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
MECHANICAL ENGINEERING

CURRICULUM AND SYLLABI OF
M.E. – ENERGY ENGINEERING

SEMESTER – I

S. No.	Course Category	Course Code	Course Title	L	T	P	C	QP
1.	PCC	19EN11C	Advanced Thermal Engineering	3	2	0	4	A
2.	PCC	19EN12C	Renewable Energy Sources Conversion and Technology	3	0	0	3	A
3.	GEN	19EN13C	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 – 1	2	0	0	0	D
7.	PCC	19EN14C	Energy Laboratory-I	0	0	4	2	-
			Total	**16**	**2**	**4**	**17**	-

SEMESTER – II

S. No.	Course Category	Course Code	Course Title	L	T	P	C	QP
1.	PCC	19EN21C	Solar Energy and Utilization	3	0	0	3	A
2.	PCC	19EN22C	Bio Energy Engineering	3	0	0	3	A
3.	PCC	19EN23C	Energy Efficient Buildings	3	0	0	3	A
4.	PEC		Elective – III	3	0	0	3	A
5.	PEC		Elective - IV	3	0	0	3	A
6.	AC-2		Audit Course – 2	2	0	0	0	D
7.	PCC	19EN24C	Energy Laboratory-II	0	0	4	2	-
8.	PCC	19EN25C	Mini Project with Seminar	0	0	4	2	-
			Total	**17**	**0**	**8**	**19**	**-**

SEMESTER – III

S. No.	Course Category	Course Code	Course Title	L	T	P	C	QP
1.	PEC		Elective – V	3	0	0	3	A
2.	PEC		Elective – VI	3	0	0	3	A
3.	PEC		Elective – VII	3	0	0	3	A
4.	PSC	19EN31C	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 COURSES								
1.	PSC	19EN41C	Project Work - II	0	0	32	16	-
			TOTAL	**0**	**0**	**32**	**16**	**-**

TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE - 71

* - *Studies to demonstrate simple basic concepts and aspects of various Energy Technologies have to be carried out by the students in the II semester which will be evaluated by the Internal Examiner.*

ELECTIVE COURSES

S. No.	Course Code	Course Title	L	T	P	C	QP
1.	19EN01E	Electrical Technology for Energy Systems	3	0	0	3	A
2.	19EN02E	Thermal Energy Systems for Electrical Engineers	3	0	0	3	A
3.	19EN03E	Advanced Power Plant Engineering	3	0	0	3	A
4.	19EN04E	Advanced Thermal Storage Technologies	3	0	0	3	A
5.	19EN05E	Alternative Fuels	3	0	0	3	A
6.	19EN06E	Cogeneration and Waste Heat Recovery Systems	3	0	0	3	A
7.	19EN07E	Design and Optimization of Energy Systems	3	0	0	3	A
8.	19EN08E	Design of Heat Exchangers	3	0	0	3	A
9.	19EN09E	Design of Experiments	3	0	0	3	A
10.	19EN10E	Energy System Modeling and Project Management	3	0	0	3	A
11.	19EN11E	Fluidized Bed Systems	3	0	0	3	A
12.	19EN12E	Fuel cells and Hydrogen Energy	3	0	0	3	A
13.	19EN13E	Materials for Energy Applications	3	0	0	3	A
14.	19EN14E	Nuclear Engineering	3	0	0	3	A
15.	19EN15E	Solar Architecture	3	0	0	3	A
16.	19EN16E	Solar Refrigeration and Air-Conditioning	3	0	0	3	A
17.	19EN17E	Waste Management and Energy Recovery	3	0	0	3	A

S. No.	Course Code	Course Title	L	T	P	C	QP
18.	19EN18E	Wind Energy Technology	3	0	0	3	A
19.	19EN19E	Energy Conservation in Thermal and Electrical Utilities	3	0	0	3	A
20.	19EN20E	Industrial Energy Management	3	0	0	3	A
21.	19EN21E	Instrumentation and Control for Energy Systems	3	0	0	3	A
22.	19EN22E	Solar Photovoltaic Power Plants: Planning, Design and Balance of Systems	3	0	0	3	A
23.	19EN23E	Materials Testing and Characterization Techniques	3	0	0	3	A
24.	19EN24E	Micro Manufacturing	3	0	0	3	A
25.	19EN25E	Non-destructive Testing and Evaluation	3	0	0	3	A
26.	19EN26E	Polymers and Composite Materials	3	0	0	3	A
27.	19EN27E	Surface Engineering	3	0	0	3	A
28.	19EN28E	Solar Energy Conversion Technologies	3	0	0	3	A
29.	19EN29E	Computational Fluid Dynamics for Energy Systems	3	0	0	3	A
30.	19GD11E	Analytical Chemistry	3	0	0	3	A
31.	19GD12E	Coordination Chemistry	3	0	0	3	A
32.	19GD13E	Material Sciences and Engineering	3	0	0	3	A
33.	19GD14E	Nanotechnology	3	0	0	3	A
34.	19GD15E	Physical Organic Chemistry	3	0	0	3	A
35.	19GD16E	Spectroscopic Methods in Chemistry	3	0	0	3	A
36.	19GD17E	Advanced Vibration Engineering	3	0	0	3	A
37.	19GD18E	Machinery Fault Diagnosis	3	0	0	3	A
38	19GD19E	Rotor Dynamics	3	0	0	3	A
39.	19GD20E	Optimization Techniques	3	0	0	3	A
	--	Courses offered by other PG programs	3	0	0	3	A

AUDIT COURSES

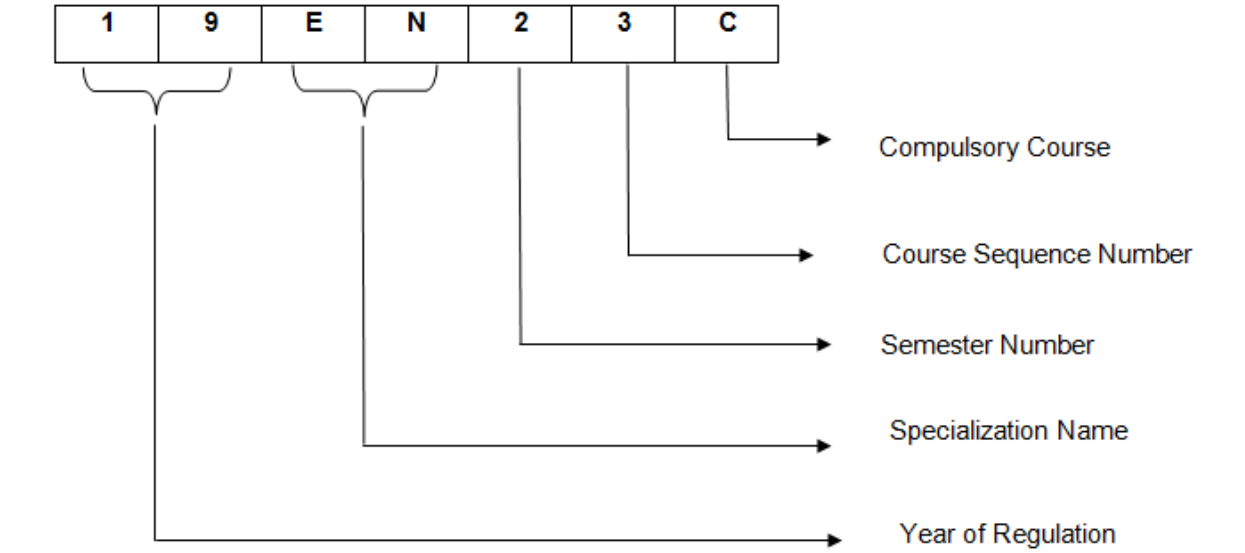
S. No	Course Category	Course Code	Course Title	L	T	P	C	QP
1	AC	19AC01E	English for Research Paper Writing	2	0	0	0	D
2	AC	19AC02E	Disaster Management	2	0	0	0	D
3	AC	19AC03E	Sanskrit for Technical Knowledge	2	0	0	0	D

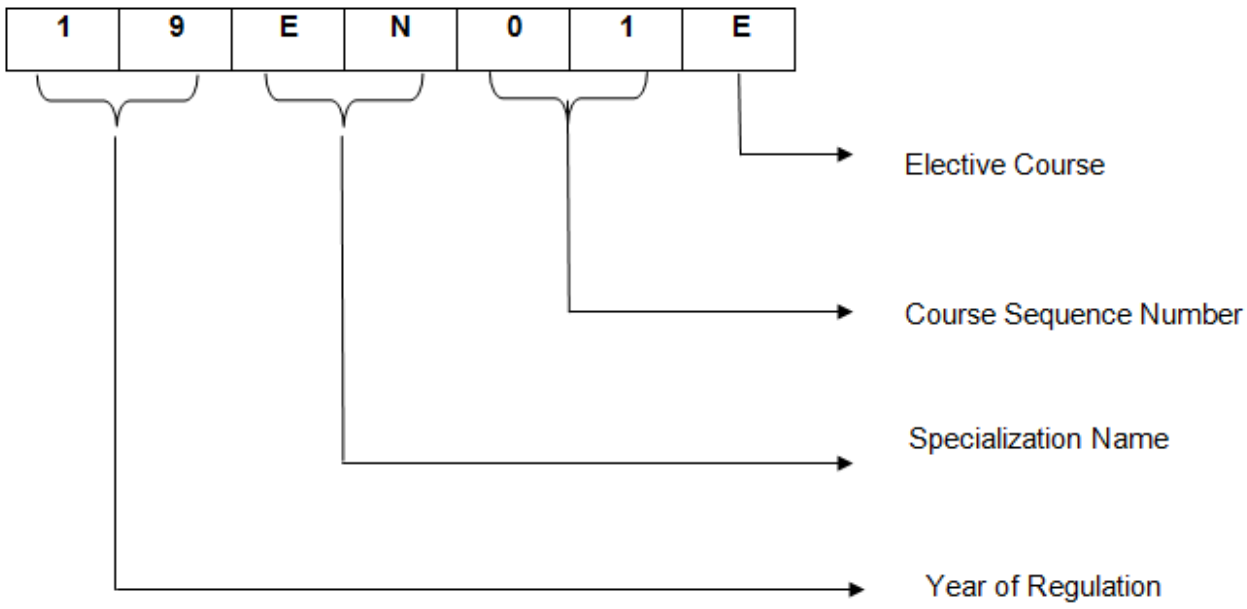
4	AC	19AC04E	Value Education	2	0	0	0	D
5	AC	19AC05E	Constitution of India	2	0	0	0	D
6	AC	19AC06E	Pedagogy Studies	2	0	0	0	D
7	AC	19AC07E	Stress Management by Yoga	2	0	0	0	D
8	AC	19AC08E	Personality Development through Life Enlightenment Skills	2	0	0	0	D

QP - QUESTION PATTERN

Subject Type	Question pattern	2 marks	4 marks	10 marks	11 marks	12 marks	20 marks	Total
Theory (3/4 Credit)	A	10	5	--	--	1 Qn Compulsory & 4 Qns (either or type)	--	100
Theory (2 Credit)	B	10	-	-	1 Qn Compulsory & 4Qn (either or type)			75
Theory (1 Credit)	C	5	--	1 Qn Compulsory & 1 Qn (either or type)	--	--	--	30
Theory Trans Disciplinary	D	--	--	--	--	--	5 out of 8	100
Design oriented	E	--	--	--	--	--	1 Qn Compulsory & 4 Qns (either or type)	100
10,11 and 12 marks questions will be a single question and no subdivisions								

FORMAT FOR COURSE CODE





19EN11C ADVANCED THERMAL ENGINEERING L T P C QP
3 2 0 4 A

COURSE OUTCOMES

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

CO 1 : apply second law of thermodynamics for the various concepts. (K3)
CO 2 : apply thermodynamic relations for the energy systems. (K3)
CO 3 : apply the theories of fluid flow and boundary layer for the energy applications (K3)
CO 4 : elucidate conduction heat transfer for the various applications. (K3)
CO 5 : reveal the modes of convection and radiation heat transfer for energy applications. (K3)

UNIT I REVIEW OF THERMODYNAMICS AND SECOND LAW ANALYSIS 15

Basic concepts of thermodynamics; irreversibility; Review of basic laws of thermodynamics and their consequences; Concept of Exergy and Entropy; Exergy for closed system; Entropy generation; entropy balance for closed system; behavior of gases; Equations of state.

UNIT II THERMODYNAMIC RELATIONS 15

Phase equilibrium; phase rule without chemical reaction; chemical potential of ideal gases; T-ds equations for simple compressible systems; Helmholtz and Gibbs functions; Maxwell relations; generalized relations for changes in enthalpy; entropy and internal energy; equations for specific heats; Clausius clapeyron equation; Joule-Thomson and Joule coefficients; applications of thermodynamic relations.

UNIT III VISCOUS FLOW AND BOUNDARY LAYER THEORIES 15

Review of basics of fluid mechanics; Three dimensional continuity equation; equations of momentum and energy and their engineering applications; Laminar and turbulent flow; laminar flow between parallel plates; Poiseuille's equation for flow through circular pipes; Turbulent flow; Darcy Weisbach equation for flow through circular pipe; Friction factor; Smooth and rough pipes; Moody diagram; Boundary Layer; displacement and momentum thickness; laminar and turbulent boundary layers in flat plates; velocity distribution in turbulent flows in smooth and rough boundaries

UNIT IV CONDUCTION HEAT TRANSFER 15

Review of the basic laws of conduction; One dimensional steady state conduction with variable thermal conductivity and with internal distributed heat source; Extended surfaces-review and design considerations; Two dimensional steady state conduction; Unsteady state conduction; solutions using Groeber's and Heisler's charts for plates, cylinders and spheres suddenly immersed in fluids.

UNIT V CONVECTION AND RADIATION HEAT TRANSFER 15

Review of convection and radiation heat transfer laws, Natural and forced convection; Heat transfer in turbulent flow; eddy heat diffusivity; Reynold's analogy between skin friction and heat transfer; von Karman; turbulent flow through circular tubes; Review of radiation principles; diffuse surfaces and the Lambert's Cosine law; Radiation through non-absorbing media; Hottel's method of successive reflections.

L: 45; T: 30; TOTAL: 75 PERIODS

REFERENCES

1. Moran MJ & Shapiro HM, “Fundamentals of Engineering Thermodynamics”, 9th Edition, John Wiley, 2019
2. A.Faghri, JHowell, Y Zhang, “Advanced Heat and Mass Transfer”, Global Digital Press, 2010
3. P.K.Nag, “Engineering Thermodynamics”, 5th Edition, Tata McGraw-Hill, 2013
4. Y.A Cengel, M.A.Boles, “Thermodynamics: An Engineering Approach”, 7th Edition, Mcgraw-Hill Series 2017
5. Bejan,A., “Advanced Engineering Thermodynamics” 4th Edition, John Wiley and Cons, 2016.
6. Streeter, V.L., Wylie, E.B., Boston, and Bedford, K.W., Fluid Mechanics, 9th Edition, WCB McGraw Hill, 2017.
7. Frank Kreith., “The CRC handbook of Thermal Engineering”, Springer, 2013.
8. Hans Dieter Baehr, Karl Stephan, “Heat and Mass Transfer”, Springer, 2011.

