM) – finite Difference method – Moment method

UNIT IV FIELD COMPUTATION FOR BASIC CONFIGURATIO 9

Computation of electric and magnetic field intensities – Capacitance and Inductance – Force, Torque, and Energy for basic configurations.

UNIT V DESIGN APPLICATIONS 9

Insulators- Bushings – Cylindrical magnetic actuators – Transformers – Rotating machines.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Mathew Sadiku,"Elements of Electromagnetics", Oxford University Press, 6th Edition, 2015
2. Nathan Ida, Joao P.A.Bastos, "Electromagnetics and calculation of fields", Springer Verlage, Second Edition, 2002.
3. Nicola Biyanchi, "Electrical Machine analysis using Finite Elements", Taylor and Francis Group, CRC Publishers, 2005.
4. S.J Salon, "Finite Element Analysis of Electrical Machines." Kluwer Academic Publishers, London, 1995 (distributed by TBH Publishers & Distributors, Chennai, India).
5. User manuals of MAGNET, MAXWELL & ANSYS software.
6. Silvester and Ferrari, "Finite Elements for Electrical Engineers" Cambridge University press, Third Edition, 1996.
7. William Hayt, "Engineering Electromagnetics" Tata McGraw-Hill Edition, 2012.

19HE02E ADVANCED ELECTROMAGNETIC FIELDS **L T P C QP**
3 0 0 3 A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: explain the basic concepts in electrostatics. (K2)
CO 2: illustrate the concepts of electric fields and space charge free fields. (K2)
CO 3: distinguish the different techniques for analyzing the electric fields. (K2)
CO 4: analyze the electric fields with combination of different computation techniques. (K2)
CO 5: estimate the electric fields behavior in conductors and dielectrics.(K2)

UNIT I ELECTROSTATICS **9**

Electrostatic Fields – Coulomb's Law – Electric Field Intensity (EFI) – EFI due to a line and a surface charge – Work done in moving a point charge in an electrostatic field – Electric Potential – Properties of potential function – Potential gradient – Gauss's law – Application of Gauss's Law – Maxwell's first law – Laplace's and Poisson's equations – Solution of Laplace's equation in one variable.

UNIT II ELECTRIC FIELDS-1 **9**

Introduction – Analytical calculation of space charge free fields – Simple geometries – Transmission conductors to ground – Fields in multi dielectric media – Experimental analogs for space charge free fields – Electrolytic tank – Semi conducting paper analog – Resistive mesh analog.

UNIT III ELECTRIC FIELDS-2 **9**

Numerical computation of space charge free fields – Successive imaging technique – The dipole method - charge-simulation technique – Finite-difference technique – Combined charge simulation and finite difference technique – Finite element technique – Combined charge simulation and finite element technique – Boundary element method – Integral equations technique – Montecarlo technique.

UNIT IV ELECTRIC FIELDS-3 **9**

Analytical calculations of fields with space charges – Numerical computation of fields with space charges finite element technique – Finite element technique combined with the method of characteristics – Charge simulation technique combined with the method of residues – Electric stress control and optimization.

UNIT V CONDUCTORS & DIELECTRICS **9**

Behavior of conductors in an electric field – Conductors and insulators – Electric field inside a dielectric material – Polarization – Dielectric – Conductor and dielectric – Dielectric boundary conditions – Energy stored and energy density in a static electric field – Current density – Conduction and convection current densities – Ohm's law in point form – Equation of continuity.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. William H. Hayt andJohn. A. Buck, "Engineering Electromagnetics", Tata Mc-Graw Hill Companies, 7th Edition, 2012.
2. Kraus J. D., "Electromagnetics", McGraw-Hill Inc., 4th Edition, 1999.
3. Gangadhar, "Field Theory", Khanna Publishers, 2002.
4. Sadiku, "Elements of Electromagnetic field theory", Oxford Publication, 2010.
5. Paul C.R. and Nasar S.A., "Introduction to E-Magnetics", Tata McGraw-Hill Publications,2005.

19HE03E HIGH VOLTAGE EQUIPMENTS

L	T	P	C	QP
3	0	0	3	A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: outline the basic concepts of circuit breakers (K2)
CO 2: inspect the behavior of HV Power Transformer (K2)
CO 3: identify the appropriate bushing techniques for high voltage applications (K2)
CO 4: illustrate the basic concepts of different types of cables and protection devices (K2)
CO 5: appraise the theory of Gas Insulated Substation (K2)

UNIT I HIGH VOLTAGE CIRCUIT BREAKERS 9

Arc interruption concept – Circuit making and breaking – Types – Airbreak, SF6 and vacuum circuit breakers.

UNIT II HIGH VOLTAGE POWER TRANSFORMER 9

Transformer insulation requirements – Dielectric strength and voltage conditions – Winding arrangements – Surge behavior – Behavior of liquid dielectric – Electrode surface phenomena – Gas evolution – Processing techniques – Construction of EHV transformer – Short circuit behavior.

UNIT III HIGH VOLTAGE BUSHINGS 9

Types – Non-condenser bushing – Condenser bushing – Bushing application for different equipments like Alternator, transformer, switchgear, wall bushing – Design of bushing and testing procedures.

UNIT IV HIGH VOLTAGE CABLES AND HIGH PROTECTION DEVICES 9

Different types of cables – Paper insulated cables – XLPE cables – Gas-filled cables – Types, Working and applications of Insulators, Surge Diverter, Lighting Arrester, Disconnect switches.

UNIT V GAS INSULATED SUBSTATION (GIS) 9

Comparison of GIS and air insulated substations – Design and layout of GIS – Description of various components of GIS - Advantages of GIS. Appraise.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Anthony J. Pansini, “Electrical Transformers and Power Equipment”, 3rd Edition, Prentice Hall Publications, 1999.
2. Ruben D. Garzon, “High Voltage Circuit Breakers: Design and Applications”, 2nd Edition, Taylor and Francis Publications, 2005
3. Nakanishi, “Switching Phenomena in High-Voltage Circuit Breakers”, Marcel – Dekker Inc, 1991.
4. M. S. Naidu, “Gas Insulated Substations”, L.K. International Publishing House Pvt. Ltd., 2008.
5. Colin Bayliss, Colin R. Bayliss, Brian J.Hardy, “Transmission and Distribution Electrical Engineering”, Elsevier Ltd., 2012

19HE04E DESIGN OF INSULATION FOR HIGH VOLTAGE APPARATUS **L T P C QP**
3 0 0 3 A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: interpret the performance of insulating systems (K2)
CO 2: outline the basic concepts of insulating materials for high voltage application (K2)
CO 3: design the insulators, capacitors and bushings (K2)
CO 4: make use of the insulation schemes, design the power transformer (K2)
CO 5: evaluate the design parameters related to instrumental transformers (K2)

UNIT I INTRODUCTION **9**

Basic arrangements of the insulation systems - Measures to avoid intensification of electric stress –Rigid and leak proof connections to insulating parts – Measures for air sealing oil insulated devices–factors affecting the performance of Dielectric materials.

UNIT II INSULATING MATERIALS IN HIGH VOLTAGE TECHNOLOGY **9**

Requirements of insulating materials – Properties of insulating materials – Natural organic and inorganic materials – Synthetic organic and inorganic insulating materials.

UNIT III ELECTROSTATIC FIELDS AND FIELD STRESS RELIEVING TECHNIQUES **9**

Grading of Fields in homogeneous, isotropic materials – Uniform field electrode – Field configuration in coaxial cylindrical and spherical field – conducting particles – Field in multi dielectric, isotropic materials – Corona Shield – Electrostatic and Electromagentic Shields – Shunts.

UNIT IV DESIGN OF INSULATORS, BUSHINGS AND CAPACITORS **9**

High Voltage capacitors - Basic configurations – Design of wound capacitors – Types of design, Bushings and lead outs – basic configuration – calculations of capacitive grading – Types of design.

UNIT V DESIGN OF INSULATION SYSTEM FOR TRANSFORMERS **9**

Insulation schemes in transformer, design of transformer windings, surge phenomena in Transformer windings-effect of series and shunt capacitance and stress control techniques.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Dieter Kind and Hermann Karner, “High Voltage insulation technology”, translated from German by Y.Narayana Rao, Friedr. Vieweg & Sohn, Braunschweig, 1985.
2. Kuffel, E., Zaengl, W.S. and Kuffel J., “High Voltage Engineering Fundamentals”, Elsvier India Pvt. Ltd, 2005.
3. Pritindra Chowdhari, “Electromagnetic transients in Power System”, John Wiley and Sons Inc., 1996.
4. Alston, L.L, “High Voltage Technology”, Oxford University Press, London 1968.
5. Karsai, K.Kerenyi, D. and Kiss. L., “Large Power Transformers”, Elsevier, Armsterdam, 1987.
6. Feinberg, R., “Modern Power Transformer Practice”, the Macmillan Press Ltd., New York, 1979.

19HE05E EHV AC POWER TRANSMISSION

L	T	P	C	QP
3	0	0	3	A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: explain the role of EHVAC Transmission and Mechanical considerations. (K2)
CO 2: calculate the line parameters for multi-conductor lines. (K2)
CO 3: estimate the voltage gradients of conductors. (K2)
CO 4: discuss the concepts of corona and radio interference. (K2)
CO 5: illustrate the effect of electrostatic field on humans and vehicles. (K2)

UNIT I INTRODUCTION **9**

Line trends and preliminary aspects – Standard transmission voltages – Power handling capacities and line losses – Mechanical aspects.

UNIT II CALCULATION OF LINE PARAMETERS **9**

Calculation of resistance, inductance and capacitance for multiconductor lines – Calculation of sequence inductances and capacitances – Line parameters for different modes of propagation - Resistance and inductance of ground return.

UNIT III VOLTAGE GRADIENTS OF CONDUCTORS **9**

Charge-potential relations for multi-conductor lines – Surface voltage gradient on conductors – gradient factors and their use – Distribution of voltage gradient on sub conductors of bundle – voltage gradients on conductors in the presence of ground wires on towers.

UNIT IV CORONA EFFECTS **9**

Power losses and audible losses: I^2R loss and corona loss – Audible noise generation and characteristics – Limits for audible noise – Day-Night equivalent noise level – Radio interference – Corona pulse generation and properties – Limits for radio interference fields.

UNIT V ELECTROSTATIC FIELD OF EHV LINES **9**

Effect of EHV line on heavy vehicles – Calculation of electrostatic field of AC lines – Effect of high field on humans, animals, and plants – Electrostatic induction in un-energized circuit of a D/C line – Induced voltages in insulated ground wires.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Rakosh Das Begamudre, “Extra High Voltage AC Transmission Engineering”, New Age International Pvt. Ltd., 2nd Edition, 2011.
2. Power Engineer’s Handbook, TNEB Engineers Association, Revised and Enlarged 6th Edition, October 2002.
3. Microtran Power System Analysis Corporation, Microtran Reference Manual, Vancouver Canada. (Website: www.microtran.com)

19HE06E ADVANCED TOPICS IN HIGH VOLTAGE ENGINEERING **L T P C QP**
3 0 0 3 A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: discuss the measurement and diagnostic technologies (K2)
CO 2: explain the SF6 insulation and monitoring system (K2)
CO 3: describe about the safety and electrostatic hazards. (K2)
CO 4: explain pulsed electric field and its applications (K2)
CO 5: apply the Pulsed electric field technology in food processing and medical fields. (K2)

UNIT I MEASUREMENT AND DIAGNOSTIC TECHNOLOGIES 9

Introduction – Digital Impulse Recorders – Digital Techniques in HV tests – Testing automation – Electric field measurement – Electro-optic Sensors- Magneto-optic Sensors – Measurement of very fast transients in GIS – Space charge measurement techniques – Electro-optical image techniques.

UNIT II SF_6 INSULATION SYSTEMS AND THEIR MONITORING 9

Introduction - Ionisation phenomena -Breakdown mechanisms in low divergence fields-Non-uniform field breakdown in SF_6-Breakdown in GIS-Possible improvements in SF_6 insulation-Partial discharge diagnostic techniques for GIS

UNIT III SAFETY AND ELECTROSTATIC HAZARDS 9

Introduction – Nature of static electricity – Triboelectric series – Basic laws of Electrostatic electricity – Materials and static electricity – Electrostatic Discharges (ESD) – Static electricity problems – Hazards of Electrostatic electricity in industry – Hazards from electrical equipment and installations – Static eliminators and charge neutralizers – Lightning protection.

UNIT IV PULSED ELECTRIC FIELDS 9

Introduction – Definitions- Mechanisms of microbial inactivation's – Electrical breakdown – Electroporation – Inactivation models – Critical factors analysis of process, product and microbial factors – Pulse generators and treatment chamber design – Research needs.

UNIT V PULSED POWER APPLICATIONS 9

Introduction - Ion beam materials treatment -Air treatment and pollution control - Pulsed corona precipitators - Biological applications - Food processing: Processing of juices, milk, egg, meat and fish-Water purification Medical applications -Ultra wideband and HPM applications - X-ray simulators.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Haddad, D. Warne, "Advances in High Voltage Engineering" published by The institution of Engineering and Technology, London, United Kingdom, 2007.
2. Malik N.H., Ai-Arainy A.A., Qureshi M.I., "Electrical Insulation in Power Systems", Marcel Dekker, Inc., 1998.
3. Mazen Abdel-Salam, Hussien Anis, Ahdab EI-Morshedy, "High Voltage Engineering", Theory and Practice, Marcel Dekker Inc., 2nd Edition, 2000.
4. Barbosa-Canovas G.V., "Pulsed electric fields in food processing: Fundamental aspects and applications" CRC Publisher Edition, March 1st, 2001.
5. Lelieveld H.L.M., Notermans S., et al, "Food preservation by pulsed electric fields: From research to application", Woodhead Publishing Ltd, October 2007.

19HE07E POLLUTION PERFORMANCE OF POWER APPARATUS AND SYSTEMS

L	T	P	C	QP
3	0	0	3	A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: explain the Mechanism of pollution flashover, Analytical determination. (K2)
CO 2: describe the artificial pollution testing methods. (K2)
CO 3: discuss the pollution performance of insulators. (K2)
CO 4: illustrate the pollution performance of surge diverters. (K2)
CO 5: demonstrate the pollution performance of indoor equipments.(K2)

UNIT I INTRODUCTION 9

Fundamental process of pollution flashover – Development and effect of contamination layer – Creepage distance – Pollution conductivity – Mechanism of pollution flashover – Analytical determination of flashover voltage.

UNIT II POLLUTION TESTING 9

Artificial pollution testing – Salt-fog method – Solid layer method – Monitoring of parameters – Measurement of layer conductivity – Field testing methods.

UNIT III POLLUTION PERFORMANCE OF INSULATORS 9

Ceramic and non-ceramic insulators – Design of shed profiles – Rib factor effect in AC and DC insulators – Various techniques to improve the performance of insulators – Modeling of insulators

UNIT IV POLLUTION PERFORMANCE OF SURGE DIVERTERS 9

External insulation – Effect of pollution on the protective characteristics of gap and gapless arresters – Modeling of surge diverters under polluted conditions.

UNIT V POLLUTION PERFORMANCE OF INDOOR EQUIPMENT 9

Condensation and Contamination of indoor switch gear – Performance of organic insulator under polluted conditions – Accelerated testing techniques.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Kind and Karner, “High Voltage Insulation”, Translated from German by Y.Narayana Rao,
2. Frider. Vieweg, & Sohn, Braunschweig, Weishaden, 1985.
3. Kuffel E., Zaengl W.S. and Kuffel J., “High Voltage Engineering Fundamentals”, Elsvier India Pvt. Ltd, 2005.
4. Klaus Ragaller, “Surges in High Voltage Networks”, Plenum Press, New York, 1980.
5. Zhijin Zhang, Xiaohuan Liu, Xingliang Jiang, Jianlin Hu, and David Wenzhong Gao, “Study on AC Flashover Performance for Different Types of Porcelain and Glass Insulators With Non-Uniform Pollution”, IEEE Transactions on Power Delivery, Vol. 28, No. 3, pp. 1691 – 1698, July 2013,.
6. Dieter Kind and Kurt Feser, “High Voltage Test Techniques”, SBA Electrical Engineering Series, New Delhi, Second Edition,1999.
7. Looms, J.S.T., “Insulators for High Voltages”, Peter Peregrinus Ltd., London, 1988.

19HE08E	CONDITION MONITORING OF HIGH VOLTAGE POWER APPARATUS	L	T	P	C	QP
		3	0	0	3	A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: describe the concept of condition monitoring of high voltage apparatus. (K2)
CO 2: explain different types of faults and its monitoring methods of power transformer. (K2)
CO 3: apply the diagnostic techniques for various power generation faults for rotating electrical machines. (K3)
CO 4: employ the idea of various diagnostic techniques and condition monitoring. (K2)
CO 5: Summarize the insulation materials in application area and various testing techniques. (K2)

UNIT I INTRODUCTION 9

Importance and necessity of maintenance-Breakdown maintenance, planned maintenance and condition based maintenance- Concept of condition monitoring of electrical equipments. Overview of Advanced tools and techniques of condition monitoring- General issues of condition monitoring – Main Components in a condition monitoring system.

UNIT II TRANSFORMER DIAGNOSTIC TESTING 9

Transformer oil paper insulation system- Dissolved Gas Analysis, Gas Evolution in a Transformer, Key Gas method, Key Ratio method - Detection of Winding Displacements, Sweep Frequency Response Analysis -OLTC and Bushing diagnostics.

UNIT III CONDITION MONITORING OF ROTATING ELECTRICAL MACHINES 9

Power generation faults and monitoring methods - Motor Current Signature Analysis (MCSA) -Air-Gap Eccentricity, Broken Rotor Bars, Bearings Damage, Shorted Turns in Stator Windings-Monitoring of rotating elements - Overall level monitoring - Frequency spectrum monitoring.

UNIT IV DIAGNOSTICS 9

Partial Discharge measurements, PD Measuring circuits, calibration - Measurement of PD under DC, Acoustic Technique - Overview of Acoustic Technique - Digital techniques – Data acquisition principles and problems.

UNIT V INSULATION MATERIALS AND MONITORING 9

Outdoor insulation: Materials, ageing, diagnostic, polymeric materials, and semi-conducting, ceramic glazes - Insulation degradation detection, Particulate detection: core monitors, chemical analysis, Gas analysis off-line, Gas analysis on-line, Lubrication oil and bearing degradation.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. W. H. Tang and Q. H. Wu, “Condition Monitoring and Assessment of Power Transformers Using computation Intelligence”, Springer, London 2010
2. Peter Tavner, Li Ran, Jim Penmanand Howard Sedding, “Condition Monitoring of Rotating Electrical Machines”, Published by The Institution of Engineering and Technology, London, United Kingdom, 2008.
3. Hamid A Toliyat, Subhasis Nandi, Seungdeog Choi, HomayounMeshgin-Kelk, “ Electric Machines: Modeling, Condition Monitoring and Fault Diagnostics, CRC Press.
4. Chakravorti Sivaji, DeyDebangshu, Chatterjee Biswendu, “Recent Trends in the Condition Monitoring of Transformers- Theory, Implementation and Analysis” Springer, 2013
5. Greg C. Stone, Edward A. Boulter, Ian Culbert, Hussein Dhirani, “Electrical Insulation for Rotating Machines: Design, Evaluation, Aging,Testing, and Repair”, IEEE Press Series on Power Engineering, A John Wiley & Sons, Inc., Publication, 2004
6. R.E. James and Q. Su, “Condition Assessment of High Voltage Insulation in Power System Equipment”, Published by The Institution of Engineering and Technology, London, United Kingdom, 2008

19HE09E	ELECTRICAL TRANSIENTS IN POWER SYSTEM	L	T	P	C	QP
		3	0	0	3	A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: understand travelling wave propagation on transmission lines. (K2)
CO 2: describe the transient effects in power networks and components (K2)
CO 3: explain the source and characteristics of lightning, switching, and temporary over voltages. (K2)
CO 4: describe the EMI issues related to high voltage engineering (K2)
CO 5: select various protective devices and insulation level. (K2)

UNIT I TRAVELLING WAVES ON TRANSMISSION LINE 9

Circuits with Lumped and Distributed Parameters– Wave Equation – Reflection, Refraction, Behavior of Travelling waves at the line terminations – Lattice Diagrams – Attenuation and Distortion – Multi-conductor system and Velocity wave.

UNIT II COMPUTATION OF POWER SYSTEM TRANSIENTS 9

Principle of digital computation – Matrix method of solution- Modal analysis- Z transform-Modelling for computation of electromagnetic transients-MNA Program -wavelet technique for determining fault in transformer.

UNIT III LIGHTNING, SWITCHING AND TEMPORARY OVERVOLTAGES 9

Lightning: Physical phenomena of lightning – Interaction between lightning and power system – Influence of tower footing and earth Resistance- Protection by ground wires- Switching over voltages: Energizing transients - closing and re-closing of lines –Switching of cables and capacitor banks, Short line or kilometric fault, - Very Fast Transient Overvoltage (VFTO) -Temporary over voltages: line dropping, load rejection, over voltages induced by fault, Ferranti effect, Ferromagnetic resonance.

UNIT IV BEHAVIOUR OF EQUIPMENTS UNDER TRANSIENT CONDITION 9

Initial and Final voltage distribution – Winding oscillation – Traveling wave solution – Behavior of the transformer core under surge condition – Rotating machine – Surge in generator and motor – Surge Arrestors.

UNIT V INSULATION CO-ORDINATION 9

Definitions, Principle of insulation coordination, Volt-time curves-Rated withstand voltage levels and clearances, relevant standard-Air Insulated Substation (AIS) and Gas Insulated Substation (GIS) – Insulation level – Statistical approach – Coordination between insulation and protection level –Overvoltage protective device.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Allan Greenwood, “Electrical Transients in Power System”, Wiley & Sons Inc. New York, 1991.
2. Juan A. Matinez-velasco, “Power system Transients- Parameter determination”, CRC press, 2010
3. Philip C. Magnusson, Gerald C. Alexander, Vijai K Tripathi, Andreas Weisshaar, “Transmission lines and wave propagation”, CRC press, 2001.
4. Arieh L. Shenkman, “Transient analysis of Electric power circuits Handbook”, Springer, 2005.
5. Pritindra Chowdhari, “Electromagnetic transients in Power System”, John Wiley and Sons Inc., 1996.
6. Naidu M S and Kamaraju V, “High Voltage Engineering”, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2009.
7. Working Group 33/13-09, “Very fast transient phenomena associated with Gas Insulated System”, CIGRE, 33-13, pp. 1-20, 1988.

19HE10E	HIGH VOLTAGE PROTECTION AND SWITCHGEAR	L	T	P	C	QP
		3	0	0	3	A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: discuss the fundamentals of relay and its importance in protection (K2)
CO 2: describe the operation various types of relays (K2)
CO 3: knowledge about fault analysis and arcing phenomena (K2)
CO 4: demonstrate about different types of circuit breakers and its operation (K2)
CO 5: discuss about various protection and relaying techniques (K2)

UNIT I PROTECTION 9

Importance of protective relaying power systems – Fundamental requirements of a good protection scheme – Primary and Back-up Relaying.

UNIT II CLASSIFICATION OF RELAYS 9

Constructional (Viz., elector mechanical and Static Relays) and Functional viz. Over current, Directional, Differential, Distance relays etc. their principles and applications. Current Trends in Protective Relaying: Microprocessor and PC based Relaying.

UNIT III SWITCHGEAR 9

Classification of Switchgear, Fault Analysis, Symmetrical Faults on a synchronous machine, Fault clearing process, Arcing Phenomena and principles of arc interruption.

UNIT IV CIRCUIT BREAKER 9

AC and DC circuit breakers, Different types of circuit breakers and their constructional features, Testing and Selection of circuit breakers. Auto- reclosing feature –Three pole & Single pole autoreclosing - Problems of capacitive and low inductive current interruptions

UNIT V CONCEPTS OF VARIOUS RELAYS 9

Distance relays their settings, errors and remedies to errors. Static & Digital Relaying: Generalised approach for two input and multi input comparators, Phase and amplitude comparison, inputs for different types of static distance protection, hardware for static relays, concept of digital relaying, main components of digital relays

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. The Elementary Council, “Power System Protection”, Vol.1-3, Peter Peregrinus, 1990
2. Van, A.R., & Warrington, C., “Protective Relays: Their Theory and Practice”, Vol.1 & 2, Chapman and Hall,1969.
3. Paithankar, Y.G., “Transmission Network Protection: Theory and Practice”, Marcel Dekker, Inc., 1998.

MAGAZINES:

1. Power Apparatus and System Magazine (PAS), IEEE.
2. Electrical Insulation Magazine, IEEE.
3. Power Energy Magazine, IEEE.

19HE11E	ELECTROMAGNETIC INTERFERENCE AND ELECTROMAGNETIC COMPATIBILITY	L	T	P	C	QP
		3	0	0	3	A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: describe the basic concepts and characteristics and design of electromagnetic compatibility (K2)
CO 2: discuss the methods of coupling and grounding (K2)
CO 3: summarize filtering, shielding and coating methods (K2)
CO 4: explain the EMI issues related to high voltage engineering (K2)
CO 5: appraise the EMI standard and regulations (K1)

UNIT I INTRODUCTION 9

Definition of EMI and EMC with examples, Classification of EMI/EMC-Sources of EMI – Conducted and radiated interference- Designing for electromagnetic compatibility (EMC) – EMC regulation – Typical noise path – Use of network theory – Methods of eliminating interferences.

UNIT II METHOD OF GROUNDING 9

Cabling – capacitive coupling - inductive coupling - shielding to prevent magnetic radiation - shield transfer impedance - Grounding – safety grounds – signal grounds - single point and multipoint ground systems- hybrid grounds - functional ground layout – grounding of cable shields- ground loops - guard shields.

UNIT III BALANCING, FILTERING AND SHIELDING 9

Power supply decoupling – Decoupling filters – Amplifier filtering – High frequency filtering shielding – near and far fields – Shielding effectiveness – Absorption and reflection loss – Shielding with magnetic material – Conductive gaskets – Windows and coatings – Grounding of shields.

UNIT IV EMI ISSUES IN HIGH VOLTAGE ENGINEERING 9

EMI coupling modes - CM and DM, ESD Phenomena and effects, Transient phenomena and suppression, High frequency EMI sources, High Power EMI sources, EMC of High Voltage Equipments.

UNIT V EMC STANDARD AND REGULATION 9

National and Intentional standardizing organizations- FCC, CISPR, ANSI, DOD, IEC, CENEEC, FCC CE and RE standards, CISPR, CE and RE Standards, IEC/EN, CS standards, Frequency assignment - spectrum conversation.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Keiser, 'Principles of Electromagnetic', Artech House , 3rd Edition ,1994
2. Donwhite Consultant Incorporate, 'Handbook of EMI / EMC',Vol I ,1985
3. Clayton R. Paul – 'Introduction to Electromagnetic compatibility', John Wiley & Sons,1992
4. Henry W.Ott, "Noise reduction techniques in electronic systems", John Wiley & Sons, 2011.
5. Bridges J.E., Milleta J. and Ricketts L.W., "EMP Radiation and Protective techniques", John Wiley and sons, USA 1976.