19EN12C RENEWABLE ENERGY SOURCES CONVERSION AND 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 : develop knowledge on solar radiation principles and its conversion (K2)
CO 2 : interpret the concepts of extraction of Wind Energy (K2)
CO 3 : reveal the various forms of Bio-Energy and Conversion techniques (K2)
CO 4 : familiarize with the concepts of Hydrogen Energy (K2)
CO 5 : recognize the basic principles of concept of various other forms of renewable energy (K2)

UNIT I SOLAR ENERGY **9**

Solar radiation its measurements and prediction - solar thermal flat plate collectors concentrating collectors – applications - heating, cooling, desalination, power generation, drying, cooking etc - principle of photovoltaic conversion of solar energy, types of solar cells and fabrication. Photovoltaic applications: battery charger, domestic lighting, street lighting, and water pumping, power generation schemes.

UNIT II WIND ENERGY **9**

Atmospheric circulations – classification - factors influencing wind - wind shear – turbulence - wind speed monitoring - Betz limit - Aerodynamics of wind turbine rotor- site selection - wind resource assessment - wind energy conversion devices - classification, characteristics and applications. Hybrid systems - safety and environmental aspects.

UNIT III BIO-ENERGY **9**

Biomass resources and their classification - chemical constituents and physicochemical characteristics of biomass - Biomass conversion processes - Thermo chemical conversion: direct combustion, gasification, pyrolysis and liquefaction - biochemical conversion: anaerobic digestion, alcohol production from biomass - chemical conversion process: hydrolysis and hydrogenation. Biogas - generation - types of biogas Plants- applications

UNIT IV HYDROGEN AND FUEL CELLS **9**

Thermodynamics and electrochemical principles - basic design, types, and applications - production methods - Biophotolysis: Hydrogen generation from algae biological pathways - Storage gaseous, cryogenic and metal hydride and transportation. Fuel cell – principle of working - various types - construction and applications.

UNIT V OTHER TYPES OF ENERGY **9**

Ocean energy resources - principles of ocean thermal energy conversion systems - ocean thermal power plants - principles of ocean wave energy conversion and tidal energy conversion – hydropower – site selection, construction, environmental issues - geothermal energy - types of geothermal energy sites, site selection, and geothermal power plants.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Sukhatme S.P., “Solar Energy”, 4th edition Tata McGraw Hill, 2017**.**
2. Mukund R. Patel, “Wind and Solar Power Systems”, 2nd edition, CRC Press, 2006.
3. Hart, A.B., and Womack, G. J.,”Fuel Cells: Theory & Applications”, 2nd edition, Prentice Hall, 2012.
4. Godfrey Boyle, “Renewable Energy, Power for a Sustainable Future”, Oxford University Press, U.K, 2012.
5. Kreith, F and Kreider, J. F.,” Principles of Solar Engineering”, 3rd edition McGraw-Hill, 2016
6. Veziroglu, T.N., “Alternative Energy Sources”, Vol.5 and 6, McGraw-Hill, 1996
7. Twidell, J.W. and Weir, A., “Renewable Energy Sources”, EFN Spon Limited, 1986.
8. Khandelwal K.C, Mahdi S.S., “Biogas Technology” - A Practical Handbook, Tata McGraw Hill, 1989.

19EN13C 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.

19EN14C **ENERGY 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: carry out the performance analysis and optimization of energy utilities (K2)
CO 2: familiarize with the parameters that affect the performance of energy systems (K2)
CO 3: analyze the characteristics of various fuels (K2)

RENEWABLE ENERGY **36**

1. Performance testing of Solar Water Collector
2. Characteristics of Solar photovoltaic devices
    - Investigation of PV Characteristics – Amorphous Silicon.
    - Investigation of PV Characteristics – Amorphous Silicon – Shadow effect
    - Comparative Performance Analysis of Mono & Poly Crystalline Silicon PV cell
3. Testing of Gasifier
4. Properties of Fuels
    - Determination of Flash and Fire Point using Pensky Marten Apparatus
    - Determination of Flash and Fire Point using Abel Apparatus
    - Determination of Density and Dynamic Viscosity of oil using Redwood Viscometer
5. Solar Radiation measurement
6. Performance testing of Solar Air Heater
7. Performance testing of Solar Still
8. Performance Study on Concentric Collectors
9. Study of biogas plant

ENERGY CONSERVATION **18**

1. Performance Test of Parallel flow and Counter flow Heat Exchanger
2. Energy consumption measurement of lighting systems
3. Performance Test on Vapour Compression Refrigeration Systems
4. Performance Test on Air conditioning Systems

ADVANCED ENERGY SYSTEMS **06**

1. Thermal Storage Systems

P: 60; TOTAL: 60 PERIODS

19EN21C SOLAR ENERGY AND UTILIZATION 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 : predict and estimate solar energy potential and its availability (K2)
CO 2 : examine various collecting techniques of solar thermal systems (K2)
CO 3 : interpret PV technology principles, and conversion of solar energy into Electricity (K2)
CO 4 : familiarize with the basic applications of photovoltaic system (K2)
CO 5 : reveal the variety of thermal energy storage systems (K2)

UNIT I SOLAR RADIATION 9

Source of radiation – Sun earth relationship- extra terrestrial radiation.– Atmospheric attenuation – Terrestrial radiation-radiation on a horizontal surfaces and inclined planes - relations between monthly, daily and hourly radiation and components of the radiations– solar charts – Critical radiation-Measurement of global, direct and diffuse solar radiation- pyroheliometer, pyrano meter, pyro geo meter, sunshine recorder – an overview of solar radiation data in India.

UNIT II SOLAR THERMAL SYSTEMS 9

Flat plate collectors-Temperature distributions- Heat removal rate- Useful energy gain – Losses in the collectors - efficiency of flat plate collectors – selective surfaces – tubular solar energy collectors– testing of flat plate collectors. Concentric collectors - Limits to concentration – concentrator mounting – tracking mechanism - Solar Desalination, Solar Water Heating, Solar Air Heating, Solar Drying.

UNIT III PHOTOVOLTAIC (PV) SYSTEMS 9

Conversion of Solar energy into Electricity - Photovoltaic Effect, Photovoltaic material - Solar Cell – Module – Silicon solar cell, Efficiency limits, Variation of efficiency with band-gap and temperature, Efficiency measurements, High efficiency cells, Recent developments in Solar Cells - PV systems - applications

UNIT IV PHOTOVOLTAIC (PV) APPLICATIONS 9

Grid-Tied PV systems - Stand-Alone PV Applications - PV Solar Home Lighting Systems - PV Battery Charging Stations - PV for Schools - PV for Protected Areas - PV Water-Pumping

UNIT V THERMAL ENERGY STORAGE 9

Sensible Heat Storage – Liquid media storage – Solid media storage – Latent heat storage - Phase change materials – Electro chemical storage – Mechanical storage – Super capacitors

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. L D. Partain, L M. Fraas, “Solar Cells and Their Applications”, 2nd Edition, John Wiley and Sons, 2010
2. Robert Foster Majid Ghassemi, Alma Cota “Solar Energy – Renewable Energy and the Environment”, CRC Press, 2nd Edition, 2010
3. Soteris Kalogirou, “Solar Energy Engineering”, Academic Press, 2009
4. Sukhatme S P, “Solar Energy”, 4th Edition, Tata McGraw-Hill Education, 2017
5. G. N. Tiwari, “Solar Energy Fundamentals, Design, Modelling and Applications”, Narosa Publishing House Private Limited, 2015
6. H.P. Garg and J. Prakash, “Solar Energy- Fundamentals & Applications”, Tata McGraw-Hill, 2000

19EN22C BIO ENERGY 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 : classify the types of biomass and its surplus availability. (K2)

CO 2 : analyze the bio-chemical energy conversion processes and technologies in terms of its technical competence and economic implications.(K3)

UNIT I INTRODUCTION 9

Biomass: types – advantages and drawbacks – Indian scenario – characteristics – carbon neutrality – conversion mechanisms – fuel assessment studies

UNIT II BIO METHANATION 9

Microbial systems – phases in biogas production – parameters affecting gas production – effect of additives on biogas yield – possible feed stocks. Biogas plants – types – design – constructional details and comparison – biogas appliances – Burner, illumination and power generation – effect on engine performance. Kinetics and mechanism - High rate digesters for industrial waste water treatment.

UNIT III COMBUSTION 9

Perfect, complete and incomplete – equivalence ratio – fixed Bed, fluid Bed – fuel and ash handling – steam cost comparison with conventional fuels. Briquetting: types of Briquetting – merits and demerits – feed requirements and preprocessing – advantages – drawbacks

UNIT IV GASIFICATION 9

Types – comparison – application – performance evaluation – economics – dual fuel engines – 100 % Gas Engines – engine characteristics on gas mode – gas cooling and cleaning train.

UNIT V PYROLYSIS AND CARBONIZATION 9

Pyrolysis-Types – process governing parameters – differential thermal analysis – differential scanning calorimetry – Typical yield rates. Effect of carbonisation temperature on yield and composition of charcoal- Industrial safety in carbonization

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. A.A. Vertès, N Qureshi, H Yukawa, “Biomass to biofuels: strategies for global industries”, John Wiley and Sons, 2010
2. J D. Wall, C S. Harwood, A L. Demain ,” Bioenergy”, ASM Press, 2008
3. D.M. Mousdale, “Biofuels”, CRC Press, 2008
4. Nijaguna, B.T.,” Biogas Technology”, New Age International Publishers Private Limited, 2006
5. Rezaiyan. J and N. P. Cheremisinoff, “Gasification Technologies, A Primer for Engineers and Scientists”, Taylor & Francis, 2005
6. IEEE Journals for Power, Energy, & Industry Applications

19EN23C ENERGY EFFICIENT BUILDINGS 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 of building and its environment (K3)
CO 2: discuss the principle of energy conscious in buildings (K3)
CO 3: explain the level of human comfort in Green buildings (K2)
CO 4: acquire the knowledge about the different climatic zones (K4)
CO 5: summarize the concept of Energy managements in building (K4)

UNIT I GENERAL ASPECTS 9

Introduction - Building Envelope - Building Materials-Indoor Environment. Components of Indoor Environment. Quality of Indoor Environment.

UNIT II ENERGY CONCIOUS IN BUILDINGS 9

Heating concept -Passive Heating - Direct Gain-Indirect Gain- Isolated Gain-Solarium. Cooling concept- Passive Cooling- Ventilation Cooling- Evaporative Cooling- Nocturnal Radiation Cooling- Desiccant Cooling- Earth Coupling- Daylighting-Basic Principles of Daylighting- Daylighting Systems

UNIT III HUMAN COMFORT 9

Human Comfort-Thermal, Visual, Acoustical and Olfactory comfort. Concept of Sol-air temperature and its significance. Ventilation and is significance.

UNIT IV CLIMATE ZONES 9

Introduction- Climatic zones and their characteristics- Factors affecting climate- Implications of climate on building design- Urban climate-Microclimate

UNIT V ENERGY MANAGEMENT SYSTEM 9

Energy Management of Buildings- Energy Audit of Buildings. – Energy - Management matrix monitoring and targeting.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Hand book on Energy Conscious Buildings (http://mnre.gov.in/centers/about-sec-2/hand-book-on-energy-conscious-buildings/)
2. J.K. Nayak and J.A. Prajapati, “Handbook on Energy Conscious Buildings, Solar Energy Control”, MNES, 2017.
3. Energy Conservation Building Codes 2017; Bureau of Energy Efficiency.
4. M.S. Sodha, N.K., Bansal, P.K. Bansal, A.Kumar and M.A.S. Malik., “Solar Passive Building, Science and Design”, Pergamon Press, 1986.
5. J.Duffie, W. Beckman, “Solar Engineering of Thermal Processes”, 4th Edition, Wiley, 2016

19EN24C **ENERGY 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: simulate and predict the performance of various energy utilities (K2)
CO 2: analyze the effect of constraints on the performance of energy systems (K2)
CO 3: model and simulate various energy systems to optimize the performance (K2)

I Cycle (using ANSYS) **24**

Steady State Conductive Heat Transfer Analysis in a cubical block
Analysis of Thermal Mixed Boundary for an infinitely long block
Analysis of Transient Thermal Heat Conduction for an infinitely long block
Study of temperature distribution along a Straight rectangular stainless steel cooling fin
Determination of heat conducted by a Cooling Spine
Laminar Flow Analysis in a 2D Duct
Analysis of flow in a System of Pipes to compute the velocity distribution

II Cycle (using TRNSYS) **36**

Performance analysis of Solar Flat Plate Collecting System
Performance analysis of Solar Evacuated Tube Collecting System
Performance analysis of Spiral Flow Solar Water Heating System
Performance analysis of Solar Air Heating System
Cooling tower Analysis
Performance analysis of Solar PV

P: 60 TOTAL: 60 PERIODS

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19EN25C	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 Energy 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

19EN01E ELECTRICAL TECHNOLOGY FOR ENERGY 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 : realize the basic working principles of Generators (K2)
CO 2 : classify the various types of Energy Saving Methods and storage concepts of electricity (K2)
CO 3 : familiarize with the concepts of Electricity Transmission & Distribution (K2)
CO 4 : recognize the concepts of Wheeling and Power Evacuation of Wind & Solar power (K2)

UNIT I GENERATION OF ELECTRICAL ENERGY 9

Sources of Electrical Energy - Working Principle of Generator - Classification of A.C and D.C Generators – Energy requirements – Maximum Demand – Types of Electrical load - Energy Savings in three phase Induction motor.

UNIT II ELECTRICAL ENERGY STORAGE 9

Introduction to Electrical Energy storage - Types of storage – Electrical Storage – Batteries – Types – Selection of Batteries - Capacitor – Super capacitors. Sine wave Inverter

UNIT III ELECTRICITY TRANSMISSION AND DISTRIBUTION 9

Introduction to Transmission – Sub transmission – Types of transmission – Losses in transmission –Control strategies in Grid – Types of grid – Distribution – Types of Distribution - Transformer - Working Principle.

UNIT IV ELECTRICAL SYSTEM FOR WIND ENERGY SYSTEMS 9

Generators for wind energy applications – Types of generators - Grid Connected and self excited Induction Generator – Speed control – Reactive Power Compensation.