19HE12E **PULSE POWER ENGINEERING**

L	T	P	C	QP
3	0	0	3	A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: Identify the static and dynamic breakdown strength of dielectric materials (K2)
CO 2: Estimate energy storage in Marx generators and pulse discharge capacitors (K2)
CO 3: Distinguish the types and operation of various switches (K2)
CO 4: Illustrate the pulse forming networks (K2)
CO 5: Appraise the pulse transmission and transformation theory (K2)

UNIT I STATIC AND DYNAMIC BREAKDOWN STRENGTH OF DIELECTRIC MATERIALS **9**

Introduction – Gases-static breakdown – Pulsed breakdown – Spark formation – Liquids – Basic electrical process – Steamer breakdown – Practical considerations – Solids – General observation – Charge transport – Injection and Breakdown – Statistical Interpretation of breakdown Strength Measurements.

UNIT II ENERGY STORAGE **9**

Pulse Discharge Capacitors – Marx Generators – Classical Marx generators – LC Marx Generator – Basic Pulsed – Power Energy Transfer Stage – Inductive energy storage – Power and voltage multiplication – Rotors and homo polar Generators.

UNIT III SWITCHES **9**

Closing switches – Gas switches – Semi conductor closing switches – Magnetic switches – Summary –Opening switches – Fuses – Mechanical interrupters – Superconducting opening switches – Plasma opening switches – Plasma flow switches – Semiconductor opening switches.

UNIT IV PULSE FORMING NETWORKS **9**

Transmission lines – Terminations and junctions – Transmission lines with losses – The finite transmission line as a circuit element – Production of pulses with lossless transmission lines – RLC networks – Circuit simulation with LEITER.

UNIT V PULSE TRANSMISSION AND TRANSFORMATION **9**

Self magnetic insulation in vacuum lines – Vacuum break down in metallic surfaces – Qualitative description of self magnetic insulation – Quantitative description of self magnetic insulation – Pulse Transformers – High Voltage Power supplies – Capacitor-Charging Techniques – Cascade Circuits –Transformation Lines.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Hansjoachim Bluhm, “Pulsed Power Systems: Principles and Applications”, Springer; 2006.
2. Pai S.T., “Introduction to High Power Pulse Technology (Advanced Series in Electrical and Computer Engineering)”, Wspc Publisher, 1995.
3. Paul W. Smith, “Transient Electronics: Pulsed Circuit Technology”, Wspc, Wiley; First Edition 2002

19HE13E **HIGH VOLTAGE DC TRANSMISSION** **L T P C QP**
3 0 0 3 A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: Demonstrate the knowledge of different types of HVDC transmission system (K2)
CO 2: Discuss the operation of HVDC converters (K2)
CO 3: Describe about HVDC control and its operation (K2)
CO 4: Knowledge about filters and protection strategies in HVDC (K2)
CO 5: Explain Recent trends in HVDC transmission and its application (K2)

UNT I INTRODUCTION 9

Introduction to HVDC transmission, Comparison between HVAC and HVDC systems - Economic, technical and reliability, limitations, Types of HVDC links - monopolar, bipolar and homopolar links, Components of HVDC transmission system.

UNIT II ANALYSIS OF HVDC CONVERTERS 9

Rectifier and Inverter operation of Graetz circuit without and with overlap. Output voltage waveforms and DC voltage in both rectifier and inverter operation, Equivalent circuit of HVDC link.

UNIT III HVDC SYSTEM CONTROL 9

Basic means of HVDC system control, desired features, power reversal, Basic controllers - constant ignition angle, constant current and constant extinction/ advance angle control, power control, high level controllers. Converter maloperations - misfire, arc through, commutation failure.

UNIT IV HARMONICS 9

Harmonics in HVDC system - Characteristic and uncharacteristic harmonics - Troubles due to harmonics – Harmonic filters - Active and passive filters - Reactive power control of converters, Protection issues in HVDC, over voltage and over current protection Voltage and current oscillations, DC reactor design, DC Circuit breakers.

UNIT V RECENT TRENDS IN HVDC TRANSMISSION 9

CSC based HVDC system, VSC based HVDC system – Multi- terminal HVDC systems and HVDC system applications in wind power generation, Interaction between AC and DC systems

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Kimbark, E.W., 'Direct Current Transmission-vol.1', Wiley Inter science, New York, 1971.
2. Padiyar, K.R., 'HVDC transmission systems', Wiley Eastern Ltd., 2010.
3. Kamakshaiah, S and Kamaraju, V, 'HVDC Transmission', 1st Edition, Tata McGraw Hill Education (India), Newdelhi 2011.
4. Arrilaga, J., 'High Voltage Direct Current Transmission', 2nd Edition, Institution of Engineering and Technology, London, 1998.
5. Vijay K. Sood, 'HVDC and FACTS Controllers', Kluwer Academic Publishers, New York, 2004.

19HE14E FLEXIBLE AC TRANSMISSION SYSTEMS

L	T	P	C	QP
3	0	0	3	A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: Explain the basic concepts of power transmission networks and FACTS controllers (K2)
CO 2: Design of SVC voltage regulator and Explain principle of operation of STATCOM (K3)
CO 3: Analyze the variable reactance model of TCSC and modeling of SSSC (K3)
CO 4: Explain about basic principle of operation of UPFC and IPFC (K2)
CO 5: Analyze different types of controller interactions (K3)

UNIT I INTRODUCTION 9

Review of basics of power transmission networks-control of power flow in AC transmission Line- Analysis of uncompensated AC Transmission line - Passive reactive power compensation: Effect of series and shunt compensation at the mid-point of the line on power transfer- Need for FACTS controllers- types of FACTS controllers and its applications.

UNIT II SVC and STATCOM 9

Configuration of Static Var Compensator- voltage regulation by SVC- Modelling of SVC for load flow analysis Design of SVC to regulate the mid-point voltage of SMIB system- Applications: Enhancement of transient stability- Static Synchronous Compensator (STATCOM) – Principle of operation – V-I Characteristics Applications: Steady state power transfer– Enhancement of transient stability.

UNIT III TCSC and SSSC 9

Concepts of Controlled Series Compensation- Operation of TCSC - Analysis of TCSC Operation - Modeling of TCSC for load flow studies- Variable reactance model –Applications - Static Synchronous Series Compensator – Operation of SSSC and the control of power flow – Modeling of SSSC in load flow and transient stability studies – Applications: SSR Mitigation

UNIT IV UPFC and IPFC 9

Principle of operation of UPFC and power flow control – modes of operation- Applications- modeling of UPFC for load flow studies and transient stability studies- Principle of operation of IPFC- Applications- Comparative Evaluation and Future direction of different types of FACTS controllers.

UNIT V CO-ORDINATION OF FACTS CONTROLLERS 9

Controller interactions – SVC - SVC interaction – SVC- HVDC interaction – SVC-TCSC interaction- TCSC-TCSC interaction- Coordination of multiple controllers using linear Control techniques and nonlinear Control techniques – Control coordination using genetic algorithms.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Mohan Mathur R. and Rajiv K. Varma, “Thyristor – Based Facts Controllers for Electrical Transmission Systems”, IEEE press and John Wiley & Sons, Inc, 2002.
2. Narain G. Hingorani, “Understanding FACTS -Concepts and Technology of Flexible AC Transmission Systems”, Standard Publishers Distributors, Delhi.
3. Padiyar K.R.,” FACTS Controllers in Power Transmission and Distribution”, New Age International (P) Limited, Publishers, New Delhi, 2008.
4. John A.T., “Flexible A.C. Transmission Systems”, Institution of Electrical and Electronic Engineers (IEEE), 1999.

19HE15E **POWER QUALITY** **L T P C QP**
3 0 0 3 A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: describe the term and definition of power quality (K2)
CO 2: Analyze voltage sag problems and suggest preventive techniques (K3)
CO 3: Identify the harmonic sources and the effects of harmonic distortion(K2)
CO 4: explain the active compensation techniques used for power factor correction(K2)
CO 5: Understand reasons for grounding and describe the wiring & grounding problems and solutions (K2)

UNIT I POWER QUALITY **9**

Overview of power quality phenomena -Basic terminologies –Power Quality Issues – Causes for reduction in Power Quality – Power Quality Standards and indices.

UNIT II VOLTAGE SAGS **9**

Causes of voltage sags – magnitude & duration of voltage sags – effect on drives and peripherals– monitoring & mitigation of voltage sags. Interruptions - Origin of Long & Short interruptions – influence on various equipments – monitoring & mitigation of interruptions.

UNIT III HARMONICS **9**

Important harmonic introducing devices – SMPS - Three phase power converters - arcing devices saturable devices - harmonic distortion of fluorescent lamps - effect of power system harmonics on power system equipment and loads.

UNIT IV POWER FACTOR IMPROVEMENT **9**

Power factor improvement- Passive Compensation- Passive Filtering- Harmonic Resonance - Impedance Scan Analysis - Active Power Factor Corrected Single Phase Front End-Control Methods for Single Phase APFC - Three Phase APFC and Control Techniques - PFC Based on Bilateral Single Phase and Three Phase Converter staticvar compensators - SVC and STATCOM

UNIT V HARMONIC FILTERING **9**

Active Harmonic Filtering - Shunt Injection Filter for single phase , three-phase three-wire and three-phase fourwire systems-d-q domain control of three phase shunt active filters - UPS - constant voltage transformers- series active power filtering techniques for harmonic cancellation and isolation . Dynamic Voltage Restorers for sag, swell and flicker problems. Grounding and wiring – introduction - NEC grounding requirements- reasons for grounding-typical grounding and wiring problems-solutions to grounding and wiring problems.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. G.T.Heydt, “Electric Power Quality”, Stars in a Circle Publications, 1991
2. Math H. Bollen , “Understanding Power Quality Problems”, IEEE Press, 1st Edition,2001
3. 3.J. Arrillaga, “Power System Quality Assessment”, John Wiley, 2000
4. J. Arrillaga, B.C. Smith, N.R. Watson & A. R.Wood, Power system Harmonic Analysis, Wiley, 1997
5. Wilson E Kazibwe, Musoke H Sendaula, “Electic Power quality control techniques”, Van
6. NostrandReinhold , NewYork,1993
7. J. Schlabbach,D. Blume,T. Stephanblome , “Voltage quality in Electrical Power Systems”,IEE, 2001.
8. Roger c. Dugan/ Mrak F. McGranaghan, Surya santoso& H. Wayne Beaty,
9. “Electrical power systems quality”, Tata Mc Graw-Hill,2010.
10. George J. Walkilesh, “Power Systems Harmonics”, springer,2007.
11. R. SastryVedam&Mulukutla S. Sarma, “Power quality VAR compensation in power systems”, CRC press, 2009.
12. Angelo Baggini, “ Handbook of power quality”, Wiley,2008.

19HE16E **RESTRUCTURED POWER SYSTEMS**

L	T	P	C	QP
3	0	0	3	A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: To understand the concepts of restructuring of power industry (K2)
CO 2: explain the basics of OASIS and market power (K2)
CO 3: analyze available transfer capability and electricity pricing (K4)
CO 4: classify the transmission cost allocation methods and significance ancillary services of Transmission network (K3)
CO 5: outline on the various power sectors in India (K2)

UNIT I INTRODUCTION TO RESTRUCTURING OF POWER INDUSTRY 9

Introduction: Deregulation of power industry, Restructuring process, Issues involved in deregulation, Deregulation of various power systems – Fundamentals of Economics: Consumer behavior, Supplier behavior, Market equilibrium, Short and long run costs, Various costs of production – Market models: Market models based on Contractual arrangements, Comparison of various market models, Electricity vis – a – vis other commodities, Market architecture, Case study.

UNIT II OPEN ACCESS SAME-TIME INFORMATION SYSTEM (OASIS) & MARKET POWER 9

Structure of OASIS - Posting of Information – Transfer capability on OASIS. Market Power: Introduction - Different types of market Power – Mitigation of Market Power -Examples.

UNIT III AVAILABLE TRANSFER CAPABILITY (ATC) & ELECTRICITY PRICING 9

Transfer Capability Issues –ATC –TTC –TRM –CBM Calculations –Calculation of ATC based on power flow. Electricity Pricing: Introduction – Electricity Price Volatility Electricity Price Indexes – Challenges to Electricity pricing – Construction of Forward Price Curves – Short-time Price Forecasting.

UNIT IV TRANSMISSION COST ALLOCATION METHODS& ANCILLARY SERVICES MANAGEMENT 9

Introduction -Transmission Cost Allocation Methods : Postage Stamp Rate Method -Contract Path Method -MW-Mile Method –Unused Transmission Capacity Method -MVA-Mile method – Comparison of cost allocation methods. Ancillary Services Management: Introduction –Reactive Power as an Ancillary Service –a Review –Synchronous Generators as Ancillary Service Providers.

UNIT V REFORMS IN INDIAN POWER SECTOR 9

Introduction – Framework of Indian power sector – Reform initiatives - Availability based tariff – Electricity act 2003 – Open access issues – Power exchange – Reforms in the near future.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Mohammad Shahidehpour, MuwaffaqAlomoush , Marcel Dekker, “Restructured electrical power systems: operation, trading and volatility” Pub., 2001.
2. Kankar Bhattacharya, Jaap E. Daadler, Math H.J. Boolen, “Operation of restructured power systems”, Kluwer Academic Pub., 2001.
3. Paranjothi, S.R. , “ Modern Power Systems” Paranjothi, S.R. , New Age International, 2017.
4. Sally Hunt,” Making competition work in electricity”, John Willey and Sons Inc. 2002.
5. Steven Stoft, “ Power system economics: designing markets for electricity”, John Wiley & Sons, 2002
6. Loi Lei Lai, Power System Restructuring and Deregulation, John Wiley & Sons Ltd., England.
7. LorrinPhilipson, H. Lee Willis, “Understanding electric utilities and de-regulation”, Marcel Dekker Pub., 1998.

19HE17E **POWER SYSTEM PLANNING AND RELIABILITY**

L	T	P	C	QP
3	0	0	3	A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: explain the characteristics of loads, concepts of load forecasting and its types for power system planning. (K2)

CO 2: comprehend the significance of reliability in power system, various methods and tools used for reliability analysis. (K2)

CO 3: describe the concepts of reliability in generation and transmission system (K2)

CO 4: describe the concepts system interconnection. (K2)

CO 5: discriminate the different modes of system failure and to explain various approaches to assess power system failure. (K2)

UNIT I LOAD FORECASTING **9**

Objectives of planning – Long and short term planning - Load forecasting – characteristics of loads – methodology of forecasting – energy forecasting – peak demand forecasting – total forecasting – annual and monthly peak demand forecasting.

UNIT II GENERATION SYSTEM RELIABILITY ANALYSIS **9**

Reliability concepts – exponential distributions – meantime to failure – series and parallel system – MARKOV process – recursive technique. Generator system reliability analysis – probability models for generators unit and loads – reliability analysis of isolated and interconnected system - generator system cost analysis – corporate model – energy transfer and off peak loading

UNIT III TRANSMISSION SYSTEM RELIABILITY ANALYSIS **9**

Transmission system reliability model analysis – average interruption rate - LOLP method - frequency and duration method

UNIT IV INTERCONNECTIONS OF SYSTEM **9**

Two plant single load system - two plant two load system - load forecasting uncertainly interconnections benefits

UNIT V MODES OF SYSTEM FAILURE **9**

Introduction to system modes of failure – the loss of load approach – frequency & duration approach – spare value assessment – multiple bridge equivalents

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Sullivan, R.L., 'Power System Planning', Heber Hill, 1987.
2. Roy Billington, 'Power System Reliability Evaluation', Gordan& Breach Scain Publishers,1990.
3. Eodrenyi, J., 'Reliability modelling in Electric Power System' John Wiley, 1980.

19HE18E **SMART GRID**

L	T	P	C	Qp
3	0	0	3	A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: understand the concepts and design of Smart grid (K2)
CO 2: explain the concepts of smart grid technologies (k2)
CO 3: explain the various communication and measurement technologies in smart grid (k2)
CO 4: summarize the renewable energy resources and storage resources available for smart grid (k2)
CO 5: outline the high performance computing for smart grid applications (K2)

UNIT I SMART GRID ARCHITECTURAL DESIGNS 9

Introduction – Comparison of Power grid with Smart grid, Concept of Resilient &Self Healing Grid – communication and standards - General View of the Smart Grid Market Drivers - Stakeholder Roles and Function - Present development & International policies in Smart Grid - Representative Architecture - Functions of Smart Grid Components-Wholesale energy market in smart grid-smart vehicles in smart grid.

UNIT II SMART GRID TECHNOLOGIES 9

Technology Drivers, Smart energy resources, Smart substations, Substation Automation, Feeder Automation , Transmission systems: EMS, FACTS and HVDC, Distribution systems: DMS, Volt/VAr control, Fault Detection Isolation and service restoration, Outage management, High-Efficiency Distribution Transformers, Phase Shifting Transformers

UNIT III SMART GRID COMMUNICATIONS AND MEASUREMENT TECHNOLOGY 9

Communication and Measurement - Monitoring, Phasor Measurement Unit (PMU), Smart Meters, Wide area monitoring systems (WAMS)- WAMPAC Systems - Advanced metering infrastructure-Intelligent Electronic Devices(IED) & their application for monitoring & protection - GIS and Google Mapping Tools.

UNIT IV RENEWABLE ENERGY AND STORAGE 9

Renewable Energy Resources - Sustainable Energy Options for the Smart Grid-Penetration and Variability Issues Associated with Sustainable Energy Technology-Demand Response Issues-Electric Vehicles and Plug-in Hybrids PHEV Technology-Environmental Implications-Storage Technologies-Grid integration issues of renewable energy sources.

UNIT V HIGH PERFORMANCE COMPUTING FOR SMART GRID APPLICATIONS 9

Local Area Network (LAN), House Area Network (HAN), Wide Area Network (WAN), Broadband over Power line (BPL), IP based Protocols, Basics of Web Service and CLOUD Computing to make Smart Grids smarter, Cyber Security for Smart Grid.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. James Momoh, “Smart Grid: Fundamentals of design and analysis”, John Wiley & sons Inc, IEEE press 2012.
2. JanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama, “Smart Grid: Technology and Applications”, John Wiley & sons inc, 2012.
3. Fereidoon P. Sioshansi, “Smart Grid: Integrating Renewable, Distributed & Efficient Energy”, Academic Press, 2012.
4. Clark W.Gellings, “The smart grid: Enabling energy efficiency and demand response”, Fairmont Press Inc, 2009.
5. Smart Grid: Technology and ApplicationsbyJanakaEkanayake, Nick Jenkins, KithsiriLiyanage, Jianzhong Wu, Akihiko Yokoyama wiley India

19HE19E	POWER ELECTRONICS IN POWER SYSTEMS	L	T	P	C	QP
		3	0	0	3	A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: outline the fundamental concept of power semiconductor devices. (K2)
CO 2: analyze the single phase and three phase controlled rectifiers. (K3)
CO 3: discuss the single phase and three phase inverter with its control strategies. (K2)
CO 4: illustrate the reactive power compensation and the FACTS devices. (K2)
CO 5: appraise the power quality and various power quality problems.(K2)

UNIT I INTRODUCTION 9

Basic Concept of Power Electronics – Basic structure and characteristics of Power semiconductor devices –Power Diodes, SCR, Power BJT, Power MOSFET and IGBT.

UNIT II AC TO DC CONVERTERS 9

Single Phase and three phase bridge rectifiers with R, RL and RLE loads – effect of source inductance- performance parameters-power factor improvement- Dual Converter

UNIT III DC TO AC CONVERTERS 9

Single Phase and three phase voltage source and current source inverters – Multi Quadrant Chopper viewed as a single phase inverter –Voltage and harmonics Control -PWM strategies.

UNIT IV STATIC REACTIVE POWER COMPENSATION 9

Shunt Reactive Power Compensation – Fixed Capacitor Banks – Switched Capacitors – Static Reactor Compensator – Thyristor Controlled Shunt Reactors (TCR) – Thyristor Controlled Transformer - FACTS Technology – Applications of static thyristor Controlled Shunt Compensators for load compensation – Static Var Systems for Voltage Control – Power Factor Control and Harmonic Control of Converter Fed Systems.

UNIT V POWER QUALITY 9

Power Quality – Terms and Definitions – Transients – Impulsive and Oscillatory Transients – Harmonic Distortion – Harmonic Indices – Total Harmonic Distortion – Total Demand Distortion-Locating Harmonic Sources - Harmonics from commercial and industrial Loads –Devices for Controlling Harmonics – Passive and Active Filters – Harmonic Filter Design.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Ned Mohan, Undeland and Robbin, “Power Electronics: Converters, Application and Design”, John Wiley and Sons, 2012.
2. Rashid M.H., “Power Electronics Circuits, Devices and Applications”, Prentice Hall of India, 2011.
3. Bose B.K., “Power Electronics and A.C. Drives”, Prentice Hall, 2010.
4. Roger C Dugan, Mark F Mc Granaghan, Surya Santaso and Wayne Beaty H., “Electrical Power Systems Quality”, Third Edition, Tata McGraw-Hill, 2012.
5. Mohan Mathur R., Rajiv K Varma, “Thyristor Based FACTS controllers for Electrical Transmission Systems”, John Wiley & Sons, 2011.

19HE20E	CONTROL OF ELECTRIC DRIVES	L	T	P	C	QP
		3	0	0	3	A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: enumerate the general concept of electrical drives. (K1)
CO 2: describe the various control strategies of DC drives. (K2)
CO 3: distinguish the various inverters fed DC drives and its dynamic behavior. (K2)
CO 4: identify the dynamic model for the electrical drives. (K2)
CO 5: explain the various measurement and control techniques (K2)

UNIT I INTRODUCTION 9

State of Art of DC Drive - Components of Electrical Drive and their functions - Types of Load-Quadrate diagram of speed –torque characteristics –Types and Characteristics of load torque – Dynamics of motor- load combination – steady state & transient stability of an electrical drive – Moment of inertia- Load equalization

UNIT II CONTROL OF DC DRIVE 9

Analysis for speed-torque equations in terms of firing angle and duty cycle; Modified speed-torque characteristics with phase controlled converters and DC-DC converters for continuous conduction and discontinuous conduction; Closed loop speed control schemes; Dynamic model of DC machine; Speed and position control scheme using the dynamic model.

UNIT III CONTROL OF AC DRIVE 9

VSI based Induction Motor control -Selection of carrier frequency and harmonic spectrum-Various operating modes for doubly fed induction machine: Sub-synchronous and super-synchronous motoring and generating; Static Scherbius drive: Design aspects - Closed-loop speed control schemes: slip control, current limit control; CSI fed IM; Speed-torque characteristics with current source.

UNIT IV DYNAMIC MODELING & CONTROL 9

Arbitrary reference frame, stationary reference frame, rotating reference frame; Principle of Vector control, Field oriented control: Stator Flux Control and Rotor Flux Control; Direct torque control

UNIT V CLOSED LOOP CONTROL OF MICROCOMPUTER BASED DRIVES 9

Voltage, Current, Torque and Speed measurements using digital measurement techniques – Types of controllers – Position and velocity measurement algorithm – Closed loop control of microcomputer based drives.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Bose B.K., “Power Electronics and Motor Drives - Advances and Trends”, IEEE Press, 2006.
2. Buxbaum, Schierau A., and Staughen K., “A design of control systems for DC drives”, Springer Verlag, Berlin, 2008.
3. Vedam Subrahmanyam, “Thyristor control of Electric drives”, Tata McGraw-Hill, 2010.
4. Krishnan R., “Electric Motor Drives, Modeling, Analysis and Control”, Prentice Hall of India, 2014.
5. Bin Wu, “High Power Converters and AC Drives”, IEEE Press, A John Wiley and Sons, Inc., 2006.
6. Dubey G.K., “Power semiconductor controlled drives”, Prentice-HALL,1989.
7. Leonard W., “Control of Electric Drives”, Springer Verlag, NY, 2006
8. Bose B.K., “Modern Power electronics and AC drives”, Prentice Hall, 2001.
9. Piotr, Wach., “Adjustable Speed A.C. drives”, Springer, 2011.

19HE21E	ADVANCED ELECTRICAL DRIVES	L	T	P	C	QP
		3	0	0	3	A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: appraise about dc and ac electrical drives (K2)
CO 2: analyze the modelling of induction motor using reference frame theory(K2)
CO 3: explain the vector control techniques for ac drives (K2)
CO 4: discuss the sensorless control techniques for electric drives (K2)
CO 5: explain the working principle of various special electrical machines(K2)

UNIT I INTRODUCTION 9

Review of dc drives– Scalar control of AC drives: Stator Control – Stator voltage control of 3-Phase induction motors: control by AC voltage controllers – Variable frequency square wave VSI drives, Rotor Control – Static Kramer drive – Static Scherbius drive – Disadvantages of scalar control of AC drives

UNIT II REFERENCE FRAME THEORY & MODELING OF INDUCTION MOTOR 9

Space vector theory – Dynamic d-q modeling of induction machines – Stator, rotor and synchronously rotating reference, frame models, state space equations and dynamic simulation, – Space Phasor model – Control – Principle of the induction motor

UNIT III VECTOR CONTROL 9

Vector controlled induction motor drive – Basic principle – Direct Rotor flux-oriented vector control–Stator flux-oriented vector control – Indirect rotor flux-oriented vector control scheme controlled induction motors– Direct torque control of Induction Motor.

UNIT IV SENSOR LESS CONTROL 9

Principles for speed sensor less control - Sensor less methods for scalar control – Sensorless methods for vector control – Introduction to observer-based techniques.

UNIT V SPECIAL MACHINES 9

Principle, construction, operation and drive application: Brushless DC Motor – PMSM – Synchronous Reluctance Motor – Switched Reluctance Motor – Stepper Motor.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. B.K. Bose, “Modern Power Electronics and AC Drives”, Pearson Education, 2002
2. R. Krishnan, “Electric Motor Drives: Modeling, Analysis and Control”, Prentice-Hall India, New Delhi, 2003
3. P. Vas, “Sensor less vector and direct torque control”, Oxford Press, 1992.
4. T.J.E. Miller, “Brushless Permanent-magnet and reluctance motor Drives” 1989.
5. Werner Leonhard, “Control of electrical drives”, Springer-2001.
6. D W Novotny and T ALipo, “Vector Control and Dynamics of AC Drives”, Oxford University Press, 1996
7. Kazmierkowski, Krishnan, Blaabjerg, “Control in Power Electronics-Selected Problems”, Academic Press, 2002

19HE22E	SOFT COMPUTING TECHNIQUES	L	T	P	C	QP
		3	0	0	3	A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: outline the concepts of intelligent expert system (K2).
CO 2: explain the components of fuzzy logic system (K2).
CO 3: distinguish various structures of ANN (K2).
CO 4: describe the basic concepts of genetic algorithms (K2).
CO 5: apply ANN, FLC and GA to various electrical applications (K2).