UNIT V ELECTRICAL SYSTEM FOR SOLAR ENERGY SYSTEMS 9

Introduction – Balance of System – Tracking – Types of tracking – MPPT - Converter – Standalone System – Grid-Tied System – Data monitoring – Types - Remote – On-site monitoring

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. B.L.Thereja " A Textbook of Electrical Technology", 25th Edition S Chand Publishers, 2008
2. S.N.Bhadra, D.Kastha and S. Banerjee, "Wind Electrical Systems", Oxford University Press, 2005
3. Chetan Singh Solanki, "Solar Photovoltaic Technology and systems", Prentice Hall of India, 2015
4. C.L. Wadhwa "Generation Distribution and Utilization of Electrical Energy" Revised Edition New Age International, 2010.
5. H.A. Kiehne "Battery Technology Handbook" Taylor & Francis, 2nd Edition, 2003.
6. B.R.Gupta "Generation of Electrical Energy" Tenth Edition, S Chand and Company Limited, 2017.

19EN02E THERMAL ENERGY SYSTEMS FOR ELECTRICAL ENGINEERS 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 fluid properties and concepts of fluid Mechanics (K2)
CO 2 : explain the basic concepts and laws of thermodynamics (K2)
CO 3 : apply the properties of steam in the analysis of steam power cycles (K3)
CO 4 : discuss the working principles of various compressors, refrigeration and air-conditioning systems (K2)

UNIT I BASIC CONCEPTS OF FLUID MECHANICS 9

Properties of fluids – capillarity and surface tension. Types of Flow, Continuity equation, Euler's equation, Bernoulli's equation – applications - Venturi meter, Orifice meter, Pitot tube - Laminar flow though circular conduits and circular annuli, Hydraulic and energy gradient. Darcy – Weisbach equation. Minor losses - Flow though pipes in series and in parallel.

UNIT II BASIC CONCEPTS AND LAWS OF THERMODYNAMICS 9

Thermodynamic systems – Control volume - System and surroundings – Universe – Properties - State-process – Cycle – Equilibrium - Work and heat transfer – Point and path functions - First law of thermodynamics for open and closed systems - First law applied to a control volume - SFEE equations [steady flow energy equation] - Second law of thermodynamics - Heat engines - Refrigerators and heat pumps - Carnot cycle - Carnot theorem.

UNIT III STEAM BOILERS AND TURBINES 9

Formation of steam - Properties of steam – Use of steam tables and charts – Steam power cycle (Rankine) - Deviation of Actual Vapor Power Cycles from Idealized Ones, Reheat cycle, Regenerative cycle

UNIT IV COMPRESSORS 9

Positive displacement compressors – Reciprocating compressors – Indicated power – Clearance volume – Various efficiencies – Clearance ratio - Volume rate - Conditions for perfect and imperfect intercooling - Multi stage with intercooling – Rotary positive displacement compressors – Construction and working principle of centrifugal and axial flow compressors. Selection of compressors for a particular application.

UNIT V REFRIGERATION AND AIR CONDITIONING 9

Refrigeration - Various methods of producing refrigerating effects (RE) – Vapour compression cycle: P-H and T-S diagram - Saturation cycles - Effect of subcooling and super heating – Other Refrigeration Systems (Qualitative treatment only)

Air-conditioning systems – Basic psychrometry - Simple psychrometric processes - Types of airconditioning systems - Selection criteria for a particular application (qualitative treatment only).

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. R.S.Khurmi & J.K.Gupta, "Thermal Engineering", S.Chand & Company Limited, 2006.
2. S.Domkundwar, C.P.Kothandaraman & A.V.Domkundwar, "Thermal Engineering", Dhanpat Rai & Company, 2017.

3. Rogers and Mayhew, “Engineering Thermodynamics – Work and Heat Transfer”, Pearson Education Private Limited, New Delhi, 2006.
4. Eastop and McConkey, “Applied Thermodynamics”, Pearson Education Private Limited, New Delhi, 2002.
5. P.K.Nag, “Engineering Thermodynamics” Tata McGraw Hill, New Delhi, 2017.
6. Rajput, B.K. Sankaar, “Thermal Engineering”, S.Chand & Company Limited, 2007.
7. Modi and Seth, “Hydraulics and Fluid Mechanics Including Hydraulics Machines” 20th Edition, Standard Book House, 2013

19EN03E ADVANCED POWER PLANT 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: analyze the steam and gas power cycles and its possible improvements.(K3)
CO 2 : analyze the gas power cycles and its improvements (K3)
CO 3: realize the advances in hydro power plants. (K2)
CO 4 : reveal the working of nuclear and MHD power plants (K2)
CO 5: identify the economic feasibility and issues related to the power plants. (K2)

UNIT I ANALYSIS OF STEAM POWER PLANTS (SPP) 9

Components of steam power plants, typical layout, Rankine Cycle – performance - energy analysis of Rankine cycle - cycle improvements – Ideal reheat Rankine cycle - The Ideal Regenerative Rankine Cycle - Open Feedwater Heaters - Closed Feedwater Heaters

UNIT II ANALYSIS OF GAS TURBINE POWER PLANTS 9

Gas turbine cycles – optimization – thermodynamic analysis of cycles – cycle improvements - Intercoolers, reheaters, regenerators - operation and performance – layouts. - comparison with other types of power plants.

UNIT III ANALYSIS OF HYDROELECTRIC POWER PLANTS (HEPP) 9

Components of HEPP, typical layout, Classification of Hydraulic Turbines - Pelton, Francis, Kaplan, Propeller, Deriaz and Bulb turbines – specific speed – hydraulic efficiency and comparison - Performance of turbines – Constant head characteristics, Constant speed characteristics and Constant efficiency curves.

UNIT IV NUCLEAR AND MHD POWER PLANTS 9

Overview of Nuclear power plants - radioactivity - fission process- reaction rates - elastic scattering and slowing down - criticality calculations – critical heat flux - power reactors - nuclear safety. MHD and MHD - steam power plants.

UNIT V ECONOMIC ASPECTS OF POWER PLANT OPERATION 9

Load curves, load factor, diversity factors and their significance, Economic scheduling of power stations. Interest and depreciation, Costs of electrical energy, Methods of determining depreciation Tariff, characteristics and types of tariff. Economic efficiency - Payback period and Net-present value methods to assess financial efficiency of power plants.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Nag, P.K., “Power Plant Engineering”, 4th Edition, Tata McGraw-Hill Education, 2017.
2. Arora and Domkundwar, “A course in Power Plant Engineering”, DhanpatRai and CO, 2016.
3. Philip Kiameh., “Power generation handbook”, Tata McGraw-Hill, 2004
4. Stan Kaplan, “Power Plant Characteristics and Costs”, Nova Science Publishers, Inc., 2012
5. R.K. Rajput , “A Textbook of Power Plant Engineering”, fifth edition, Laxmi Publications, 2016

19EN04E ADVANCED THERMAL STORAGE TECHNOLOGIES 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: familiarize with the various types of thermal storage systems and the storage materials (K2)
CO 2: develop the model and analyze the sensible and latent heat storage units (K3)
CO 3: recognize various applications of thermal storage systems (K2)

UNIT I INTRODUCTION 9

Necessity of thermal storage – types-energy storage devices – comparison of energy storage technologies - seasonal thermal energy storage - storage materials.

UNIT II SENSIBLE HEAT STORAGE SYSTEM 9

Basic concepts and modeling of heat storage units - modeling of simple water and rock bed storage system – pressurized water storage system for power plant applications – packed beds.

UNIT III REGENERATORS 9

Parallel flow and counter flow regenerators – finite conductivity model – non – linear model – transient performance – step changes in inlet gas temperature – step changes in gas flow rate – parameterization of transient response – heat storage exchangers.

UNIT IV LATENT HEAT STORAGE SYSTEMS 9

Modeling of phase change problems – temperature based model - enthalpy model - porous medium approach - conduction dominated phase change – convection dominated phase change.

UNIT V APPLICATIONS 9

Specific areas of application of energy storage – food preservation – waste heat recovery – solar energy storage – green house heating – power plant applications – drying and heating for process industries.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Ibrahim Dincer and Mark A. Rosen, “Thermal Energy Storage Systems and Applications”, John Wiley & Sons 2010.
2. A Thumann, D. Paul Mehta , “Handbook of energy engineering“, 7th Edition, The Fairmont Press, Inc., 2013
3. Halime Ö Paksoy, “Thermal energy storage for sustainable energy consumption”, Springer, 2007
4. IEEE Journals for “Power, Energy & Industry Applications”

19EN05E ALTERNATIVE FUELS 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: get an insight into the availability of petroleum based fuels, their progress and its influence on environment. (K2)

CO 2: explore the need, production and technology of utilizing different alternative liquid and gaseous fuels for transportation which include alcohol, biodiesel, CNG, LPG, DME, DEE and hydrogen (K2)

UNIT I OVERVIEW 9

Introduction – Alternative fuels – Potential solid - liquid - and gaseous fuels. – Alcohols – ethanol, methanol, M85, E85 and gashol – properties – SI engine combustion performance and emission characteristics. Alcohols for CI engine – Alcohol fumigation – Dual fuel injection – Surface ignition and spark ignition- storage, dispensing and safety – material compatibility.

UNIT II VEGETABLE OILS AND OTHER SIMILAR FUELS DERIVED 9

Vegetable oils- properties – advantages and disadvantages – Biodiesel – trans-esterification - Factors affecting the process – Properties- Biodiesel blends – engine combustion, performance and emission characteristics- material compatibility , other alternative liquid fuels – benzol – acetone – diethyl ether.

UNIT III NATURAL GAS AND LPG 9

Alternative gaseous fuels – natural gas and LPG – production – properties of natural gas and LPG – CNG conversion kits – Advantages and disadvantages of NG and LPG – comparison of gasoline and LPG – CNG and LPG fuel feed system – LPG & CNG for CI engine – methods of fuel induction engine combustion, performance and emission characteristics.

UNIT IV HYDROGEN AS ALTERNATIVE FUEL 9

Hydrogen energy – properties , production , thermo- chemical methods – Hydrogen storage – Delivery – conversion – safety – Hydrogen engines, methods of usage in SI and CI engine – Hydrogen injection system – Hydrogen induction in SI engine.

UNIT V BIOGAS FOR IC ENGINES 9

Biogas – properties – Biogas for running IC engine – Biogas as vehicle fuel – biogas consumption – engine performance and emission- Biomass gasification – producer gas – consumption – dual fuel operation – engine performance and emission.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. D Tomes, P Lakshmanan., Biofuels: “Global Impact on Renewable Energy, Production Agriculture, and Technological Advancements”, Springer, 2013
2. Ram B. Gupta, “Hydrogen fuel: production, transport, and storage”, CRC Press, 209
3. Ganesan.V, - “Internal Combustion Engines”, Tata McGraw-Hill Education, 2012
4. M.F. Hordeski, “Alternative fuels: the future of hydrogen”,2nd Edition, The Fairmont Press, Inc., 2008
5. Sunggyu Lee, J. G. Speight, S. K. Loyalka, “Handbook of Alternative Fuel Technologies”, CRC Press, 2011.
6. B. T. Nijaguna, “Biogas Technology”, New Age International, 2006
7. IEEE Journals for “Power, Energy & Industry Applications”

19EN06E COGENERATION AND WASTE HEAT RECOVERY 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: realize the importance of cogeneration in improving the overall efficiency and economy and limiting global warming (K2)

CO 2: analyze the basic energy generation cycles (K4)

CO 3: interpret the concepts of cogeneration, its types and probable areas of applications (K3)

CO 4: identify the significance of waste heat recovery systems and carry out its economic analysis (K2)

UNIT I INTRODUCTION 9

Introduction - principles of thermodynamics – cycles - topping - bottoming – combined cycle - organic rankine cycles – performance indices of cogeneration systems – waste heat recovery – sources and types – concept of tri generation.

UNIT II COGENERATION TECHNOLOGIES 9

Configuration and thermodynamic performance – steam turbine cogeneration systems – gas turbine cogeneration systems – reciprocating IC engines cogeneration systems – combined cycles cogeneration systems – advanced cogeneration systems: fuel cell, Stirling engines etc.,

UNIT III ISSUES AND APPLICATIONS OF COGENERATION TECHNOLOGIES 9

Cogeneration plants electrical interconnection issues – utility and cogeneration plant interconnection issues – applications of cogeneration in utility sector – industrial sector – building sector – rural sector – impacts of cogeneration plants – fuel, electricity and environment

UNIT IV WASTE HEAT RECOVERY SYSTEMS 9

Election criteria for waste heat recovery technologies - recuperators - Regenerators - Economizers - plate heat exchangers - thermic fluid heaters - Waste heat boilers classification, location, service conditions, design Considerations - fluidized bed heat exchangers - heat pipe exchangers - heat pumps – sorption systems.

UNIT V ECONOMIC ANALYSIS 9

Investment cost – economic concepts – measures of economic performance – procedure for economic analysis – examples – procedure for optimized system selection and design – load curves - sensitivity analysis – regulatory and financial frame work for cogeneration and waste heat recovery systems.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. R.Kehlhofer, B. Rukes, F. Hannemann, F. Stirnimann, “Combined-cycle Gas & Steam Turbine Power Plants”, 3rd Edition, PennWell Books, 209.
2. Steve Doty, Wayne C. Turner, “Energy management handbook”,7th Edition, The Fairmont Press, Inc., 2009
3. A.Thumann, D. Paul Mehta, “Handbook of energy engineering”, 7th Edition, The Fairmont Press, Inc., 2012
4. B.F.Kolanowski, “Small-scale cogeneration handbook”, 2nd Edition, Fairmont Press, 2003
5. M.P. Boyce, “Handbook for cogeneration and combined cycle power plants”, ASME Press, 2010
6. EDUCOGEN – “The European Educational tool for cogeneration”, 2nd Edition, 2001

19EN07E DESIGN AND OPTIMIZATION OF ENERGY 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: perform the Simulation and Modeling of typical energy system (K2)
CO 2: analyse the effect of constraints on the performance of energy systems (K4)
CO 3: design energy systems and perform Energy-Economic Analysis for typical applications (K4)

UNIT I INTRODUCTION 9

Engineering Design- Design as Part of Engineering Enterprise- Thermal Systems

UNIT II BASIC CONSIDERATIONS IN DESIGN 9

Formulation of the Design Problem- Conceptual Design- Steps in the Design Process- Computer-Aided Design of Thermal Systems- Material Selection

UNIT III MODELING OF THERMAL SYSTEMS 9

Types of Models - Mathematical Modeling - Physical Modeling and Dimensional Analysis - Curve Fitting

UNIT IV ECONOMIC CONSIDERATIONS 9

Introduction - Worth of Money as a Function of Time-Series of Payments - Economic Factor in Design- Application to Thermal Systems

UNIT V OPTIMIZATION 9

Basic Concepts- Optimization Methods- Optimization of Thermal Systems- Practical Aspects in Optimal Design

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Jasbir Arora, Introduction to Optimum Design, 4rd Edition, Elsevier Science & Technology, 2016.
2. Stoecker W.F., Design of Thermal Systems, McGraw Hill, 2011.
3. C. Balaji, Essentials of Thermal System Design and Optimization, CRC Press, 2011.
4. William S. Janna, Design of Fluid Thermal Systems, 4th Edition, Cengage Learning, 2016.
5. Yogesh Jaluria, Design and Optimization of Thermal systems, 3rd Edition, CRC Press, 2011.
6. Kalyanmoy Deb, Optimization for Engineering design: Algorithms and examples, PHI Learning Private Limited, 2004.
7. IEEE Journals for Power, Energy & Industry Applications

19EN08E DESIGN OF HEAT EXCHANGERS 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: realize the basic principles of Heat transfer & Heat Exchangers and applications (K2)

CO 2: classify various types of flows and disturbances (K2)

CO 3: design Shell& Tube and Double-Pipe Heat Exchanger, Compact and Plate Heat exchanger, Condenser and performance analysis of Cooling Towers (K3)

UNIT I FUNDAMENTALS OF HEAT EXCHANGER 9

Introduction – Modes of Heat transfer - Temperature distribution and its implications types – Heat exchangers – Classification - Regenerators and Recuperators – Analysis of heat exchangers – Logarithmic Mean temperature difference – Number of transfer Units – Applications.