UNIT I INTRODUCTION **9**

Approaches to intelligent control – Architecture for intelligent control – Symbolic reasoning system – rule – Based systems – AI approach – Knowledge representation – Expert systems.

UNIT II ARTIFICIAL NEURAL NETWORKS **9**

Concept of Artificial Neural Networks and its basic mathematical model – McCulloch-Pitts neuron model – Simple perceptron – Adaline and Madaline – Feed-forward Multilayer Perceptron – Learning and Training the neural network – Data Processing: Scaling – Fourier transformation – Principal – Component analysis and wavelet transformations – Hopfield network, Self-organizing network and Recurrent network – Neural Network based controller.

UNIT III FUZZY LOGIC SYSTEM **9**

Introduction to crisp sets and fuzzy sets – Basic fuzzy set operation and approximate reasoning – Introduction to fuzzy logic modeling and control – Fuzzification, inferencing and defuzzification – Fuzzy knowledge and rule bases – Fuzzy modeling and control schemes for nonlinear systems – Self-organizing fuzzy logic control – Fuzzy logic control for nonlinear time – Delay system.

UNIT IV GENETIC ALGORITHM **9**

Basic concept of Genetic algorithm and detail algorithmic steps – Adjustment of free parameters – Solution of typical control problems using genetic algorithm – Concept on some other search techniques like tabu search and ant-colony search techniques for solving optimization problems.

UNIT V APPLICATIONS **9**

GA application to power system optimization problem – Case studies: Identification and control of linear and nonlinear dynamic systems using Matlab – Neural Network toolbox – Stability analysis of Neural –Network interconnection systems – Implementation of fuzzy logic controller using Matlab fuzzy – Logic toolbox – Stability analysis of fuzzy control systems.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Jacek M Zurada, "Introduction to Artificial Neural Systems", Jaico Publishing House, 1999.
2. Kosko.B, "Neural Networks And Fuzzy Systems", Prentice-Hall of India Pvt Ltd., 1994.
3. Klir G.J. and Folger T.A., "Fuzzy sets, Uncertainty and Information", Prentice-Hall of India Pvt. Ltd., 1993.
4. Zimmerman H.J., "Fuzzy set theory-and its Applications"-Kluwer Academic Publishers, 1994.
5. Driankov and Hellendroon, "Introduction to Fuzzy Control", Narosa Publishers, 2001

19HE23E	EVOLUTIONARY COMPUTING	L	T	P	C	QP
		3	0	0	3	A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: explain the basic concepts of evolutionary computation. (K2)
CO 2: classify the various representations, selection and search operations (K2)
CO 3: discuss the basics of fitness evaluation and constraint handling mechanism. (K2)
CO 4: outline the concepts of hybrid systems. (K2)
CO 5: interpret the effect of parameter setting and applications. (K2)

UNIT I INTRODUCTION TO EVOLUTIONARY COMPUTATION 9

Introduction – Possible applications of evolutionary computations – History of evolutionary computation – Genetic algorithms – Evolution strategic – Evolutionary programming – Derivative methods – Stochastic processes – Modes of stochastic convergence – Schema processing – Transform methods – Fitness landscape – Probably Approximately Correct(PAC) learning analysis – Limitation of evolutionary computation methods – Local performance measures.

UNIT II REPRESENTATION, SELECTION AND SEARCH OPERATOR 9

Representation – Binary strings – Real-valued vectors – Permutations – Finite-state representation – Parse trees – Guidelines for a suitable encoding – Other representations Selection – Proportional selection and sampling algorithms – Tournament selection – Rank based selection – Boltz Mann selection – Other selection methods – Hybrids Generation gap methods – A comparison of selection mechanisms – Interactive evolution – Search Operators – Mutation – recombination – Other operators.

UNIT III FITNESS EVALUATION AND CONSTRAINT HANDLING 9

Fitness Evaluation – Encoding and decoding functions – Competitive fitness evaluation – Complexity based fitness evaluation – Multi objective optimization – Constraint handling techniques – Penalty functions – Decoders – Repair algorithms – Constraint preserving operators – Other constraint handling methods – Constraint satisfaction problems – Population structures – Niching Methods – Specification methods – Island (migration) models.

UNIT IV HYBRID SYSTEM 9

Self-adaptation – Meta evolutionary approaches – Neural – Evolutionary systems – New areas for evolutionary computation research in evolutionary systems – Fuzzy-Evolutionary Systems – Combination with Other Optimization Methods – Combination with local search – Combination with dynamic programming – Simulated annealing and tabu search – Comparison with existing optimization.

UNIT V PARAMETER SETTING AND APPLICATIONS 9

Heuristics for Parameter setting Issues – Population size – Mutation parameters – Recombination parameters – Implementation of Evolutionary Algorithms – Efficient implementation of algorithms – Computation time of evolutionary operators – Applications – Classical optimization problems – Control Identification – Scheduling – Pattern recognition – Simulation models.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Thomas Back et al, “Handbook on evolutionary computation”, Institute of Physics, Publishing, 2000.
2. Xin Yao, “Evolutionary Computations: Theory and Applications”, World Scientific 39 Publishing, 1999.
3. Goldberg, “Genetic algorithm in search, optimization and machine learning”, Addison Wesley, 1998.
4. Davis, “Hand book on Genetic Algorithms”, NewYork, 1991.
5. Kenneth A De Jong, “Evolutionary Computation: A Unified Approach”, MIT Press, 2006.

19HE24E OPTIMIZATION TECHNIQUES

L	T	P	C	QP
3	0	0	3	A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: outline the basic concepts of optimization problems (K2)
CO 2: perform optimization using linear and non linear programming (K2)
CO 3: make use of integer, stochastic and geometric programming for optimization Problems (K2)
CO 4: summarize various direct search techniques in optimization techniques (K2)

UNIT I INTRODUCTION 9

Engineering Applications of optimization – statement of an optimization problem – Classification of optimization problems.

UNIT II LINEAR AND NON LINEAR PROGRAMMING 9

Linear programming, Simplex algorithm – Duality – Revised simplex algorithm – Sensitivity analysis. Non linear programming: Unconstrained optimization – Gradient based methods – Newton's method – Quasi Newton's method – Constrained optimization – Penalty function methods.

UNIT III INTEGER, STOCHASTIC AND GEOMETRIC PROGRAMMING 9

Integer Programming- Introduction – Formulation – Gomory cutting plane algorithm – Zeroor one algorithm, branch and bound method. Stochastic Programming: Basic concepts of probability theory – Random variables distributions mean – Ariance – Correlation – Co variance – Joint probability distribution – Stochasticlinear – Dynamic programming. Geometric Programming: Posynomials – Arithmetic – Geometric inequality – Unconstrained G.P- Constrained G.P

UNIT IV DIRECT SEARCH TECHNIQUES – I 9

Univariate methods – Pattern search methods – Branch and bound method for mixed integer problems – Simulated annealing – Tabu search.

UNIT V DIRECT SEARCH TECHNIQUES – II 9

Genetic algorithm – Particle swarm optimization – Ant colony optimization – Differential evolution techniques – Multi objective optimization – Pareto solutions.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. S.S.Rao, "Optimization theory and Applications", New Age International, 1984.
2. Kalyanmoy Deb, "Optimization for Engineering Design", PHI, 2012.
3. S.D.Sharma, "Operations Research – Theory and Applications", Macmillan Publications, 2009.
4. H.A.Taha , "Operation Research", TMH, 1982.
5. R.LRardin, "Optimization in operations research", Pearson New International, 2014.
6. Belagundu & Chandraputla, "Optimization Concepts and Applications in Engineering", Pearson Asia, 2011.
7. M.C.Joshi, K.M.Moudgalya, "Optimization Techniques theory and practice", Narosa Publications, 2004.

19HE25E	ENERGY MANAGEMENT	L	T	P	C	QP
		3	0	0	3	A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: identify the energy management skills and strategies in the energy management system (K2).

CO 2: identify economic aspects in energy management (K2)

CO 3: review of cogeneration in industry and waste heat recovery techniques and devices (K2)

CO 4: design suitable energy monitoring system to analyz and optimize the energy consumption in an organization (K2)

CO 5: outline the basics of advanced energy management with application on different sectors. (K2)

UNIT I GENERAL ASPECTS 9

Definition and Objective of Energy Management, General Principles of Energy Management, Energy Management Skills, Energy Management Strategy. Energy Management Approach, Understanding Energy Costs, Bench marking, Energy performance, Matching energy usage to requirements, Maximizing system efficiency, Optimizing the input energy requirements, Fuel and Energy substitution.

UNIT II PRINCIPLES OF ECONOMIC ANALYSIS IN THE ENERGY MANAGEMENT 9

Fundamental of Energy conservation, Energy Management and Audit, Basics of Energy Demand and Supply, Principles of Economic analysis in the Energy Management and Audit Programme, Supply side and demand side energy management, Boilers and Firing System, Steam, Condensation Systems,.

UNIT III ENERGY CONSERVATION AND MANAGEMENT 9

Energy Conservation and Management in power plant, Energy conservation in Buildings, Heating, Ventilation and Air Conditioning System, Degree day in energy use monitoring, Energy Conservation Opportunities, in chemical industries, Waste heat recovery, Co-generation, Energy Conservation in Agricultural Sector, Energy conservation in illumination engineering, Combustion stoichiometry, air-fuel ratio, optimum loading in boilers.

UNIT IV ENERGY BALANCE & MIS 9

First law of efficiency and Second law of efficiency, Facility as an Energy system, Methods for preparing process flow, Materials and Energy Balance diagram, Identification of losses, Improvements. Energy Balance sheet and Management Information System (MIS) Energy Modeling and Optimization.

UNIT V ADVANCED ENERGY MANAGEMENT 9

Details of Energy management programme in industrial sector, Domestic sector, Agricultural and Transport sectors. Analysis of energy utilization in boiler and firing system. Evaluation of heat loss and heat gain in buildings systems, thermal design building systems, evaluation of window and glazing, solar simulation of building systems, Methods of improving thermal equality. Methods of improving thermal equality.Estimation on energy saving at the industrial houses, Energy budget.Estimation of energy loss in Electrical utilities. Electrical load management

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. D. Yogi Goswami, Frank Kreith, “Energy Management and ConservationHandbook”, CRC Press, 2008.
2. Marguerite A. H Ruffner, Yacov Y. Haimes“Energy Auditing and Conservation: Methods, Measurements, Management, and Case Studies”, Taylor and Francis,1980.

3. General Aspects of Energy management and Energy audit, Second Edition, Bureau of Energy Efficiency, Ministry of Power, India, 2005
4. Energy Efficiency in Electrical Utilities, Second Edition 2005, Bureau of Energy Efficiency, Ministry of Power, India.
5. Energy management handbook, John Wiley and Sons Wayne C. Turner, 2006

19HE26E	NANO TECHNOLOGY	L	T	P	C	QP
		3	0	0	3	A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: explain crystal lattice structures, heterostructures and quantum structures. (K2)
CO 2: discuss the fabrication techniques of of nano materials. (K2)
CO 3: describe the characterization techniques in nano technology fields. (K2)
CO 4: outline the applications of nano technology in science and engineering. (K2)

UNIT I CRYSTALLINE PROPERTIES OF SOLID 9

Crystal lattice and seven crystal systems – Unit cell concept – Weigner-Seitz cell – Bravais lattices – Space and point groups – Miller indices – Reciprocal lattice – Brillouin zone.

UNIT II SEMICONDUCTOR HETEROSTRUCTURES AND LOW DIMENSIONAL QUANTUM STRUCTURES 9

Energy bands, Application of model solid theory – Anderson model for hetero junctions – Multiple quantum wells (MQWs) and super lattices – Two-dimensional nanostructure: quantum well – One dimensional nanostructure: quantum wire – Zero-dimensional nanostructure: quantum dot – Optical properties of low-dimensional structures – Examples and applications in real world.

UNIT III FABRICATION OF NANO STRUCTURES 9

Basic compound semiconductors – Bulk single crystal growth techniques – Epitaxial growth techniques – Physical vapour deposition and sputtering – Thermodynamics and kinetics of growths – Nano scale growth modes.

UNIT IV CHARACTERIZATION TECHNIQUES 9

Structural X-ray diffraction – Electron microscopy – Energy dispersive analysis using X-rays – X-ray photoelectron spectroscopy – Scanning probe microscopy – Optical – Photoluminescence spectroscopy – Absorbance measurement – Raman spectroscopy – Fourier transform spectroscopy.

UNIT V APPLICATIONS OF NANO TECHNOLOGY 9

Future of semiconductor device and research – Necessity of innovative technology and prospect for future – Applications in food, energy, transportation, communication, entertainment, health and medicine.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. M. Razeghi, “Fundamentals of Solid State Engineering”, 2nd Edition, Springer, 2006.
2. K.K.Chattopadhyay, A.N. Banerjee, “Introduction to Nanoscience and Nanotechnology”, PHI Learning Private Limited, 2011.
3. W. R. Fahrner, “Nanotechnology and Nano electronics: Materials, Devices, Measurement Techniques”, Springer-Verlag Berlin Heidelberg, 2005.
4. R. W. Kelsall, I. W. Hamley, and M. Geoghegan, “Nano scale Science and Technology”, John Wiley & Sons Limited, England, 2005.
5. M.A.Shah, Tokeer Ahmad, “Principles of Nano science and Nanotechnology”, Narosa Publishing home Private Limited, 2010.
6. B.Viswanathan, “Nano materials”, Narosa Publishing home Private Limited, 2009.
7. William Illsey Atkinson, “Nanotechnology”, Jaico Publishing Home, 2008.

19HE27E	OPTIMAL CONTROL AND FILTERING	L	T	P	C	QP
		3	0	0	3	A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: Explain the classification of optimal control problem. (K2)
CO 2: Solve the optimal control problems. (K3)
CO 3: Explain the numerical techniques for optimal control. (K2)
CO 4: Analyze the kalman filter properties. (K3)

UNIT I INTRODUCTION 9

Statement of optimal control problem – Problem formulation and forms of optimal Control – election of performance measures. Necessary conditions for optimal control – Pontryagin's minimum principle – State inequality constraints – Minimum time problem.

UNIT II LQ CONTROL PROBLEMS AND DYNAMIC PROGRAMMING 9

Linear optimal regulator problem – Matrix Riccatti equation and solution method – Choice of weighting matrices – Steady state properties of optimal regulator – Linear tracking problem – LQG problem – Computational procedure for solving optimal control problems – Characteristics of dynamic programming solution – Dynamic programming application to discrete and continuous systems – Hamilton Jacobi Bellman equation.

UNIT III NUMERICAL TECHNIQUES FOR OPTIMAL CONTROL 9

Numerical solution of 2-point boundary value problem by steepest descent and Fletcher Powell method solution of Ricatti equation by negative exponential and interactive Methods.

UNIT IV FILTERING AND ESTIMATION 9

Filtering – Linear system and estimation – System noise smoothing and prediction –Gauss Markov discrete time model – Estimation criteria – Minimum variance estimation – Least square estimation – Recursive estimation.

UNIT V KALMAN FILTER AND PROPERTIES 9

Filter problem and properties – Linear estimator property of Kalman Filter – Time invariance and asymptotic stability of filters – Time filtered estimates and signal to noise ratio improvement – Extended Kalman filter.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Kirk.D.E., "Optimal Control Theory – An introduction", Dover Publication,2001.
2. Anderson, BD.O. And Moore J.B., "Optimal Filtering", 2nd Edition, Prentice hall Inc., 2005.
3. S.M. Bozic, "Digital and Kalman Filtering", 2nd edition Edward Arnold, London, 1994.
4. David G.Hull., "Optimal control theory for Applications", Springer Publishing Company, 2001.
5. D. Subbaram Naidu, "Optimal control systems", CRC Press, Aug 2002.

19HE28E	DIGITAL CONTROL SYSTEM	L	T	P	C	QP
		3	0	0	3	A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: Estimate discrete time models, which approximate continuous time dynamics. (K2)
CO 2: Design a compensator for digital control system to achieve desired specification. (K2)
CO 3: Analyze the state variable concepts in digital control system. (K2)

UNIT I SIGNAL PROCESSING IN DIGITAL CONTROL 9

Advantage of Digital Control – Principles of Signal Conversion – Basic Discrete Time Signal – Time Domain Models for Discrete Time Systems – Review of Z Transforms – Transfer Function Models –Sample and Hold System – Sampled Spectra and Aliasing – Reconstruction of Analog Signals – Selection of Sampling Rate –Principles of Discretization

UNIT II MODELS OF DIGITAL CONTROL DEVICES AND SYSTEMS 9

Basic Digital Control Scheme – Z Domain Description of Sampled Continuous Time Plants – Z Domain Description of Systems with Dead Time – Implementation of Digital Controller – Digital PID controller – Digital Temperature Control System – Digital Position Control System – Stepping Motors and their Control

UNIT III DESIGN OF DIGITAL CONTROLLER 9

Introduction - Z Plane Specifications of Control System Design – Digital Compensator Design Using Frequency Response Plots – Digital Compensator Design Using Root Locus Plots – Z Plane Synthesis – Stability on the Z Plane and Jury Stability Criterion

UNIT IV STATE VARIABLE ANALYSIS OF DIGITAL CONTROL SYSTEMS 9

State Descriptions of Digital Processors – State Description of Sampled Continuous Time Plants - State Description of System with Dead Time – Solution of State Difference Equations – Controllability and Observability

UNIT V DIGITAL CONTROL SYSTEMS WITH STATE FEEDBACK 9

State Regulator Design –State Observers – Separation Principle – State feedback with Integral control – Dead beat control by state feedback and dead beat observers - Pole Placement Design by State Feedback (Single Input) –Pole Placement Design by Output Feedback (Single Input)

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. M.Gopal “Digital Control and State Variable Methods”, 4th Edition, Tata Mc-Graw Hill, 2012.
2. Benjamin C. Kuo “Digital control systems”, Oxford University Press, 2004. 2. G. F. Franklin, J. D. Powell and M Workman, “Digital Control of Dynamic Systems”, PHI (Pearson), 2002.

19HE29E ROBOTICS AND INDUSTRIAL AUTOMATION

L	T	P	C	QP
3	0	0	3	A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: Explain the individual components of Robotics. (K2)
CO 2: Summarize the kinematics transformation techniques used in Robotics. (K2)
CO 3: Explain about Jacobian matrix used for robotic differential motion and velocities. (K2)
CO 4: Describe the role of image processing and vision system for an automation of robot. (K2)

UNIT I INTRODUCTION AND TERMINOLOGIES 9

Definition-Classification-History- Robots components - Degrees of freedom - Robot joints coordinates - Reference frames-workspace-Robot languages-actuators-sensors-Position, velocity and acceleration sensors-Torque sensors-tactile and touch sensors proximity and range sensors-social issues.

UNIT II KINEMATICS 9

Mechanism-matrix representation-homogenous transformation-DH representation – Inverse kinematics-solution and programming-degeneracy and dexterity.

UNIT III DIFFERENTIAL MOTION AND VELOCITIES 9

Jacobian-differential motion of frames-Interpretation-calculation of Jacobian-Inverse Jacobian-Design - Lagrangian mechanics-dynamic equations-static force analysis.

UNIT IV ROBOT CONTROL SYSTEM 9

Sensor characteristics- Hydraulic, Pneumaticand Electric actuators-trajectory planning decentralised PID control- non-linear decoupling control.

UNIT V IMAGE PROCESSING AND VISION SYSTEMS 9

Two and three dimensional images-spatial and frequency domain representation-noise and edges - convolution masks - Processing techniques – thersholding - noise reductionedge detection - segmentation - Image analysis and object recognition.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Saeed B. Niku, “Introduction to Robotics”, 2nd Edition, Pearson Education, 2010.
2. Fu, Gonzalez and Lee McGrahill, “Robotics”, International TATA McGraw Hill, 2008.
3. R.D. Klafter, TA Chmielewski and Michael Negin, “Robotic Engineering, An Integrated Approach”, Prentice Hall of India, 2003.

19HE30E	FIELD COMPUTATION LABORATORY	L	T	P	C
		0	0	4	2

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: interpret the field distribution model of insulating/dielectric medium. (K2)

CO 2: analyze the generation of transient and overvoltages using simulation tool. (K2)

List of Experiments

1. Electrostatic Analysis of Single and multiple dielectric capacitance model using FEM
2. Modelling of high voltage porcelain insulator with and without contamination layer using FEM
3. Modelling of high voltage bushing with and without contamination layer using FEM
4. Modelling of high voltage glass insulator with and without contamination layer using FEM
5. Modelling of solid dielectric material with different size of void and position using FEM
6. Simulation of Lightning and Switching Impulse voltage generator
7. Simulation of RL,RC and RLC-DC transient circuit
8. FEM Simulation of different electrode configurations

P: 60; TOTAL: 60 PERIODS

19HE31E	POWER SYSTEM SIMULATION LABORATORY	L	T	P	C
		0	0	4	2

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: estimate Y-bus and Z-bus matrix for the given system. (K2)
CO 2: compare the different load flow methods. (K2)
CO 3: intrepret the different stability analysis and short circuit analysis of variety of power systems. (K2)
CO 4: solve Economic load dispatch and Unit commitment problems. (K2)
CO 5: perform state estimation of power system. (K2)

LIST OF EXPERIMENTS

1. Develop Program for Y BUS formation by Singular Transformation method.
2. Develop Program for Z BUS Building Algorithm.
3. Develop Program for Short Circuit Analysis using Z BUS Algorithm.
4. Develop Program for G-S Load Flow Algorithm.
5. Develop Program for DC load Flow Algorithm.
6. Develop Program for DC Power flow analysis by Newton – Raphson method and Fast decoupled method
7. Develop Program for DC Transient stability analysis of single machine - infinite bus system using classical machine model
8. Develop Program for DC Contingency analysis: Generator shift factors and line outage distribution factors
9. Develop Program for DC Economic dispatch using lambda - iteration method
10. Develop Program for DC Unit commitment: Priority - list schemes and dynamic programming
11. Develop Program for DC State Estimation (DC)
12. Develop Simulation and Implementation of Voltage Source Inverter

P: 60; TOTAL: 60 PERIODS

19HE32E	PROTECTION AND SWITCHGEAR LABORATORY	L	T	P	C
		0	0	4	2

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: demonstrate and explain the characteristics of numerical protection relays. (K2)

CO 2: make use of knowledge in using ETAP and SCADA software for power system studies. (K2)

List of Experiments

1. Study and plotting Characteristics of IDMT type Induction over current relay
2. Study and plotting Characteristics of digital over current relay
3. Testing on (i) Under Voltage Relay and (ii) Earth Fault Relay
4. Differential protection of transformer
5. Motor protection using numerical relay
6. Protection of Transmission line using Impedance relay
7. Load flow solution using ETAP software
8. Symmetrical and unsymmetrical fault analysis using ETAP software
9. Relay coordination studies using ETAP software
10. GUI development for any one application using SCADA software
11. Simulation of various power system faults using SCADA software

P: 60; TOTAL: 60 PERIODS

19HE33E	SOFT COMPUTING LABORATORY	L	T	P	C
		0	0	4	2

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: implement various structures of ANN to system identification and control of linear and nonlinear systems. (K2)

CO 2: develop program with fuzzy relationship to control electrical drives. (K2)

CO 3: employ GA to power system optimization and control problems. (K2)

LIST OF EXPERIMENTS

1. Implement Discrete Hopfield Network and Test for Input Pattern.
2. Implement Adaline with Bipolar Inputs and Outputs
3. Implement Back Propagation Network for a Given Input Pattern.
4. Implement Composition of Fuzzy and Crisp Relations.
5. Perform max-min composition of two matrices obtained from cartesian product.
6. System identification using neural network
7. Controlling linear and nonlinear dynamic systems using neural network
8. Short term load forecasting using neural network
9. Implement the fuzzy logic controller for motor drives
10. Economic dispatch problem using GA
11. Load scheduling problem using GA
12. Unit commitment problem using GA
13. PID controller tuning using GA
14. System identification using GA

P: 60; TOTAL: 60 PERIODS

19GD01E BUSINESS ANALYTICS **L T P C QP**
3 0 0 3 A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: Understand the importance of business analytics in an organization and understand relationships between business analytics process and organization decision making process. (K1)
CO2: Study the data analytics process and issues (K2)
CO3: Study the descriptive analytics and predictive analytics for business data (K2)
CO4: Use decision-making models for formulation of decision theory. (K2)

UNIT I BUSINESS ANALYTICS **9**

Overview of Business analytics- Scope of Business Analytics- Business Analytics Process- Relationship of Business Analytics Process and organization- competitive advantages of Business Analytics. Statistical Tools: Statistical Notation- Descriptive Statistical methods-Review of probability distribution and data modeling- Statistical Testing.

UNIT II DATA ANALYTICS PROCESS AND ISSUES **9**

Organization/sources of data, Importance of data quality, Dealing with missing or incomplete data Data Mining Process Introduction to Data Mining, Data Classification: Decision trees, Association Analysis: Market Basket Analysis – Data mining tools.

UNIT III DESCRIPTIVE ANALYTICS **9**

Introduction, Visualizing and Exploring business data, Descriptive Statistics, Sampling and Estimation: Sampling Methods, Sampling Estimation, Introduction to Probability Distributions, Marketing/Planning Case Study on Descriptive Analytics model.

UNIT IV PREDICTIVE ANALYTICS **9**

Introduction, Predictive Modeling: Logic-Driven Models, Data-Driven Models, Data mining for Types of Variation in Time Series Data, Regression Model, Smoothing, Fitting models to Data, Marketing/Planning Case Study on Predictive Analytics model.

UNIT V DECISION THEORY **9**

Introduction, Decision Theory Model Elements for business process, Types of Decision Environments, Decision Theory Formulation, Decision-Making Under Certainty, Decision-Making Under Risk, Decision-Making under Uncertainty, Expected Value of Perfect Information, Sequential Decisions and Decision Trees, The Value of Imperfect Information: Bayes's Theorem, Decision Theory Practice Problems.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Marc J. Schniederjans, Dara G.Schniederjans, Christopher M. Starkey, Business analytics Principles, Concepts, and Applications, Pearson FT Press, 1st Edition, 2014.
2. James R Evans, "Business Analytics", Pearson Education, 2nd Edition, 2017

19GD02E **INDUSTRIAL SAFETY** **L T P C QP**
3 0 0 3 A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: list out important legislations related to health, Safety and Environment. (K1)
CO 2: list out requirements mentioned in factories act for the prevention of accidents. (K1)
CO 3: understand the health and welfare provisions given in factories act. (K2)
CO 4: understand the statutory requirements for an Industry on registration, license and its renewal. (K2)
CO 5: prepare onsite and offsite emergency plan. (K2)

UNIT I INTRODUCTION 9

Industrial safety: Accident-causes- types- results and control- mechanical and electrical Hazards-types-causes and preventive steps/procedure- describe salient points of factories act 1948 for health and safety- wash rooms- drinking water layouts- light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes- Fire prevention and firefighting-equipment and methods.