UNIT II FLOW AND STRESS ANALYSIS 9

Flow – types – Disturbances in flow - Effect of turbulence – friction factor – Pressure loss – stress in tubes – Fouling – Process – types of fouling – control strategies - thermal stresses – types - shear stresses

UNIT III DOUBLE PIPE AND SHELL AND TUBE HEAT EXCHANGER 9

Introduction to Double pipe heat exchangers – Types – Bare inner tube – finned inner tube - Design – Applications - Shell and tube heat exchangers - Types – Design – sizing of heat exchangers – Pressure drop calculations - Applications

UNIT IV COMPACT AND PLATE HEAT EXCHANGERS 9

Introduction to Compact and Plate heat exchanger - Types – merits and demerits – design of compact heat exchangers, plate heat exchangers – performance influencing parameters - limitations.

UNIT V CONDENSERS AND COOLING TOWERS 9

Condensers – Types – Shell & tube – Plate condenser - Design - Cooling tower – types – Natural draft – Mechanical draft - performance characteristics – Range and approach of a cooling tower

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. R. W. Serth, “Process heat transfer: principles and applications”, Academic Press, 2007
2. R. K. Shah, D P. Sekulić, “Fundamentals of Heat Exchanger Design”, John Wiley and Sons, 2003
3. Sadik Kakac and Hongtan Liu, “Heat Exchangers Selection, Rating and Thermal Design”, CRC Press, 2012
4. T. Kuppan, “Heat exchanger design handbook”, Marcel Dekker, 2010
5. IEEE Journals for “Power, Energy & Industry Applications”

19EN09E DESIGN OF EXPERIMENTS L T P C QP

3 0 0 3 A

COURSE OUTCOMES

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

CO1: describe the statistical process control concepts and implementation. (K2)
CO2: identify the experimental factors and parameters. (K2)
CO3: collect data and perform analysis for the experiments. (K2)
CO4: use various components of design of experiment. (K2)
CO5: select appropriate method of design of experiment. (K3)

UNIT I DESIGN OF EXPERIMENTS: AN INTRODUCTION 9

Statistical process control and system – Scientific basis for design of experiments – process improvement with Statistical process control – Organizing and implementing industrial experiments.

UNIT II EXPERIMENTAL METHODS 9

Types of experiments – Experimental design factors – Experimental design protocol and examples.

UNIT III DATA COLLECTION AND DATA ANALYSIS FOR DESIGNING EXPERIMENTS 9

Types of data – Data collection – Summarizing Data – Randomization – Replication – Frequency distributions – frequency histograms – scatter diagrams – check sheets – Distribution characteristics – use of standard normal distributions – charts for individual measurements – analyzing control charts

UNIT IV GENERAL METHODS OF DESIGNING EXPERIMENTS 9

ANOVA - Completely Randomized design, Randomized Block design - Two and three factor full Factorial experiments, 2^k factorial Experiments, Confounding and Blocking designs, Fractional factorial design

UNIT V GENERAL APPROACHES IN DESIGNING EXPERIMENTS 9

Taguchi's approach - Steps in experimentation, Design using Orthogonal Arrays, Data Analysis, Robust Design - Control and Noise factors, S/N ratios, Response surface methodology

L: 45; TOTAL: 45 PERIODS

TEXT BOOK

1. Robert F. Brewer, "Design of Experiments for Process Improvement and Quality Assurance" Narosa Publishing House, 2009.

REFERENCES

1. Dieter, George E., "Engineering Design - A Materials and Processing Approach", McGraw Hill, International Editions, Singapore, 2017.
2. Anita Goyal, Karl T Ulrich, Steven D Eppinger, "Product Design and Development", 4th Edition, 2011, Tata McGraw-Hill Education

19EN10E ENERGY SYSTEM MODELING AND PROJECT 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: model and simulate energy systems. (K3)

CO 2: apply new generation optimization techniques for energy system simulation. (K3)

CO 3: perform economic analysis of various renewable energy systems. (K3)

CO 4: categorize management strategies for project evaluation. (K4)

UNIT I INTRODUCTION 9

Primary energy analysis - energy balance for closed and control volume systems - applications of energy analysis for selected energy system design - modeling overview - levels and steps in model development - Examples of models – curve fitting and regression analysis

UNIT II MODELING AND SYSTEMS SIMULATION 9

Modeling of energy systems – heat exchanger - solar collectors – distillation -rectification turbo machinery components - refrigeration systems - information flow diagram - solution of set of nonlinear algebraic equations - successive substitution - Newton Raphson method- examples of energy systems simulation

UNIT III OPTIMIZATION TECHNIQUES 9

Objectives - constraints, problem formulation - unconstrained problems - necessary and sufficiency Conditions. Constrained optimization - Lagrange multipliers, constrained variations, Linear Programming - Simplex tableau, pivoting, sensitivity analysis - New generation optimization Techniques – Genetic algorithm and simulated annealing – examples

UNIT IV ECONOMIC ANALYSIS 9

Economics of Standalone Power Supply Systems: Solar Energy - Biomass Energy - Wind Energy and other Renewable Sources of Energy - Economics of Waste Heat Recovery and Cogeneration - Energy Conservation Economics.

UNIT V PROJECT MANAGEMENT 9

Project Management-Financial Accounting: Cost Analysis - Budgetary Control - Financial Management - Techniques for Project Evaluation.

L: 45; TOTAL 45 PERIODS

REFERENCES

1. Stoecker W.F., “Design of Thermal Systems”, McGraw Hill, 2011.
2. D.H. Fredrick and J.C.Newell, C.M .Close, “Modeling and analysis of dynamic systems”, John Wiley & Sons, 2002
3. J.Duffie and W. Beckman “Solar Engineering of Thermal Processes” 4th Edition, Wiley, 2013
4. Singiresu S. Rao, “Applied Numerical Methods for Engineers and Scientists”, Prentice Hall, Upper Saddle River, NJ, 2001.

19EN11E FLUIDIZED BED 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: comprehend the concepts of fluidization and heat transfer in fluidized beds. (K2)

CO 2: recognize the design principles and apply the same for industrial applications.(K3)

UNIT I FLUIDIZED BED BEHAVIOUR 9

Characterization of bed particles - comparison of different methods of gas – solid contacts. Fluidization phenomena - regimes of fluidization – bed pressure drop curve.Two phase and well-mixed theory of fluidization. Particle entrainment and elutriation – unique features of circulating fluidized beds.

UNIT II HEAT TRANSFER 9

Different modes of heat transfer in fluidized bed – bed to wall heat transfer – gas to solid heat transfer – radiant heat transfer – heat transfer to immersed surfaces.Methods for improvement – external heat exchangers – heat transfer and part load operations.

UNIT III COMBUSTION AND GASIFICATION 9

Fluidized bed combustion and gasification – stages of combustion of particles – performance - start-up methods. Pressurized fluidized beds.

UNIT IV DESIGN CONSIDERATIONS 9

Design of distributors – stoichiometric calculations – heat and mass balance – furnace design – design of heating surfaces – gas solid separators.

UNIT V INDUSTRIAL APPLICATIONS 9

Physical operations like transportation, mixing of fine powders, heat exchange, coating, drying and sizing.Cracking and reforming of hydrocarbons, carbonization, combustion and gasification. Sulphur retention and oxides of nitrogen emission control.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Prabir Basu., “Combustion and gasification in fluidized beds”, CRC/Taylor & Francis, 2006
2. Simeon Oka, E. J. Anthony, “Fluidized bed combustion”, M. Dekker, 2004
3. Wen-ching Yang, “Handbook of fluidization and fluid-particle systems”, Marcel Dekker, 2003
4. C. K. Gupta, D. Sathiyamoorthy ,”Fluid bed technology in materials processing”, CRC Press, 1999
5. Otto Molerus, Karl-Ernst Wirth, “Heat transfer in fluidized beds”, Springer, 1997

19EN12E FUEL CELLS AND HYDROGEN ENERGY 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 hydrogen production methodologies, possible applications and various storage options (K3)

CO 2: converse about the working of a typical fuel cell, its types and to elaborate on its thermodynamics and kinetics (K2)

CO 3: analyze the cost effectiveness and eco-friendliness of Fuel Cells (K4)

UNIT I FUEL CELL BASICS 9

Fuel cell definition, Difference between batteries and fuel cells, fuel cell history, components of fuel cells, principle of working of fuel cells Fuel cell thermodynamics - second law analysis of fuel cells, efficiency of fuel cells fuel cell electrochemistry - Nernst equation, Electrochemical kinetics, Butler-Volmer equation

UNIT II FUEL CELL TYPES 9

Classification by operating temperature/electrolyte type, Fuel Cell Performance, Activation, Ohmic and Concentration over potential

UNIT III FUEL CELL DESIGN AND COMPONENTS 9

Cell components, stack components, system components, Overview of intermediate / high temperature fuel cells - Solid oxide fuel cells (SOFC), Molten carbonate fuel cells (MCFC), Phosphoric acid fuel cells (PAFC) Polymer Electrolyte fuel cells ,Heat and mass transfer in polymer electrolyte fuel cells, water management in PEFCs, Current issues in PEFCs, Direct methanol fuel cells (DMFC) - Electrochemical kinetics methanol oxidation, Current issues in MFCs, Fuel crossover in DMFCs, Water management in DMFCs, high methanol concentration operation, limiting current density

UNIT IV HYDROGEN PRODUCTION METHODS 9

Production of hydrogen from fossil fuels, electrolysis, thermal decomposition, photochemical and photo-catalytic methods.

UNIT V HYDROGEN STORAGE METHODS 9

Metal hydrides, metallic alloy hydrides, carbon nano-tubes, sea as source of deuterium.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. A Faghri and Y Zhang, “Transport Phenomena in Multiphase Systems”, Elsevier 2006
2. S Srinivasan, “Fuel Cells: From Fundamentals to Applications”, Springer 2006
3. O’Hayre, SW Cha, W Colella and FB Prinz, “Fuel Cell Fundamentals”, Wiley, 2016
4. Xianguo Li, “Principles of Fuel Cells”, Taylor and Francis, 2005
5. J Larminie and A Dicks, “Fuel Cell Systems Explained, 2nd Edition”, Wiley,2018
6. IEEE Journals for “Power, Energy & Industry Applications”

19EN13E MATERIALS FOR ENERGY APPLICATIONS 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: apply the concepts in materials and engineering in the development and design of new product, to ensure quality assurance in the practice of material engineering. (K3)

CO 2: characterize the synthesized materials. (K2)

CO3: recognize the different types of materials used in electronics (K2)

CO 4: gain fundamental understanding of electrical conduction (transport) in solids, major properties of bulk and nanostructured superconductors. (K2)

CO 5: comprehend the scientific basis to ensure the safe and responsible development of engineered nanoparticles and nanotechnology-based materials and products (K2)

UNIT I ADVANCED MATERIALS AND TOOLS 9

Smart materials, exhibiting ferroelectric, piezoelectric, optoelectric, semiconducting behavior, lasers and optical fibers, photoconductivity and superconductivity, nanomaterials, synthesis, properties and applications.

UNIT II PHYSICAL METHODS FOR CHARACTERIZATION 9

X-ray diffraction, Powder diffraction, Single crystal X-ray diffraction, Electro-optical and related techniques like SEM, TEM, EDS, WDS/EPMA etc.; Spectroscopic techniques - Vibrational, UV-visible and Electron resonance spectroscopies. Thermal analysis (Differential thermal analysis, Thermogravimetric analysis, Differential scanning calorimery)

UNIT III ELECTRONIC MATERIALS 9

Dielectric properties, Polarization mechanism, Frequency and Temperature effects, Electrical breakdown, Classification of ferroelectric materials, Piezoelectricity, Capacitor dielectric materials, Insulating materials and Pyroelectric materials, ceramic composites as capacitors & sensors.

UNIT IV SUPERCONDUCTIVITY 9

History and background of superconductivity, Superconducting phenomenon, low temperature Superconductors, Bardeen – Cooper and Schrieffer Theory (BCS), Cooper pair, High temperature Superconductivity. Applications of Superconductors.

UNIT V NANOMATERIALS AND NANOTECHNOLOGY 9

Top down and bottom up approaches, classification of nanomaterials, carbon nanotubes (CNT), particulate reinforced metal/ceramic/polymer nanocomposites, Characterization of nanomaterials, Applications of nanotechnology in medicine, automobile sector, Bragg reflector, Butterfly-wings, Different applications.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Mehta V K, Rohit Mehta “Principle of Electronics” S.Chand Publications, 2014
2. S. O. Kasap – “Principles of Electronic Materials and Devices”3rd Edition, Tata Mc Graw-Hill Publication, 2017.
3. C.N. Banwell, “Fundamentals of Molecular Spectroscopy“, 4th Edition, Tata McGraw-Hill Education, 2017.
4. Charles P. Poole Jr. , Horacio A. Farach, Richard J. Creswick, Ruslan Prozorov, “Superconductivity” 3rd edition, Elsevier, 2018.
5. Thomas Varghese, Balakrishna K.M, “Nanotechnology: An Introduction to Synthesis, Properties and Applications of Nanomaterials” Atlantic, 2012

19EN14E NUCLEAR 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: comprehend the fundamentals of nuclear reactions (K3)

CO 2: infer nuclear fuels cycles, characteristics, fundamental principles governing nuclear fission chain reaction and fusion (K3)

CO 3: develop awareness on future nuclear reactor systems with respect to generation of energy, fuel breeding, incineration of nuclear material and safety. (K4)

UNIT I NUCLEAR REACTIONS 9

Mechanism of nuclear fission - nuclides - radioactivity – decay chains – neutron reactions - the fission process - reactors - types of fast breeding reactor - design and construction of nuclear reactors - heat transfer techniques in nuclear reactors - reactor shielding.