UNIT II FIRE HAZARDS AND PREVENTION 9

Sources of ignition – fire triangle – principles of fire extinguishing – active and passive fire protection systems – various classes of fires – A, B, C, D, E – types of fire extinguishers – fire stoppers –hydrant pipes – hoses – monitors – fire watchers – lay out of stand pipes – fire station-fire alarms and sirens – maintenance of fire trucks – foam generators – escape from fire rescue operations – fire drills– notice-first aid for burns. Sprinkler-hydrants-stand pipes – special fire suppression systems like deluge and emulsifier, selection criteria of the above installations, reliability, maintenance, evaluation and standards – alarm and detection systems. Other suppression systems – CO2 system, foam system, dry chemical powder(DCP) system, halon system – need for halon replacement – smoke venting. Portable extinguishers –flammable liquids – tank farms – indices of inflammability-fire fighting systems.

UNIT III BIOLOGICAL AND ERGONOMICAL HAZARDS 9

Classification of Biohazardous agents – examples, bacterial agents, rickettsial and chlamydial agents, viral agents, fungal, parasitic agents, infectious diseases - Biohazard control program, employee health program-laboratory safety program-animal care and handling-biological safety cabinets - building design. Work Related Musculoskeletal Disorders –carpal tunnel syndrome CTS- Tendon pain-disorders of the neck- back injuries..

UNIT IV CHEMICAL HAZARDS AND PREVENTION 9

Recognition of chemical hazards-dust, fumes, mist, vapour, fog, gases, types, concentration, Exposure vs. dose, TLV - Methods of Evaluation, process or operation description, Field Survey, Sampling methodology, Industrial Hygiene calculations, Comparison with OSHAS Standard. Air Sampling instruments, Types, Measurement Procedures, Instruments Procedures, Gas and Vapour monitors, dust sample collection devices, personal sampling Methods of Control - Engineering Control, Design maintenance considerations, design specifications - General Control Methods - training and education

UNIT V INDUSTRIAL ACTS 9

Statutory authorities – inspecting staff, health, safety, provisions relating to hazardous processes,welfare, working hours, employment of young persons – special provisions – penalties and procedures-Tamilnadu Factories Rules 1950 under Safety and health chapters of Factories Act 1948, Occupational Safety and Health act of USA (The Williames - Steiger Act of 1970) – Health and safety work act (HASAWA 1974, UK) – OSHAS 18000 – ISO 14000 – American National Standards Institute (ANSI).

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Practical Industrial Safety, Risk Assessment and Shutdown Systems, 1st Edition, Dave Macdonald, Elsevier publications, 2003
2. Occupational Ergonomics: Practical Approach, Theresa Stack, Lee T.Ostrom, Cheryl A. Wilhelmsen, Wiley Publications, 2016
3. The Handbook of Safety Engineering: Principles and Applications, Frank R. Spellman and Nancy E. Whiting, Government Institutes, 2009
4. Benjamin O.Alli, “Fundamental Principles of Occupational Health and Safety”, ILO Geneva, 2nd Edition, 2008.
5. Danuta Koradecka, Handbook of Occupational Health and Safety, CRC, 2010.
6. National seminar on hazardous waste management organized by National Safety council, Ministry of environment and forests, Government of India, United States – Asia environmental partnership, Tamilnadu pollution control board and Indian chemical manufacturers association, April 2001.

19GD03E OPERATIONS RESEARCH **L T P C QP**
3 0 0 3 A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: apply the dynamic programming to solve problems of discrete and continuous variables. (K2)
CO2: apply the concept of non-linear programming. (K2)
CO3: carry out sensitivity analysis.(K2)
CO4: model the real world problem and simulate it. (K2)

UNIT I INTRODUCTION **9**

Optimization Techniques- Model Formulation- models, General L.R Formulation- Simplex Technique-Sensitivity Analysis

UNIT II LINEAR PROGRAMMING **9**

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming-Transportation and Assignment problems

UNIT III NONLINEAR PROGRAMMING PROBLEM **9**

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT.

UNIT IV SCHEDULING AND INVENTORY CONTROL MODELS **9**

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.

UNIT V FINITE AND INFINITE QUEUING MODELS **9**

Finite Queuing Models: Introduction, Finite Queuing Models, nfinite Queuing Models: Introduction, Queuing Theory, Operating Characteristics of a Queuing System, Constituents of a Queuing System, Service Facility, Queue Discipline

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
3. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
4. Pannerselvam, Operations Research: Prentice Hall of India 2010
5. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

19GD04E COST MANAGEMENT OF ENGINEERING PROJECTS L T P C QP
3 0 0 3 A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: Students should able to apply the dynamic programming to solve problems of discreet and continuous variables. (K1)

CO2: Students should able to apply the concept of non-linear programming Students should able to carry out sensitivity analysis. (K2)

CO 3: Student should able to model the real world problem and simulate(K2)

UNIT 1 **9**

Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

UNIT II **9**

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project

UNIT III **9**

Execution: conception to commissioning. Project execution as conglomeration of technical and non-technical activities.Detailed Engineering activities. Pre project execution main clearances and documents Project team: Role of each member. Importance Project site: Data required with significance. Project contracts.Types and contents. Project execution Project cost control. Bar charts and Network diagram. Project commissioning: mechanical and process

UNIT IV **9**

Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems.Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing, Life Cycle Costing. Costing of service sector.Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints.Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis.Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets.Measurement of Divisional profitability pricing decisions including transfer pricing.

UNIT V **9**

Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory

L: 45;TOTAL: 45 PERIODS

REFERENCES

1. Charles T. Horngren, Srikant M. Datar, “Cost Accounting A Managerial Emphasis”, Prentice Hall of India, 14th Edition,New Delhi. 2011
2. Charles T. Horngren and George Foster,“Advanced Management Accounting”. Pearson Education India; 16th Edition,2013.
3. Ashish K. Bhattacharya, “Principles & Practices of Cost Accounting” A. H. Wheeler publisher,Delhi
4. N.D. Vohra,” Quantitative Techniques in Management”, Tata McGraw Hill Book Co. Ltd.

19GD05E COMPOSITE MATERIALS **L T P C QP**
3 0 0 3 A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO 1: Identify, describe and evaluate the properties of fibre reinforcements polymermatrix materials and commercial composites. (K1)

CO 2: Develop competency in one or more common composite manufacturingtechniques, and be able to select the appropriate technique for manufactureof fibre-reinforced composite products.(K1)

CO 3: Analyse the elastic properties and simulate the mechanical performance of composite laminates; and understand and predict the failure behaviour of fibre-reinforced composite products. (K2)

CO 4: Apply knowledge of composite mechanical performance and manufacturing methods to a composites design project.(K2)

UNIT I INTRODUCTION 9

Definition – Classification and characteristics of Composite materials. Advantages and application of composites- Types of reinforcements and matrices-Functional requirements of reinforcement and matrix. Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT II REINFORCEMENTS 9

Preparation-layup, curing- properties and applications of glass fibers-carbon fibers, Kevlar fibers and Boron fibers. Properties and applications of whiskers, particle reinforcements. Mechanical Behavior of composites: Rule of mixtures-Inverse rule of mixtures-Isostrain and Isostress conditions.

UNIT III MANUFACTURING OF METAL MATRIX COMPOSITES 9

Casting – Solid State diffusion technique,Cladding – Hot isostatic pressing. Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving. Properties and applications.

UNIT IV MANUFACTURING OF POLYMER MATRIX COMPOSITES 9

Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications**.**

UNIT V DESIGN AND ANALYSIS OF COMPOSITE MATERIALS 9

Strength: Laminar Failure Criteria-strength ratio- maximum stress criteria-maximum strain criteria-interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength;Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots;stress concentrations.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Mechanics of Composite Materials, Autor K Kaw,Taylor & Francis, 2nd Edition, 2006
2. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany,1993
3. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R.Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.

19GD06E **WASTE TO ENERGY** **L T P C QP**
3 0 0 3 A

COURSE OUTCOMES

Upon completion of this course, the students will be able to

CO1: analyze the various aspects of Waste to Energy Management Systems (K2)
CO2: understand biochemical conversion of biomass for energy application, bioenergy systems and process integration.(K2)
CO3: understand the management of e-waste (K2)

UNIT I INTRODUCTION TO WASTE AND WASTE PROCESSING 9

Solid waste sources solid waste sources, types, composition, properties, global warming; Municipal solid waste: Physical, chemical and biological properties, waste collection and, transfer stations, waste minimization and recycling of municipal waste, segregation of waste, size reduction, managing waste, status of technologies for generation of energy from waste treatment and disposal aerobic composting, incineration, furnace type and design, medical waste / pharmaceutical waste treatment technologies, incineration, environmental impacts, measures to mitigate environmental effects due to incineration

UNIT II WASTE TRATMENT AND DISPOSAL 9

Land fill method of solid waste disposal land fill classification, types, methods and sitting consideration, Layout and preliminary design of landfills: Composition, characteristics, generation, movement and control of landfill leach ate and gases, environmental monitoring system for land fill gases.

UNIT III BIO-CHEMICAL CONVERSION 9

Energy generation from waste bio-chemical conversion: Sources of energy generation, anaerobic digestion of sewage and municipal waste, direct combustion of MSW-refuse derived solid fuel. Industrial waste, agro residues and anaerobic digestion.

UNIT IV THERMO-CHEMICAL CONVERSION 9

Biogas production, land fill gas generation and utilization, thermo-chemical conversion: Sources of energy generation, gasification of waste using gasifies briquetting, utilization and advantages of briquetting, environmental benefits of bio-chemical and thermo- chemical conversion.

UNIT V E- WASTE MANAGEMENT 9

E-waste: E-waste in the global context: Growth of electrical and electronics industry in India, environmental concerns and health hazards; Recycling e-waste: A thriving economy of the unorganized sector, global trade in hazardous waste, impact of hazardous e-waste in India; Management of e-waste: E-waste legislation, government regulations on e-waste management, international experience, need for stringent health safeguards and environmental protection laws of India.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Nicholas P Cheremisinoff, “Handbook of Solid Waste Management and Waste Minimization Technologies”, An Imprint of Elsevier, New Delhi, 2003.
2. Paul Breeze, “Energy from Waste”, An Imprint of Elsevier, New Delhi, 2018.
3. P Aarne Vesilind, William A Worrell and Debra R Reinhart, “Solid Waste Engineering”, 2nd Edition 2002.
4. C Parker and T Roberts (Ed), “Energy from Waste”, An Evaluation of Conversion Technologies, Elsevier Applied Science, London, 1985.
5. KL Shah, “Basics of Solid and Hazardous Waste Management Technology”, Prentice Hall, Reprint Edition, 2000.
6. M Datta, “Waste Disposal in Engineered Landfills”, Narosa Publishing House, 1997.

M.E. – HIGH VOLTAGE ENGINEERING

AUDIT COURSES

19AC01E ENGLISH FOR RESEARCH PAPER WRITING

L	T	P	C	QP
2	0	0	0	D

COURSE OUTCOMES

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

CO1: Understand that how to improve your writing skills and level of readability (K2)

CO2: Learn about what to write in each section (K1)

CO3: Understand the skills needed when writing a title and ensure the good quality of paper at very first-time submission (K2)

UNIT I **5**

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

UNIT II **5**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts. Introduction

UNIT III **5**

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

UNIT IV **5**

Key skills are needed when writing a Title; key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

UNIT V **5**

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions.

UNIT VI **5**

Useful phrases, how to ensure paper is as good as it could possibly be the first- time submission

L: 30; TOTAL:30 PERIODS

REFERENCES

1. Using English for Academic Purposes. A guide for students in higher education, comprises a large collection of links, including writing materials: http://www.uefap.com/.
2. British Association of Lecturers in English for Academic Purposes: http://www.baleap.org.uk/.
3. Goldbort R, Writing for Science, Yale University Press, 2006
4. Day R How to Write and Publish a Scientific Paper, Cambridge University Press, 2011
5. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook, 1998.
6. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht

19AC02E **DISASTER MANAGEMENT** **L T P C QP**
2 0 0 0 D

COURSE OUTCOMES

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

CO1: Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and manitarian response.(K2)

CO2: Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives. (K2)

CO3: Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations. (K2)

CO4. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in (K2)

UNIT I INTRODUCTION 4

Disaster: Definition- Factors and Significance- Difference Between Hazard and Disaster- Natural And Manmade Disasters: Difference-Nature- Types And Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS 6

Economic Damage: Loss Of Human And Animal Life, Destruction Of Ecosystem-Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods ,Droughts and Famines, Landslides and Avalanches- Man-made disaster- Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA 6

Study Of Seismic Zones: Areas Prone To Floods And Droughts-Landslides and Avalanches-Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami- Post-Disaster Diseases and Epidemics.

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6

Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard-Evaluation Of Risk-Application Of Remote Sensing- Data from Meteorological and other Aaencies-Media Reports-Governmental and Community Preparedness**.**

UNIT V RISK ASSESSMENT AND DISASTER MITIGATION 8

Disaster Risk: Concept and Elements- Disaster Risk Reduction- Global and National Disaster Risk Situation-Techniques of Risk Assessment-Global Co-Operation In Risk Assessment and Warning, People's Participation In Risk Assessment- Strategies for Survival**.**

Meaning: Concept And Strategies Of Disaster Mitigation-Emerging Trends In Mitigation-Structural Mitigation and Non-Structural Mitigation-Programs of Disaster Mitigation In India.