UNIT II REACTOR MATERIALS 9

Nuclear Fuel Cycles - characteristics of nuclear fuels - Uranium - production and purification of Uranium - conversion to UF4 and UF6 - other fuels like Zirconium, Thorium - Berylium.

UNIT III REPROCESSING 9

Nuclear fuel cycles - spent fuel characteristics - role of solvent extraction in reprocessing - solvent extraction equipment.

UNIT IV SEPARATION OF REACTOR PRODUCTS 9

Processes to be considered - 'Fuel Element' dissolution - precipitation process – ion exchange - redox - purex - TTA - chelation -U235 - Hexone - TBP and thorax Processes - oxidative slaging and electro - refinng - Isotopes - principles of Isotope separation.

UNIT V WASTE DISPOSAL AND RADIATION PROTECTION 9

Types of nuclear wastes - safety control and pollution control and abatement - international convention on safety aspects - radiation hazards prevention.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Raymond LeRoy Murray, “Nuclear energy: an introduction to the concepts, systems, and applications of nuclear processes”,6th Edition, Butterworth-Heinemann, 209
2. John R. Lamarsh, “Introduction to nuclear reactor theory”, American Nuclear Society, 2002
3. Glasstone, S. and Sesonske, A, “Nuclear Reactor Engineering”, 4th Edition, Springer, 1994.
4. Winterton, R.H.S., “Thermal Design of Nuclear Reactors”, Pergamon Press, 2010.

19EN15E SOLAR ARCHITECTURE 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: elaborate the current trends in solar architecture and following key concepts: Solar Passive Architecture and heat transfer in buildings (K3)

CO 2: recognize the Natural Heating/Cooling concepts for Building, Earth to Air Heat exchanger, Thermal Comfort Requirements (K4)

CO 3: outline the concept of Energy Conservation & Concept of Zero Energy Buildings (K2)

UNIT I INTRODUCTION 9

Bio-climatic classification of India, Passive Solar Passive Building and Green Building Concepts, National Building Code, Energy Star Rating , Policies on Energy Efficient and Green buildings.

UNIT II PASSIVE HEATING AND COOLING CONCEPTS 9

Passive heating concepts: Direct heat gain, indirect heat gain, isolated gain and sunspaces, Solar Green Houses, Solar Wall, Solar Trombe wall Evaporative cooling, radiative cooling, Application of wind, water and earth for cooling, Shading, paints and cavity walls for cooling, Roof radiation traps, Earth air-tunnel systems for cooling.

UNIT III THERMAL ANALYSIS AND DESIGN FOR HUMAN COMFORT 9

Thermal comfort, Criteria and various parameters, Psychometric chart, Thermal indices,Climate and comfort zones, Concept of sol-air temperature and its significance, Calculation of instantaneous heat gain through building envelope, Calculation of solar radiation on buildings, Building orientation, Introduction to design of shading devices, Overhangs, Factors that affect energy use in buildings, Ventilation and its significance, Air-conditioning systems.

UNIT IV HEAT TRANSMISSION IN BUILDINGS 9

Surface co-efficient: air cavity, internal and external surfaces, overall thermal transmittance, Wall and windows, Heat transfer due to ventilation/infiltration, internal heat transfer, solar temperature, Decrement factor, Phase lag, Day lighting, Estimation of Building loads: Steady state method, network method, numerical method, correlations.

UNIT V PASSIVE SOLAR DESIGNS OF BUILDING 9

Thumb rules for design of buildings and building codes, Typical design of selected buildings in various climatic zones, Simulation Software's for carrying out thermal design of buildings and predicting performance.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. David Findley, "Solar Power for Your Home", McGraw-Hill Professional, 2010
2. Jan F. Kreider, P Curtiss, Ari Rabl, "Heating and Cooling of Buildings: Design for Efficiency", 2nd Edition, CRC Press, 2010.
3. Sue Reed, "Energy-Wise Landscape Design", New Society Publishers, 2010
4. S Roaf, M Fuentes, S Thomas, "Ecohouse: a design guide", 3rd Edition, Architectural Press, 2007
5. DS Lal "Climatology", Sharda Pustak Bhawan, Allahabad, 2003
6. Christian Schittich, "Solar architecture: strategies, visions, concepts", Edition Detail, 2003
7. Daniel D. Chiras, "The solar house: passive heating and cooling", Chelsea Green Publishing, 2002
8. IEEE Journals for "Power, Energy & Industry Applications"

19EN16E SOLAR REFRIGERATION AND AIR-CONDITIONING 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: realize the Basic Thermodynamic Modelling, Design Studies and Evaluation methods for Solar Cooling Systems. (K2)

CO 2: familiarize with the economical use of the systems (K2)

UNIT I INTRODUCTION 9

Potential and scope of solar cooling. Types of solar cooling systems, solar collectors and storage systems for solar refrigeration and airconditioning.

UNIT II VAPOUR ABSORPTION AND COMPRESSION REFRIGERATION SYSTEMS 9

Solar operation of vapour absorption – Lithium Bromide –Water Absorption system – Aqua Ammonia Absorption system Intermitent Absorption Refrigeration system – Vapour compression refrigeration cycles and their assessment.

UNIT III THERMODYNAMIC MODELLING 9

Thermal modelling and computer simulation for continuous and intermittent solar refrigeration and airconditioning systems.

UNIT IV SOLAR COOLING SYSTEMS 9

Solar dessicant cooling systems. Open cycle absorption/ desorption solar cooling alternatives. Advanced solar cooling systems. Refrigerant storage for solar absorption cooling systems.

UNIT V ECONOMICS 9

Solar thermoelectric refrigeration and airconditioning. Solar economics of cooling systems.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Ursula Eicker, “Low Energy Cooling for Sustainable Buildings”, John Wiley and Sons, 2010
2. Hans-Martin Henning, “Solar-assisted air conditioning in buildings: a handbook for planners” , Springer, 2007
3. M. Santamouris, D. Asimakopoulos, “Passive cooling of buildings”, Earthscan, 2013
4. A. A. M. Sayigh, J. C. McVeigh, “Solar air conditioning and refrigeration”, Pergamon Press, 2012.
5. IEEE Journals for “Power, Energy & Industry Applications”

19EN17E WASTE MANAGEMENT AND ENERGY RECOVERY 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: reveal the various methods of waste management (K2)

CO 2: familiarize with recent energy generation techniques and recent technologies of waste disposal (K2)

CO 3: realize the importance of healthy environment (K2)

UNIT I SOLID WASTE – CHARACTERISTICS AND PERSPECTIVES 9

Definition - types – sources – generation and estimation. Properties: physical, chemical and biological – regulation

UNIT II COLLECTION, TRANSPORTATION AND PROCESSING TECHNIQUES 9

Onsite handling, storage and processing – types of waste collection mechanisms - transfer Stations : types and location – manual component separation – volume reduction : mechanical, thermal – separation : mechanical, magnetic electro mechanical

UNIT III LIQUID WASTE MANAGEMENT 9

Basics, types, working and typical conversion efficiencies of composting – anaerobic digestion – RDF – combustion – incineration – gasification – pyrolysis

UNIT IV HAZARDOUS WASTE MANAGEMENT 9

Hazardous waste – definition - potential sources - waste sources by industry – impacts – waste control methods – transportation regulations - risk assessment - remediation technologies – Private public paternership – Government initiatives.

UNIT V ULTIMATE DISPOSAL 9

Landfill – classification – site selection parameters – design aspects – Leachate control – environmental monitoring system for Land Fill Gases.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Michael D. Lagrega., et al., “Hazardous Waste Management”, Waveland Pr Inc, 2010
2. Paul T. Williams, “Waste treatment and disposal”, 2nd Edition, John Wiley and Sons, 2005
3. Velma I. Grover, “Recovering Energy”, Science Publishers, 2002
4. Tchobanoglous, Theisen and Vigil, “Integrated Solid Waste Management”, 2nd Edition, McGraw-Hill, New York, 1993
5. Stanley E. Manahan. “Hazardous Waste Chemistry, Toxicology and Treatment”, Lewis Publishers, Chelsea, Michigan, 1990

19EN18E WIND ENERGY 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 : comprehend the fundamentals of wind energy and its conversion system (K2)
CO 2 : disseminate with the wind measurement techniques (K2)
CO 3 : summarize the concepts of aerodynamics, wind farms and cycles (K2)
CO 4 : analyze the economics of wind energy systems (K2)

UNIT I WIND CHARACTERISTICS AND RESOURCES 9

Characteristics of the Wind Resource- Characteristics of the Atmospheric Boundary Layer-Wind Data Analysis and Resource Estimation-Wind Turbine Energy Production Estimates Using Statistical Techniques-Regional Wind Resource Assessment-Wind Prediction and Forecasting-Wind Measurement and Instrumentation.

UNIT II AERODYNAMICS OF WIND TURBINES 9

One-dimensional Momentum Theory and the Betz Limit-Ideal Horizontal Axis Wind Turbine with Wake Rotation-Airfoils and General Concepts of Aerodynamics-Blade Design for Modern Wind Turbines-Performance Prediction-Blade Shape for Optimum Rotor with Wake Rotation-Generalized Rotor Design Procedure-Effect of Drag and Blade Number on Optimum Performance-Aerodynamics of Horizontal and Vertical Axis Wind Turbines

UNIT III MODERN WIND TURBINE CONTROL AND MONITORING SYSTEM 9

Details of Pitch and Yaw Systems- Protections & Safety Consideration in Wind turbines- Wind Turbine Monitoring- SCADA & Databases: Remote Monitoring and Generation Reports, Operation & Maintenance for Product Life Cycle, Balancing technique (Rotor & Blade).

UNIT IV CONCEPT OF WIND FARMS 9

Wind Farms - Site Preparation-Installation and Operation Issues - Wind Farms in Electrical Grids-Typical Grid-connected Turbine Operation. Environmental concerns: Pollution free power; Noise; birds; Aesthetics, Radio waves, interference, Rainfall,

UNIT V ECONOMICS ANALYSIS 9

Economic Assessment of Wind Energy Systems- Capital Costs of Wind Energy Systems-Operation and Maintenance Costs- Value of Wind Energy- Economic Analysis Methods- Wind Energy Market Considerations

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. T Burton, et.al, “Wind Energy Handbook”, 2nd Edition, John Wiley and Sons, 2011
2. J.F. Manwell, et.al, “Wind Energy Explained”, 3rd Edition, John Wiley and Sons, 2019
3. D. A. Spera, “Wind Turbine Technology: Fundamental concepts of Wind Turbine Engineering”, 2nd Edition, ASME Press, 2016
4. William W. Peng, “Fundamentals of turbomachinery”, John Wiley and Sons, 2016
5. Mukund. R. Patel, “Wind and solar power systems” 2nd Edition, Taylor & Francis,2006

19EN19E ENERGY CONSERVATION IN THERMAL AND ELECTRICAL UTILITIES

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 : recognize the combustion process and able to calculate the amount of air required for combustion of solid, liquid and gaseous fuels. (K2)

CO 2 : evaluate the performance of boilers and suggest energy conservation strategies.(K4)

CO 3 : workout and suggest prevention techniques for energy loses in steam circuits. (K4)

CO 4 : carryout performance evaluation of electric motors, fans and pumps. Further, identify energy conservation opportunities. (K3)

CO 5 : identify the new generation lightings and operating principles of energy efficiency devices. (K3)

UNIT I FUELS AND COMBUSTION 9

Introduction to fuels - properties of fuel oil, coal and gas - storage, handling and preparation of fuels - principles of combustion - combustion of oil, coal and gas. - draft system – combustion controls - Agro-residue/biomass handling, preparation and combustion.

UNIT II BOILERS AND COGENERATION 9

Combustion in boilers - performances evaluation – direct and indirect method- analysis of losses - feed water treatment, blow down - boiler efficiency calculation - energy conservation opportunities. Cogeneration - principles & operation – Power Ratio - economics of cogeneration scheme – classification - heat balance - steam turbine efficiency.

UNIT III STEAM SYSTEM 9

Properties of steam - assessment of steam distribution losses, steam leakages, steam trapping - condensate and flash steam recovery system - identifying opportunities for energy savings. Steam utilization - Performance assessment - thermo-compressor, steam pipe insulation - condensate pumping - steam dryers.

UNIT IV ELECTRIC MOTORS, FANS AND PUMPS 9

Electric motor types - losses in induction motors - motor efficiency, factors affecting motor performance - energy saving opportunities with energy efficient motors.

Fans and Pumps – types - performance evaluation - efficient system operation - flow control strategies and energy conservation opportunities.

UNIT V LIGHTING SYSTEM AND ENERGY EFFICIENCY DEVICES 9

Lighting sources - choice of lighting - luminance requirements and energy conservation avenues. New generation luminaries - Light Emitting Diodes (LEDs) - high efficiency street lighting. Maximum demand controllers – Automatic power factor controllers – Soft starters with energy saver - electronic ballast - occupancy sensors – energy efficient lighting controls.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Amlan Chakrabarti, “Energy Engineering and Management”, Prentice Hall India, 2018
2. Beggs, Clive, “Energy – Management, Supply and Conservation”, Taylor and Francis, 2nd Edition, 2009.
3. Handbook on Energy Efficiency, TERI, New Delhi, 2009.
4. Smith C.B., “Energy Management Principles”, Pergamon Press, 2015.
5. White L. C., “Industrial Energy Management and Utilization”, Hemisphere Publishers, 2002.
6. Trivedi P.R. and Jolka K.R., “Energy Management”, Common Wealth Publication, 2002.
7. Bureau of energy efficiency – Hand outs New Delhi.

19EN20E INDUSTRIAL 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 : realize the present energy scenario and the need for energy conservation and various energy conservation measures (K2)

CO 2 : familiarize with various energy policies (National and International) & standards. (K2, A1)

CO 3 : comprehend the concepts of recovery system and perform energy analysis.(K2)

CO 4 : conduct energy audit and optimize energy requirements. (K3)

CO 5 : recognize the economics of energy conservation schemes in industrial energy management systems (K2)

UNIT I INTRODUCTION 9

Energy Scenario - world and India. Energy Resources Availability in India. Energy consumption pattern. Energy conservation potential in various Industries and commercial establishments. Energy intensive industries - an overview. Energy conservation and energy efficiency – needs and advantages. Energy Conservation Act.