L: 30; TOTAL: 30 PERIODS

REFERENCES

1. Singhal J.P. "Disaster Management", Laxmi Publications, ISBN-10: 9380386427 ISBN-13: 978-9380386423, 2010.
2. Tushar Bhattacharya, "Disaster Science and Management", McGraw Hill India Education Pvt. Ltd., ISBN-10: 1259007367, ISBN-13: 978-125900736, 2012.
3. Gupta Anil K, Sreeja S. Nair, "Environmental Knowledge for Disaster Risk Management", NIDM, New Delhi, 2011.
4. Kapur Anu, "Vulnerable India: A Geographical Study of Disasters", IIAS and Sage Publishers, New Delhi, 2010.
5. National Disaster Management Plan, 2018, https://ndma.gov.in/images/pdf/NDMP-2018-Revised-Draft-1-2018OCT16-A.pdf
6. National Disaster Management Authority, Government of India, 2018, https://ndma.gov.in/images/pdf/Draft-Guidelines-thunderstorm-final.pdf

19AC03E SANSKRIT FOR TECHNICAL KNOWLEDGE **L T P C QP**
2 0 0 0 D

COURSE OUTCOMES

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

CO1: Learn the Sanskrit sources of technical knowledge (K1)
CO2: Drawing their attention to a different dimension of Sanskrit literary tradition (K3)
CO3: Create awareness of the contemporary relevance of the Sanskrit sources of traditional wisdom (K3)

UNIT I INTRODUCTION **7**

Scope and meaning of study of technical literature in Sanskrit. Different disciplines-interdisciplinary approach-dimensions-contemporary relevance- important works in this direction-scientific methodology in ancient India.

UNIT II AYURVEDA **7**

Beginnings of Ayurveda in Atharvaveda-Ayurvedic literature-basic principles of Ayurveda-Pancabhutasiddhanta-Tridosasiddhanta-eight anga-s of Ayurveda- Rasacikitsa-contribution of Kerala to Ayurveda

UNIT III ASTRONOMY AND MATHEMATICS **8**

Major texts in Vedic and classical period-Vedangajyotisa-Sulbasutra-s-Aryabhatiya- Aryabhata's contribution-Varahamihira-Brahmagupta-Lalla-etc. Suryasiddhanta- Kerala school Parahita and drk systems-Later astronomical works commentaries.

UNIT IV VASTUSASTRA AND ARTHASASTRA **8**

Principles of Vastusastra-Basic texts-Vastuvidya and Ecology-Iconography and sculpture-Kerala tradition of Vastusastra. Arthasastra, a historical and sociaological perspective-structure and contents of the text-emphasis to aspects of agriculture and architecture.

L: 30; TOTAL: 30 PERIODS

REFERENCES

1. Ramakrishna Mission Institute ,"Cultural Heritage of India", (Vol. i and iii), Calcutta,2010
2. Dr. P. C. Muraleemadhavan and Dr. N. K.Sundareswaran," Sanskrit in Technological Age, (Ed.) ", New Bharatiya Book Corporation, Delhi, 2006
3. https://sanskritdocuments.org/articles/ScienceTechSanskritAncientIndiaMGPrasad.pdf
4. http://www.vedanta.gr/wp-content/uploads/2012/03/3_GlossaryOfCommonSanskrit Terms.pdf

19AC04E **VALUE EDUCATION** **L T P C QP**
2 0 0 0 D

COURSE OUTCOMES

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

CO1: Understand the need of values and its classification in contemporary society (K2)
CO2: Become aware of role of education in building value as dynamic social reality. (K1)
CO3: Know the importance of value education towards personal, national and global development. (K1)

UNIT I **10**

Values and self-development –Social values and individual attitudes- Work ethics- Indian vision of humanism-Moral and non- moral valuation- Standards and principles-Value judgements.
Importance of cultivation of values-Sense of duty- Devotion- Self-reliance- Confidence-Concentration -Truthfulness-Cleanliness- Honesty- Humanity- Power of faith- National Unity-Patriotism-Love for nature- Discipline.

UNIT II **10**

Personality and Behavior Development - Soul and Scientific attitude- Positive Thinking -Integrity and discipline-Punctuality- Love and Kindness-Avoid fault Thinking-Free from anger- Dignity of labour-Universal brotherhood and religious tolerance-True friendship-Happiness Vs suffering- love for truth-Aware of self-destructive habits-Association and Cooperation- Doing best for saving nature.

UNIT III **10**

Character and Competence –Holy books vs Blind faith- Self management and Good health-Science of reincarnation- Equality- Nonviolence- Humility-Role of Women- All religions and same message-Mind your Mind-Self-control-Honesty- Studying effectively.

L: 30; TOTAL: 30 PERIODS

REFERENCES

1. Sharma, S.P., "Moral and Value Education: Principles and Practices", Kanishka publishers, 2013.
2. Kiruba Charles & V.Arul Selvi.," Value Education", Neelkamal Publications, New Delhi, 2012.
3. Passi, B.K. and Singh, P.,"Value Education", National Psychological Corporation, Agra. 2004.
4. http://cbseportal.com/exam/e-books/download-free-ncert-e-book-education-for-values-in-school-a-framework/
5. http://cbseacademic.in/web_material/ValueEdu/Value%20Education%20Kits.pdf

19AC05E CONSTITUTION OF INDIA **L T P C QP**
2 0 0 0 D

COURSE OUTCOMES

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

CO1: understand the premises informing the twin themes of liberty and freedom from a civil rights perspective. (K2)

CO2: address the growth of Indian opinion regarding modern Indian intellectuals constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism. (K2)

CO3: address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution. (K1)

UNIT I HISTORY AND PHILOSOPHY OF INDIAN CONSTITUTION 6

History-Drafting Committee, (Composition & Working). - Preamble- Salient Features.

UNITII CONTOURS OF CONSTITUTIONAL RIGHTS & DUTIES 6

Fundamental Rights - Right to Equality-Right to Freedom - Right against Exploitation - Right to Freedom of Religion - Cultural and Educational Rights - Right to Constitutional Remedies - Directive Principles of State Policy- Fundamental Duties.

UNIT III ORGANS OF GOVERNANCE 6

Parliament- Composition-Qualifications and Disqualifications- Powers and Functions- Executive-President-Governor-Council of Ministers- Judiciary- Appointment and Transfer of Judges-Qualifications-Powers and Functions**.**

UNIT IV LOCAL ADMINISTRATION 6

District's Administration head: Role and Importance- Municipalities: Introduction, Mayor and role of Elected Representative-CEO of Municipal Corporation-Pachayati raj: Introduction, PRI:ZilaPachayat- Elected officials and their roles,-CEO ZilaPachayat: Position and role- Block level: Organizational Hierarchy (Different departments)-Village level: Role of Elected and Appointed officials- Importance of grass root democracy.

UNIT V ELECTION COMMISSION 6

Election Commission: Role and Functioning -Chief Election Commissioner and Election Commissioners-State Election Commission: Role and Functioning.-Institute and Bodies for the welfare of SC/ST/OBC and women.

L: 30; TOTAL: 30 PERIODS

REFERENCES

1. Subhash .C, kashyap "Our Constitution", 5th Edition, 2017
2. www.ieagreements.org/IEA-Grad-Attr-Prof-Competencies.pdf
3. The Constitution of India, 1950 (Bare Act), Government Publication.
4. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
5. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
6. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

19AC06E PEDAGOGY STUDIES **L T P C QP**
2 0 0 0 D

COURSE OUTCOMES

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

CO1: Describe the pedagogical practices used by teachers in formal and informal classrooms (K3)

CO2: Understand the effectiveness of these pedagogical practices, in what conditions, and with what population of learners (K2)

CO3: Analyze how teacher education (curriculum and practicum) and the school curriculum with guidance materials support effective pedagogy (K3)

UNIT I INTRODUCTION AND METHODOLOGY 8

Aims and rationale, Policy background, Conceptual framework and terminology-Theories of learning, Curriculum, Teacher education.Conceptual framework, Research questions**.** Overview of methodology and Searching. Thematic overview- Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries- Curriculum- Teacher education.

UNIT II EFFECTIVENESS OF PEDAGOGICAL PRACTICES 8

Evidence on the effectiveness of pedagogical practices-Methodology for the in depth stage: quality assessment of included studies- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy- Theory of change- Strength and nature of the body of evidence for effective pedagogical Practices- Pedagogic theory and pedagogical approaches- Teachers attitudes and beliefs and Pedagogic strategies.

UNIT III PROFESSIONAL DEVELOPMENT 7

Alignment with classroom practices and follow-up support- Peer support-Support from the head teacher and the community-Curriculum and assessment-Barriers to learning: limited resources and large class sizes.

UNIT IV RESEARCH GAPS AND FUTURE DIRECTIONS 7

Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

L:30; TOTAL:30 PERIODS

REFERENCES

1. Dr.S.K.Bhatia and Dr.Sonia Jindal, “A Text Book Of Curriculum, Pedagogy And Evaluation”,Paragon International Publications, 2016.
2. Ackers J, Hardman F Classroom interaction in Kenyan primary schools, Compare, 31 (2):245-261, 2001.
3. Agrawal M ,"Curricular reform in schools: The importance of evaluation", Journal of Curriculum Studies, 36 (3): 361-379,2004.
4. Akyeampong K ," Teacher training in Ghana - does it count?", Multi-site teacher education research project (MUSTER) country report 1. London: DFID,2003.
5. Akyeampong K, Lussier K, Pryor J, Westbrook J ," Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count?", International Journal Educational Development, 33 (3): 272–282,2013.
6. Alexander RJ,"Culture and pedagogy: International comparisons in primary education",Oxford and Boston: Blackwell,2001.
7. Chavan M, "Read India: A mass scale, rapid, ‘learning to read’", campaign, 2003.
8. www.pratham.org/images/resource%20working%20paper%202.pdf.

19AC07E STRESS MANAGEMENT BY YOGA **L T P C QP**
2 0 0 0 D

COURSE OUTCOMES

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

CO1: achieve overall health of body and mind (K1)

CO2: overcome stress (K2)

UNIT I INTRODUCTION **10**

Introduction to Stress-Concept of Stress-Solutions through Mandukya karika - Relaxation and stimulation combined as the core for stress management-Practice of Stimulation and relaxation.

UNIT II ASAN AND PRANAYAM **10**

Definitions of Eight parts of yoga. (Ashtanga)-Various yoga poses and their benefits for mind & body-Regularization of breathing techniques and its effects-Types of pranayam.

UNIT III YOGA AND STRESS MANAGEMENT **10**

Concepts and Techniques of Stress Management in Ashtanga Yoga of Patanjali - specific practices for stress management-breathe awareness.

L:30; TOTAL:30 PERIODS

REFERENCES

1. Swami Vivekananda, Advaita Ashrama ,“Rajayoga or conquering the Internal Nature”, 2016.
2. K.N.Udupa**, “**Stress and Its Management by Yoga”, Edited by R.C.Prasad, Motilal Banarashidass Publishers, Delhi, 2010.
3. Lisa Shea,”Yoga for Stress Relief and Forgiveness”, Kindle Edition, 2015.
4. BKS Iyengar, “Yoga: The path to Holstic Health”, DK Publication, 2019
5. https://www.longdom.org/open-access/stress-and-yoga-2157-7595.1000109.pdf

19AC08E	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	L T P C QP 2 0 0 0 D

COURSE OUTCOMES

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

CO1: learn to achieve the highest goal happily (K1)

CO2: become a person with stable mind, pleasing personality and determination (K1)

CO3: awaken wisdom in students (K1)

UNIT I INTRODUCTION TO PERSONALITY DEVELOPMENT 10

The concept of personality - Dimensions of personality – Theories of Freud & Erickson- Significance of personality development. The concept of success and failure: What is success? - Hurdles in achieving success - Overcoming hurdles - Factors responsible for success – What is failure - Causes of failure-SWOT analysis.

UNIT II LIFE ENLIGHTENMENT SKILLS 10

Neetisatakam-Holistic development of personality, Verses 19,20,21,22 (wisdom), Verses 29,31,32 (pride & heroism), Verses 26,28,63,65 (virtue), Verses 52,53,59 (dont's), Verses 71,73,75,78 (do's).Approach to day to day work and duties, Shrimad Bhagwad Geeta, Chapter 2-Verses 41, 47,48, Chapter 3 Verses 13, 21, 27, 35, Chapter 6 Verses 5,13,17, 23, 35, Chapter 18 Verses 45, 46, 48.

UNIT III SHRIMAD BHAGWAD GEETA STATEMENTS 10

Statements of basic knowledge, Shrimad Bhagwad Geeta: Chapter2 Verses 56, 62, 68, Chapter 12 Verses 13, 14, 15, 16,17, 18, Personality of Role model. Shrimad Bhagwad Geeta, Chapter2 Verses 17, Chapter3 Verses 36,37,42, Chapter4 Verses 18, 38,39, Chapter18 Verses 37,38,63

L:30; TOTAL:30 PERIODS

REFERENCES

1. Swami Swarupananda Advaita Ashram ,"Srimad Bhagavad Gita" , Publication Department, Kolkata.
2. P.Gopinath, Rashtriya Sanskrit Sansthanam, " Bhartrihari's Three Satakam (Niti-sringar-vairagya) ", New Delhi.