UNIT II ENERGY POLICIES 9

National energy policy in the last plan periods, Energy use and Energy supply, Overview of renewable energy policy and the Five Year Plan programmes, Basic concept of Input-Output analysis, Concept of energy multiplier and implication of energy multiplier for analysis of regional and national energy policy- Carbon Trading- Renewable Energy Certification - CDM

UNIT III WASTE HEAT RECOVERY 9

Recuperators, regenerators, heat pipes, heat pumps. Cogeneration - concept, options (steam/gas turbines/diesel engine based), selection criteria, control strategy. Heat exchanger networking - concept of pinch, target setting, problem table approach, composite curves. Demand side management.

UNIT IV ENERGY CONSERVATION AND AUDITING 9

Definition, need, and types of energy audit; Energy management (audit) approach: Understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements; Fuel & energy substitution. Energy auditing - types, methodologies, barriers.Energy audit instruments; Duties and responsibilities of energy managers and auditors - Energy audit questionnaire.

UNIT V ENERGY MANAGEMENT 9

Organizational background desired for energy management persuasion, motivation, publicity role, industrial energy management systems. Energy monitoring and targeting - Elements, data, information analysis and techniques – Energy consumption, production, cumulative sum of differences (CUSUM). Energy Management Information Systems (EMIS). Economics of various energy conservation schemes – Energy policy and energy labeling.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Steve Doty, Wayne C. Turner “Energy Management Handbook”, 7th Edition, the Fairmont Press, Inc., 2013.
2. F Kreith, D. Y Goswami, “Energy management and conservation handbook”, CRC Press, 2017.
3. “Industrial Energy Conservation Manuals”, MIT Press, Mass, 2007.
4. YP Abbi and Shashank Jain. “Handbook on Energy Audit and Environment Management”, TERI Publications, 2006.
5. R Loulou, P R Shukla and A Kanudia, “Energy and Environment Policies for a sustainable Future”, Allied Publishers Limited, New Delhi, 1997
6. Guide book for “National Certification Examination for Energy Managers and Energy Auditors” (Could be downloaded from www.energymanagertraining.com)

19EN21E INSTRUMENTATION AND CONTROL FOR ENERGY 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 : describe the basic characteristics of instruments for measurement of specific properties (K2)
CO 2 : familiarize with the instruments used for measuring thermo-physical properties (K2)
CO 3 : recognize the advanced measurement techniques (K2)
CO 4 : interpret the concepts of system control and process parameters (K2)
CO 5 : reveal the concepts of data acquisition and intelligent instruments (K2)

UNIT I MEASUREMENT CHARACTERISTICS 9

Instrument classification - characteristics of instruments – static and dynamic - experimental error analysis - systematic and random errors - statistical analysis – uncertainty - experimental planning and selection of measuring instruments - reliability of instruments

UNIT II MEASUREMENT OF PHYSICAL QUANTITIES 9

Measurement of thermo – physical properties, instruments for measuring temperature - pressure and flow

UNIT III ADVANCED MEASUREMENT TECHNIQUES 9

Shadow graph – Schileren – Interferometer - Laser doppler anemometer - Hot wire anemometer, Heat flux sensors - Telemetry in measurement.

UNIT IV CONTROL SYSTEMS 9

Introduction - controllability, observability, Continuous and discrete process Controllers – Control Mode – Two – Step mode – Proportional Mode – Derivative Mode – Integral Mode – PID Controllers – Programmable Logic Controllers - Microprocessor PC based control applications.

UNIT V DATA ACQUISITION AND PROCESSING 9

Multi Channel Data acquisition system – Architecture of data acquisition and computer control system - Compact Data loggers – Sensor based, Computerized data systems - Micro – computer interfacing - Intelligent instruments in use.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. ManabendraBhuyan, “Intelligent Instrumentation”, CRC Press, 2010
2. Morris A.S., “Principles of Measurements and Instrumentation”, Butterworth-Heinemann, 2003
3. Ernest Doebelin, “Measurement Systems”, McGraw-Hill, 2011
4. Singh. S. K., “Industrial Instrumentation and Control”, Tata McGraw-Hill, 2015
5. Holman J.P. “Experimental methods for Engineers, 8th Edition”, McGraw-Hill, 2011
6. Rangan., “Instrumentation Devices and Systems”, Tata McGraw-Hill Education, 2017
7. John G. Webster., “The Measurement, Instrumentation, and Sensors Handbook”, Springer, 1999

19EN22E SOLAR PHOTOVOLTAIC POWER PLANTS: PLANNING, DESIGN AND BALANCE OF 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: describe the physics of photo cells (K2)
CO 2: compare various technologies along with their pros & cons (K2)
CO 3: design & analyze on-grid PV applications (K3)
CO 4 : design & analyze off-grid PV applications (K3)
CO 5: realize cost benefit analysis of PV installations (K2)

UNIT I SOLAR CELL FUNDAMENTALS 9

Contribution of Solar PV in Global Energy Scenario – Fundamentals of Semiconductors and Solar cells, Energy band, Charge carriers – Motion, PN Junction diode, Solar cells – Design characteristics, Solar radiation.

UNIT II SOLAR CELL TECHNOLOGIES 9

Silicon cell – Mono crystalline & Multi crystalline – Production, Silicon – Wafer based Solar cell, Thin film solar cells – A-Si, Cd-Te & CIGS, Concentrated PV cells, Emerging technologies – Organic cells, Dye sensitized cells.

UNIT III ON-GRID APPLICATIONS 9

Solar cells to solar array – On-Grid PV system – With & Without storage – Balance of system – DCDC converters – Inverters – Net Metering – Design & analysis – Performance evaluation & monitoring – Field visit – Grid tied PV power plant.

UNIT IV OFF-GRID APPLICATIONS 9

Off-Grid stand alone PV system – System sizing – Module & Battery – Storage – Batteries for PV systems – Sun Tracking mechanism – Types of tracking – One-axis, Two-axis – Maximum power point tracking – Design & analysis – Performance evaluation & monitoring – Field visit – Off-grid PV system.

UNIT V COMMERCIALS FOR SOLAR PV INSTALLATIONS 9

Cost and manufacturability – Cost modeling – Manufacturing economics – scaling – Pricing – Trends in retail pricing – energy economics – grid tied –stand alone applications

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Chetan Singh Solanki “Solar Photovoltaics Fundamentals, Technologies and applications”, 3rd Edition, Prentice Hall of India, 2015
2. A.K. Mukerjee, Nivedita Thakur “Photovoltaic Systems- Analysis and Design” Prentice Hall of India, 2011
3. Robert Foster Majid Ghassemi, Alma Cota “Solar Energy – Renewable Energy and the Environment”, CRC Press, 2010
4. James P. Dunlop “Photovoltaic Systems”, 3rd Edition by American Technical Publishers, 2013
5. Eduardo Lorenzo “Solar Electricity: Engineering of Photovoltaic Systems” by PROGENSA, 1994
6. www.pveducation.org

19EN23E MATERIALS TESTING AND CHARACTERIZATION TECHNIQUES

L	T	P	C	QP
3	0	0	3	A

COURSE OUTCOMES

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

CO1: Explain the Optical microscopy and X-ray diffraction of material characterization (K2)

CO2: Explain the electron microscopy techniques of material characterization. (K2)

CO3: Impart knowledge on chemical and thermal analysis techniques of material characterization. (K2)

CO4: Discuss the various static mechanical testing methods. (K2)

CO5: Discuss the various dynamic mechanical testing methods. (K2)

UNIT I OPTICAL MICROSCOPY AND X-RAY DIFFRACTION 9

Introduction to Macro and Micro analysis - Optical Microscopy - Introduction, Optical principles, Instrumentation, Specimen preparation-metallographic principles, Imaging Modes, Applications, Limitations –X- Ray Diffraction (XRD) - Introduction, Basic principles of diffraction, X - ray generation, Instrumentation, Types of analysis, Data collection for analysis, Applications, Limitations.

UNIT II ELECTRON MICROSCOPY 9

Interaction of Electron Beam with Materials –Transmission Electron Microscopy –Specimen Preparation –Imaging Techniques –BF & DF –SAD –Electron Probe Microanalysis – Scanning Electron Microscopy –Construction & working of SEM –various Imaging Techniques –Applications – Atomic Force Microscopy-Construction & working of AFM – Applications.

UNIT III CHEMICAL AND THERMAL ANALYSIS 9

Basic Principles, Practice and Applications of X-Ray Spectrometry, Wave Dispersive X-Ray Spectrometry, Auger Spectroscopy, Secondary Ion Mass Spectroscopy, Fourier Transform Infra-Red Spectroscopy (FTIR)-Proton Induced X-Ray Emission Spectroscopy, Differential Thermal Analysis, Differential Scanning Calorimetry (DSC) And Thermo Gravity metric Analysis (TGA).

UNIT IV MECHANICAL TESTING –STATICTESTS 9

Hardness –Brinell, Vickers, Rockwell and Micro Hardness Test –Tensile Test –Stress -Strain plot –Proof Stress –Torsion Test – Ductility Measurement –Impact Test –Charpy & Izod – DWTT – Fracture Toughness Test, Codes and standards for testing metallic and composite materials.

UNIT V MECHANICAL TESTING –DYNAMIC TESTS 9

Fatigue –Low & High Cycle Fatigues –Rotating Beam & Plate Bending HCF tests –S-N curve –LCF tests –Crack Growth studies –Creep Tests –LM parameters –Acoustic Emission Tests – modal analysis – Applications of Dynamic Tests.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Culity B.D., Stock S.R& Stock S., Elements of X ray Diffraction, (3rd Edition). Prentice Hall, 2001.
2. Dieter G.E., Mechanical Metallurgy, (3rd Edition), ISBN: 0070168938, McGraw Hill,

1988.
3. Davis, H.E., Hauck G. & Troxell G.E., The Testing of engineering Materials, (4th Edition), McGraw Hill, College Divn., 1982.
4. Suryanarayana A. V. K., Testing of metallic materials, (2nd Edition), BS publications, 2007.

REFERENCES

1. Goldsten,I.J., Dale.E., Echin.N.P.& Joy D.C., Scanning Electron Microscopy & X ray-Micro Analysis, (2nd Edition), ISBN – 0306441756, Plenum Publishing Corp., 2000.
2. Newby J., Metals Hand Book- Metallography & Micro Structures, (9th Edition), ASM International, 1989.
3. Grundy P.J. and Jones G.A., Electron Microscopy in the Study of Materials, Edward Arnold Limited, 1976.
4. Morita.S, Wiesendanger.R, and Meyer.E, —Non-contact Atomic Force Microscopy Springer, 2002,
5. Davis J. R., Tensile Testing, 2nd Edition, ASM International, 2004.
6. ASM Hand book-Materials characterization, Vol – 10, 2004.

19EN24E	MICRO MANUFACTURING	L	T	P	C	QP
		3	0	0	3	A

COURSE OUTCOMES

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

CO1: Describe the applications and process parameters of various micro machining processes. (K2)
CO2: Describe the applications and process parameters of various micro machining processes. (K2)
CO3: Discuss the working principle of nano polishing technique
CO4: Discuss the features of micro forming and micro welding technique
CO5: Explain recent trends and applications in micro manufacturing. (K2)

UNIT I MICRO MACHINING I 10

Mechanical Micro machining – Ultra Sonic Micro Machining – Abrasive Jet Micro Machining – Water Jet Micro Machining – Abrasive Water Jet Micro Machining – Micro turning – Chemical and Electro Chemical Micro Machining – Electric discharge micro machining.

UNIT II MICRO MACHINING II 10

Beam Energy based micro machining – Electron Beam Micro Machining – Laser Beam Micro Machining – Electric Discharge Micro Machining – Ion Beam Micro Machining – Plasma Beam Micro Machining – Hybrid Micro machining – Electro Discharge Grinding – Electro Chemical spark micro machining – Electrolytic in process Dressing.

UNIT III NANO POLISHING 9

Abrasive Flow finishing – Magnetic Abrasive Finishing – Magneto rheological finishing – Magneto Rheological abrasive flow finishing - Magnetic Float polishing – Elastic Emission Machining – chemo-mechanical Polishing.

UNIT IV MICRO FORMING AND WELDING 9

Micro extrusion – Micro and Nano structured surface development by Nano plastic forming and Roller Imprinting – Micro bending with LASER – LASER micro welding – Electron beam

for micro welding.

UNIT V RECENT TRENDS AND APPLICATIONS 7

Metrology for micro machined components – Ductile regime machining– AE based tool wear compensation– Machining of Micro gear, micro nozzle, micro pins – Applications.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Jain V. K., Micro Manufacturing Processes, CRC Press, Taylor & Francis Group, 2012.
2. Janocha H., Actuators – Basics and applications, Springer publishers – 2012.
3. Jain V.K., - Introduction to Micro machining'Narosa Publishing House, 2011.

REFERENCES

1. Bharat Bhushan, Handbook of nanotechnology, springer, Germany, 2010.
2. Bandyopadhyay. A.K., Nano Materials, New age international publishers, New Delhi, 2008, ISBN:8122422578.
3. Jain V.K., Advanced Machining Processes, Allied Publishers, Delhi, 2002
4. Mcgeoug.J.A., Micromachining of Engineering Materials, CRC press 2001, ISBN10:0824706447.
5. www.cmxr.com/industrial/
6. www.sciencemag.org.handbook.

19EN25E	NON-DESTRUCTIVE TESTING AND EVALUATION	L	T	P	C	QP
		3	0	0	3	A

COURSE OUTCOMES

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

CO1: Discuss liquid penetrant test for identifying welding defects. (K2)
CO2: Discuss eddy current testing and acoustic emission to identify defects in welded components. (K2)
CO3: Discuss magnetic particle test and thermography for identifying defects. (K2)
CO4: Discuss the standards in ultrasonic testing of welded structures. (K2)
CO5: Discuss radiographic test to identify defects in welded components. (K2)

UNIT I NON-DESTRUCTIVE TESTING: AN INTRODUCTION, VISUAL INSPECTION & LIQUID PENETRANT TESTING 9

Introduction to various non-destructive methods, Comparison of Destructive and Nondestructive Tests, Visual Inspection, Optical aids used for visual inspection, Applications. Physical principles, procedure for penetrant testing, Penetrant testing materials, Penetrant testing methods-water washable, Post-Emulsification methods, Applications.

UNIT II EDDY CURRENT TESTING & ACOUSTIC EMISSION 9

Principles, Instrumentation for ECT, Absolute, differential probes, Techniques –High sensitivity techniques, Multi frequency, Phased array ECT, Applications. Principle of AET, Instrumentation, Applications -testing of metal pressure vessels, Fatigue crack detection in aerospace structures.

UNIT III MAGNETIC PARTICLE TESTING & THERMOGRAPHY 9

Principle of MPT, procedure used for testing a component, Equipment used for MPT, Magnetizing techniques, Applications. Principle of Thermography, Infrared Radiometry, Active thermography measurements, Applications –Imaging entrapped water under an epoxy coating, Detection of carbon fiber contaminants.

UNIT IV ULTRASONIC TESTING 9

Principle, Ultrasonic transducers, Ultrasonic Flaw detection Equipment, Modes of display A-scan, B-Scan, C-Scan, Applications, Inspection Methods -Normal Incident Pulse-Echo Inspection, Normal Incident Through-transmission Testing, Angle Beam Pulse-Echo testing, TOFD Technique, Applications of Normal Beam Inspection in detecting fatigue cracks, Inclusions, Slag, Porosity and Intergranular cracks -Codes, standards, specification and procedures and case studies in ultrasonics test.

UNIT V RADIOGRAPHY 9

Principle of Radiography, x-ray and gamma ray sources-safety procedures and standards, Effect of radiation on Film, Radiographic imaging, Inspection Techniques –Single wall single image, Double wall Penetration, Multiwall Penetration technique, Real Time Radiography - Codes, standards, specification and procedures and case studies in Radiography test. Case studies on defects in cast, rolled, extruded, welded and heat-treated components - Comparison and selection of various NDT techniques.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Baldev Raj, T.Jayakumar, M.Thavasimuthu “Practical Non-Destructive Testing”, Narosa Publishing House, 2009.
2. Parmer R.S, “Welding Engineering and Technology”, 2nd Edition, Khanna publishers, Delhi, 2010.

REFERENCES

1. Krautkramer. J., “Ultra Sonic Testing of Materials”, 1st Edition, Springer –Verlag Publication, New York, 1996.
2. Peter J. Shull “Non-Destructive Evaluation: Theory, Techniques and Application” Marcel Dekker, Inc., New York, 2002.
3. ASM Metals Handbook Vol. 17 –Non-destructive Evaluation and Quality Control, published by ASM, USA
4. R Halmshaw, “Introduction to the Non-Destructive Testing of Welded Joints”- 2nd Edition, Woodhead Publishing, 1997.
5. www.nde-ed.org.
6. www.ndt.net.

19EN26E	POLYMERS AND COMPOSITE MATERIALS	L	T	P	C	QP
		3	0	0	3	A

COURSE OUTCOMES

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

CO1: Impart knowledge on types, physical properties and processing of polymer. (K2)
CO2: Explain matrix material, reinforcements of polymer matrix composites, MMC and ceramic matrix composites. (K2)
CO3: Discuss various processing of polymer matrix composites. (K2)
CO4: Discuss various processing of metal matrix composites. (K2)
CO5: Explain various processing of ceramic matrix composites and carbon-carbon composites. (K2)

UNIT I PROCESSING OF POLYMERS 9

Classification of Polymers –Properties of Thermo plastics –Properties of Thermosetting Plastics – Extrusion –Injection Moulding –Blow Moulding –Compression and Transfer Moulding –Casting –Thermo Forming. General Machining properties of Plastics –Machining Parameters and their effect –Joining of Plastics –Thermal bonding –Applications.

UNIT II FIBERS AND MATRIX MATERIALS 9

Fibers –Fabrication, Structure, properties and applications –Glass fiber, Boron fiber, carbon fiber, organic fiber, ceramic and metallic fibers – whiskers–Fabrication of Matrix materials – polymers, metals and ceramics and their properties –interfaces –Wettability –Types of bonding at the interface –Tests for measuring interfacial strength -Physical and chemical properties.

UNIT III PROCESSING OF POLYMER MATRIX COMPOSITES 9

Thermoset matrix composites: hand layup, spray, filament winding, Pultrusion, resin transfer moulding, autoclave moulding -bag moulding, compression moulding with Bulk Moulding Compound and sheet Moulding Compound –thermoplastic matrix composites – film stacking, diaphragm forming, thermoplastic tape laying, injection moulding –interfaces in PMCs -structure, properties and application of PMCs –recycling of PMCs.

UNIT IV PROCESSING OF METAL MATRIX COMPOSITES 9

Metallic matrices: Aluminium, Titanium, Magnesium, Copper alloys –processing of MMCs: liquid state, Solid state, in situ fabrication techniques –diffusion bonding –powder metallurgy techniques – interfaces in MMCs –mechanical properties –machining of MMCs – Applications.

UNIT V PROCESSING OF CERAMIC MATRIX COMPOSITES AND CARBON-CARBON COMPOSITES 9

Processing of CMCs: cold pressing, sintering, reaction bonding, liquid infiltration, lanxide process –in situ chemical reaction techniques: chemical vapour deposition, chemical vapour impregnation, sol-gel –interfaces in CMCs –mechanical properties and applications of CMCs –Carbon-carbon Composites –applications.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. ASM Handbook –Composites, Vol-21, 2001, ISBN: 978-0-87170-703-1.
2. Harold Belofsky, Plastics, Product Design andProcess Engineering, Hanser Publishers, 2002.

3. Jamal Y. Sheikh-Ahmad, Machining of Polymer Composites, Springer, USA, 2009. ISBN: 978-0-387-35539-9.
4. Krishnan K Chawla, Composite Materials: Science and Engineering, International Edition, Springer, 2012, ISBN:978-0-387-74364-6.

REFERENCES

1. Mallick P.K., Fiber Reinforced Composites: Materials, Manufacturing and Design, CRC press, New Delhi, 2010, ISBN:0849342058.
2. Mallick, P.K. and Newman.S., Composite Materials Technology, Hanser Publishers, 2003.
3. Said Jahanmir, Ramulu M.and Philp Koshy, Machining of Ceramics and Composites, Marcel Dekker Inc., New York, 1999, ISBN: 0-8247-0178-x.8.Seamour, E.B. Modern Plastics Technology, Prentice Hall, 2002.

19EN27E	SURFACE ENGINEERING	L	T	P	C	QP
		3	0	0	3	A

COURSE OUTCOMES

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

CO1: Discuss about the fundamental of Surface Engineering. (K2)
CO2: Discuss about the Conventional Surface Engineering. (K2)
CO3: Explain the various surface treatment techniques. (K2)
CO4: Explain the characterization of coatings and surfaces. (K2)
CO5: Explain the various advanced alloys used as engineering materials. (K2)

UNIT I FUNDAMENTALS OF SURFACE ENGINEERING 7

Fundamentals of surface engineering: definition, scope, classification, and general principles, surface dependent properties and failures, Surface and surface energy: Structure and types of interfaces.

UNIT II CONVENTIONAL SURFACE ENGINEERING 7

Conventional surface engineering practice: Surface engineering by material removal: like etching, grinding, polishing, etc. Surface engineering by material addition: like hot dipping, Electro- plating, carburizing, Cyaniding, etc.

UNIT III SURFACE TREATMENTS 12

Introduction – Surface properties, Superficial layer – Changing surface metallurgy – Wear resistant coatings and Surface treatments – Techniques – PVD – CVD – Physical CVD – Ion implantation – Surface welding – Thermal spraying – Laser surface hardening and alloying, Applications of coatings and surface treatments in wear and friction control – Characteristics of Wear resistant coatings – New trends in coating technology – DLC – CNC – Thick coatings – Nano-engineered coatings – Other coatings, Corrosion resistant coatings.

UNIT IV CHARACTERIZATION OF COATINGS AND SURFACES 9

Characterization of coatings and surfaces: Measurement of coatings thickness, porosity & adhesion of surface coatings, Measurement of residual stress & stability, Surface microscopy, topography and Spectroscopic analysis of modified surfaces.

UNIT V ENGINEERING MATERIALS 10

Introduction – Advanced alloys – Super alloys, Titanium alloys, Magnesium alloys, Aluminium alloys, and Nickel based alloys – Ceramics – Polymers – Biomaterials – Applications – Bio Tribology Nano Tribology.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. G.W.Stachowiak & A.W .Batchelor , “Engineering Tribology”, Butterworth Heinemann, UK, 2005.
2. Rabinowicz.E, “Friction and Wear of materials”, John Willey &Sons, UK,1995.
3. Halling, J. (Editor) – “Principles of Tribology “, Macmillian – 1984.
4. Williams J.A. “Engineering Tribology”, Oxford Univ. Press, 1994.

REFERENCES

1. S.K.Basu, S.N.Sengupta & B.B.Ahuja ,”Fundamentals of Tribology”, Prentice –Hall of India Pvt Ltd , New Delhi, 2005
2. Fontana G., “Corrosion Engineering”, McGraw Hill, 1985.

19EN28E SOLAR ENERGY CONVERSION TECHNOLOGIES L T P C
3 0 0 3

COURSE OUTCOMES

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

CO1: Analyze the performance of solar flat plate collectors.
CO2: Analyze the performance of concentrating solar collectors
CO 3: Design PV system ranging from a residential rooftop system to a utility scale solar farm
CO 4: Apply the concepts of solar energy for other different applications

UNIT I FLAT PLATE COLLECTORS 9

Flat plate collector - Materials for flat plate collector and their properties - Thermal Analysis of Flat-plate Collector and Useful Heat Gain - fin efficiency - collector efficiency factor – Heat Removal Factor.

UNIT II SOLAR CONCENTRATING COLLECTORS 9

Line-focusing and point-focusing concentrators: parabolic trough, parabolic dish, heliostat field with central receiver, Fresnel lenses, compound parabolic concentrator. Performance - concentration ratio, useful energy gain, energy losses, efficiency

UNIT III STAND ALONE PV SYSTEMS 9

Stand-alone PV Systems – Schematics – Components – Batteries - Charge Conditioners - Balancing of system components for DC and AC Applications – Design of components for stand-alone PV system.

UNIT IV GRID CONNECTED PV SYSTEMS 9

Grid Connected PV Systems - Schematics, Components, Charge Conditioners, Interface Components – Balancing of system Components - Design of components for grid connected PV system - PV System in Buildings.

UNIT V SOLAR APPLIANCES 9

Solar Cooking – Solar Water Heating – Solar Desalination – Solar Air Heater - Solar Ponds – Solar Pumps – Solar Furnaces - Solar Drying - Solar Chimney – Solar VARS – Solar ACs - Solar Green Houses - Solar Passive Architecture

L:45; TOTAL: 45 PERIODS

REFERENCES

1. C.S.Solanki., "Solar Photovoltaics – Fundamentals, Technologies and Applications", PHI Learning Pvt. Ltd., 2011.
2. Sukhatme S P, "Solar Energy", 4th Edition, Tata McGraw-Hill Education, 2017
3. Martin A. Green., "Solar Cells Operating Principles, Technology, and System Applications" Prentice- Hall, 2008.
4. Artur V.Kilian, "Solar Collectors: Energy Conservation, Design and Applications", Nova Science Publishers Incorporated, 2009.
5. Soteris A.Kalogiru, "Solar Energy Engineering: Processes and systems", 1st Edition, Academic press, 2009.
6. Michael Boxwell, The Solar Electricity Handbook, Code Green Publishing, UK, 2009.
7. Rik DeGunther, Solar Power Your Home for Dummies, Wiley Publishing Inc, 2008.
8. Photovoltaics: Design and Installation Manual, Published by Solar Energy Int. 2004.
9. https://nptel.ac.in/courses/115103123, Solar Energy Engineering and Technology.

19EN29E COMPUTATIONAL FLUID DYNAMICS FOR ENERGY SYSTEMS

L	T	P	C
3	0	0	3

COURSE OUTCOMES

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

CO1: Demonstrate the method of modelling the flow and heat transfer phenomenon.
CO2:Develop finite difference and finite volume discretized forms of the CFD equations
CO3: Apply the various numerical schemes to solve convection and diffusion equations.

UNIT I INTRODUCTION 9

Numerical simulation – Advantages, Methods of classification of PDE's, Elliptic, parabolic and hyperbolic equations, Initial and boundary conditions, Discretization Methods, Finite Difference Expressions from Taylor's series, Uniform and non-uniform Grids - Numerical Errors, Grid Independence Test.

UNIT II CONSERVATION EQUATION 9

Mass, Momentum and Energy Equation three dimensions, Eulerian and Lagrangian Approach, Equation of State, Navier's Strokes equation, Differential and Integral form of general transport equations.

UNIT III CONDUCTION HEAT TRANSFER 9

Steady one-dimensional conduction, Two- and three-dimensional steady state problems, Transient one-dimensional problem, Two-dimensional Transient Problems - Finite difference and Finite Volume approach.

UNIT IV INCOMPRESSIBLE FLUID FLOW 9

Stream Function – Vorticity methods, Finite volume methods for Convection and diffusion problem

–Central difference scheme, Upwind scheme, Hybrid scheme – Assessment of each scheme – Solution algorithm for pressure – velocity – coupling in steady flows - SIMPLE Procedure of Patankar and Spalding, SIMPLER and PISO Algorithm

UNIT V TURBULENCE MODELS 9

Algebraic Models – One equation model, K – ϵ Models, Standard and High and Low Reynolds number models, Prediction of fluid flow and heat transfer using standard codes.

TOTAL: 45 HOURS

REFERENCES

1. Muralidhar, K., and Sundararajan, T., “Computational Fluid Flow and Heat Transfer”, Narosa Publishing House, New Delhi, 2014.
2. Ghoshdasdidar, P.S., “Computer Simulation of flow and heat transfer” Tata McGraw-Hill Publishing Company Ltd., 1998.
3. Subas, V. Patankar “Numerical heat transfer fluid flow”, Hemisphere Publishing Corporation, 2018.
4. Taylor, C and Hughes, J.B. “Finite Element Programming of the Navier-Stokes Equation”, Pine ridge Press Limited, U.K., 1981.
5. Anderson, D.A., Tannehill, J.I., and Pletcher, R.H., “Computational fluid Mechanics and Heat Transfer “Hemisphere Publishing Corporation, New York, USA,1984.
6. Fletcher, C.A.J. “Computational Techniques for Fluid Dynamics 1” Fundamental and General Techniques, Springer – Verlag, 1987.
7. Fletcher, C.A.J. “Computational Techniques for Fluid Dynamics 2” Specific Techniques for Different Flow Categories, Springer – Verlag, 1987.
8. Bose, T.X., “Numerical Fluid Dynamics”, Narosa Publishing House, 1997.
9. https://onlinecourses.nptel.ac.in/noc21_me126/preview, Computational Fluid Dynamics.

19GD11E ANALYTICAL CHEMISTRY 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: select a proper chromatographic technique to isolate the compound. (K1)
CO 2: apply the knowledge in solving problems / tasks in the field of electro analytical chemistry. (K3)
CO 3: interpret the data and qualitative estimation by wet chemical analysis. (K2)
CO 4: evaluate and access chemical reaction and kinetic properties between 0-1600°C for compound. (K5)
CO 5: extend the knowledge of radiochemical analytical technique. (K2)

UNIT I CHROMATOGRAPHIC METHODS 9

Principle – Classification of chromatographic techniques – Technique and applications of paper chromatography – Thin-layer chromatography – HPTLC – Column chromatography – HPLC, GC-MS and its applications.

UNIT II ELECTRO ANALYTICAL TECHNIQUES 9

Conductometry and its applications – Potentiometry – pH metry and ion selective electrodes – Electrogravimetry – Cyclic Voltammetry and its applications – Amperometric titrations and applications.

UNIT III WET CHEMICAL METHODS OF ANALYSIS 9

Principle of volumetric analysis – Neutralization, Complexometric titrations – Precipitation titrations – Redox titrations – Theoretical aspects of titration curves and end point evaluation – Gravimetric analysis.

UNIT IV THERMAL METHODS 9

Principle, theory, instrumentation and applications of thermogravimetry (TGA) – Differential thermal analysis (DTA) – Differential scanning calorimetry (DSC).

UNIT V RADIOCHEMICAL METHODS 9

General theoretical considerations – Special precautions for radiochemical studies – Equipment for measuring radio activity – G.M. Counter– Determination of characteristics of GM counter – Determination of the absorption curve for ^{234}Th – ^{234}Pa sample.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. L. Price, Analytical Chemistry: Processes and Techniques, Willford Pr, England, 2019
2. F. Settle, “Handbook of Instrumental Techniques for Analytical Chemistry”, Pearson Education, Singapore, 2004.
3. B. Sivasankar, “Instrumental Methods of Analysis”, Oxford Higher Education, 2012.
4. D.A. Skoog, Principles of Instrumental Analysis, 2014.
5. S.K Anand and G.R. Chatwal, Instrumental Methods of Chemical Analysis, 2014

19GD12E COORDINATION CHEMISTRY 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: elucidate the structure of the coordination compounds. (K2)
CO 2: apply the theories and identify the nature of hybridization. (K3)
CO 3: assign term symbols for any transition metal complexes. (K3)
CO 4: identify the reaction mechanism of metal complexes. (K2)
CO 5: describe the keyways by which the biological important metal ion catalysis. (K2)

UNIT I NOMENCLATURE OF METAL COMPLEXES 9

Coordination compounds – Nomenclature – Characteristics – Structural isomerism – Stereoisomerism – Optical isomerism – Stability of complexes – Geometry of complexes.

UNIT II THEORIES OF COORDINATION COMPOUNDS 9

Valence bond theory – Electroneutrality principle and back bonding – Crystal field theory (CFT) – Assumptions of CFT theory – Crystal field splitting of *d*-orbitals in different geometries – Octahedral, square planar and tetrahedral complexes – Molecular orbital theory of π- bonding

UNIT III SPECTRAL TERMS OF METAL COMPLEXES 9

Russell-Saunders state – Quantum numbers – Spin-spin coupling, orbit-orbit coupling and spin-orbit coupling – Orgel diagrams – Tanabe-sugano diagram for d^3 complex – Electronic spectra of d^2, d^3, d^4, d^5, d^6, d^7, d^8 and d^9 complexes – Charge transfer spectra.

UNIT IV REACTIONS OF METAL COMPLEXES 9

Ligand substitution reactions – S_N1, S_N2 and S_N1CB mechanism – Outer sphere mechanism – Inner sphere mechanism – Trans effect – Theories of trans effect – Applications of trans effect.

UNIT V BIOLOGICAL IMPORTANCE OF METALS 9

Biological importance of transition metals; Biological roles of Mn, Fe, V, Cu, and Zn in proteins and enzymes – Electron transfer reactions in ferredoxins – Catalysis – blue-copper proteins – Metalloenzymes.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. N.W. Alcock, T.K. Chandrashekar, R.J. Deeth, T.J. Kemp, J. Leciejewicz, H.D. Lutz, M. Ravikanth , Coordination Chemistry (Structure and Bonding), 2013.
2. S. Guha, J.D. Lee Concise Inorganic Chemistry for JEE (MAIN AND ADVANCED) Generic; 4th Edition, 2018.
3. J.E. Huheey, E.A. Keiter, R.L. Keiter, O. Medhi, Inorganic Chemistry 4th Ed: principles of Structure and Reactivity - Pearson Publication, 2014
4. B. Kent, Advanced Inorganic Chemistry, Ny Research Pr, 2019.
5. F.A. Cotton, G. Wilkinson, C.A. Murillo, M. Bochmann, Advanced Inorganic Chemistry, 6th Edition, John Wiley and Sons, 2009.

19GD13E MATERIAL SCIENCES AND 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: select advanced materials for various engineering applications. (K3)
CO 2: know the role of structure and banding of materials in material application (K2)
CO3: analyze the crystal structure by knowing the bonding of materials. (K4)
CO4: draw the phase diagram of iron and iron carbide system (K3)
CO5: nd electrical and thermal properties of materials. (K2)

UNIT I ADVANCED MATERIALS 9

Materials and Engineering, Types of materials - Metallic materials - Dual phase steels, High strength low alloy (HSLA) steel, Transformation induced plasticity (TRIP) Steel,- Advanced structural ceramics, WC, TIC, Al_2O_3, SiC, Si_3N_4, and diamond –properties, processing and applications - Future trends in materials usage

UNIT II ATOMIC STRUCTURE AND BONDING 9

Structure of atoms- - Bohr's atomic model-Sommerfeld's extension of atomic structure; Electronic structure - Electronic configuration and Quantum numbers; Shapes of s,p,d,f orbitals - Pauli's exclusion principle - Hund's Rule of maximum multiplicity- Aufbau principle, , Types of atomic and molecular bonding – Octet rule - Primary Bonds - Ionic Bonds, Covalent Bonds, Metallic Bonds - Secondary Bonds - Permanent Dipole Bonds, Fluctuating Dipole Bonds

UNIT III CRYSTAL STRUCTURE AND CRYSTAL GEOMETRY 9

Space lattice, crystal systems and Bravais lattices, principal metallic crystal structures, Miller indices, crystallographic planes and directions, comparisons of principle metallic crystal structures, volume and density calculations, crystal structure analysis.

UNIT IV PHASE DIAGRAM AND PHASE TRANSFORMATION 9

Gibbs phase rule, Binary alloy system, Iron-iron carbide diagram, Heat treatment of steels and other non ferrous materials Solidification, crystalline imperfections and diffusion in solids Electrical, optical and mechanical properties of materials.

UNIT V MAGNETIC PROPERTIES OF THE MATERIALS 9

Magnetic Properties **-** Definition of Magnetic Properties, Types of magnetic bodies, Diamagnetism and Pascal's Constant, Russell-Saunders or **LS** Coupling, Multiple width Large compared to kT, Multiple width small compared to kT, Stereo chemical applications of Magnetic Properties of the First Transition Series, Determination of magnetic susceptibility by Gouy's Method, Derivation of Van Vleck formula for Susceptibility.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. W.D.Callister and D.G.Rethwisch, "Materials Science and Engineering: An Introduction", John Wiley & Sons Inc; 9th Edition, 2013.
2. O.P. Khanna, Material Science & Metallurgy, Dhanpat Rai Publications, 2014
3. P. Atkins, J. Paula, and James Keeler, Atkins' Physical Chemistry, OUP Oxford; 11th Edition, 2017.
4. J.M.D. Magnetism and Magnetic Materials, Cambridge University Press; Reprint Edition 2019

19GD14E NANOTECHNOLOGY 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: ensure the safe and responsible development of engineered nanoparticles and nanotechnology based materials and products. (K2)
CO 2: recognize the risks of nanomaterials for health and the environment (K2)
CO 3: explore, characterize and evaluate unique nanoscale packaging materials for thin film passive components. (K2)
CO 4: familiarize with semiconductors and devices including the P-N junction, and the transistors. (K2)

UNIT I FUNDAMENTALS OF SOLID STATE ENGINEERING 9

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

UNIT II CRYSTALLINE PROPERTIES OF SOLID 9

Crystal lattice and seven crystal systems, the unit cell concept, The Weigner-Seitz cell, Bravais lattices, Space and point groups, Miller indices, reciprocal lattice, Brillouin zone

UNIT III SEMICONDUCTOR HETEROSTRUCTURES AND LOW-DIMENSIONAL QUANTUM STRUCTURES 9

Energy bands, Application of model solid theory, Anderson model for heterojunctions, 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 IV FABRICATION OF NANOSTRUCTURES 9

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

UNIT V CHARACTERIZATION TECHNIQUES 9

Structural, X-ray diffraction, Electron microscopy, Energy dispersive analysis using X-rays, X-ray photoelectron spectroscopy, Secondary ion mass spectroscopy, Rutherford backscattering, Scanning probe microscopy, Optical, Photoluminescence spectroscopy, Absorbance measurement, Raman spectroscopy, Fourier transform spectroscopy.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. S.O. Pillai, Solid State Physics, New Age International publishers, 8th Edition, 2018.
2. S. Kulia, Essentials of Solid State Physics, New Central Book Agency; 2013.
3. T. Pradeep, A Textbook of Nanoscience and Nanotechnology, Tata McGraw Hill Education, 2012
4. W.R. Fahrner, Nanotechnology And Nanoelectronics: Materials, Devices, Measurement Techniques, Springer, 2011
5. A. Giovanni, X Rays Diffraction: Theory and Experiment, LAP Lambert Academic Publishing 2015

19GD15E PHYSICAL ORGANIC CHEMISTRY 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: draw mechanism, knowledge, reactivity and their structure in various molecular rearrangement. (K3)

CO 2: recall reagents and predict products for a defined set of organic reactions and to propose mechanism. (K2)

CO 3: determine the electronic structure of solids and crystal / (dis) order and defects. (K3)

CO 4: outline the mechanistic aspect for the important photochemical reaction. (K2)

CO 5: choose appropriate reagent for selective functional group transformations and to discuss the mechanism of important organic transformations. (K2)

UNIT I MOLECULAR REARRANGEMENTS 9

Types of rearrangements, Nucleophilic, electrophilic and free radical reactions – Wagner - Meerwein – Pinacol-Pinacolone – Benzil-Benzilic acid – Demjanov – Baeyer Villiger and Curtius rearrangements

UNIT II NAME REACTIONS 9

Mechanism of the following reactions: Aldol condensation – Perkin reaction – Stobbe condensation – McMurry reaction – Fries rearrangement – Sandmeyer reaction – Schmidt rearrangement – Sonogashira coupling reaction – Kolbe reaction.

UNIT III SOLID STATE 9

Structure of Solids – Crystalline and amorphous solids – Basic crystal systems – Crystal structures of sodium chloride, zinc blende, wurtzite, rutile – Schottky defects – Frenkel defects – Optical and electrical properties of semiconductors – Photovoltaic effect.

UNIT IV PHOTOCHEMISTRY 9

Introduction to photochemical reactions – Cis-trans isomerisation – Paterno-Buchi reaction – Norrish type I & II reaction – Photo reduction of Ketones – Photochemistry of arenes – Barton reaction – Photophysical process.

UNIT V REAGENTS IN ORGANIC SYNTHESIS 9

Reagents for organic synthesis and functional group transformations: Lithium aluminum hydride – Gilman's reagent – Sodiumborohydride – LDA – DCC – Von Rudloff reagent – Lemieux-Johnson reagent – Vaskas catalyst – Wilkinson's catalyst – Ziegler-Natta catalyst.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. Michael B. Smith, March'S Advanced Organic Chemistry : Reactions, Mechanisms, And Structure, 7th edition, John Wiley & sons, 2015
2. A.R. West, Solid State Chemistry and its Applications, 2nd Edition, John Wiley & sons, 2014.
3. N. Tewari, Organic Chemistry: A Modern Approach Vol-II, Mcgrawhill, 1st Edition, 2018
4. Jonathan Clayden, Nick Greeves, Stuart Warren, Organic Chemistry: Oxford University Press; 2nd Edition (1 July 2014).

19GD16E SPECTROSCOPIC METHODS IN CHEMISTRY 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: elucidate the electronic transition and the effect of conjugation present in the metal complex. (K2)

CO 2: identify the functional group and vibration of any metal complex. (K2)

CO 3: predict the splitting pattern and interpret integration of NMR spectra. (K3)

CO 4: predict the fragmentation pattern to find molecular mass and to identify the structure of a compound. (K3)

CO 5: interpret experiment spectra and analyzing the results to identify the geometry of the compound. (K2)

UNIT I ULTRAVIOLET SPECTROSCOPY 9

Electronic energy levels – Types of electronic excitations in UV-Vis spectroscopy – Change in position and intensity of absorption – Chromophores and auxochromes – Factors affecting the position of UV bands – Application of UV-Vis spectroscopy to transition metal complexes.

UNIT II INFRARED SPECTROSCOPY 9

Absorption of IR radiation and molecular vibrations – Spectral feature of major functional groups and interpretation of aromatic compounds – Characteristic IR absorption frequencies of important functional groups – Distinction between intermolecular and intramolecular hydrogen bonding – Applications of IR Spectroscopy.

UNIT III NUCLEAR MAGNETIC RESONANCE SPECTROSCOPY 9

Principles of ^{1}H,^{13}C NMR – Shielding mechanism – Chemical shift – Spin-Spin coupling – Coupling constants – Splitting of signals – Applications of NMR to organic compounds.

UNIT IV MASS SPECTROMETRY 9

Principle of mass spectrometry – Molecular peak, base peak, isotopic peak, metastable peak and their uses – Mass spectrum of organic compounds – identification – alcohols, aldehydes and aromatic hydrocarbons.

UNIT V ELECTRON SPIN RESONANCE (ESR) SPECTROSCOPY 9

Principle of ESR – Spin-spin relaxation – Hyperfine splitting – Zeeman splitting – *g*-values – Factors affecting *g*-value – Determination of *g* value – Zero field splitting – Application of ESR measurements.

L: 45; TOTAL: 45 PERIODS

REFERENCES

1. P.S. Kalsi, Spectroscopy of Organic Compounds, New Age International Private Limited, 2016.
2. R.S. Drago, Physical Methods in Inorganic Chemistry, Affiliated East-west Press PVT. Ltd.- New delhi, 2012.
3. Jag Mohan, Organic spectroscopy. Narosa Publishing House, New Delhi, 2011.
4. D.A. Skoog, Principles of Instrumental Analysis, Thomson Asia Private Limited, 2014

19GD17E ADVANCED VIBRATION ENGINEERING

L	T	P	C
3	0	0	3

COURSE OUTCOMES

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

CO1: Explain the concepts of Mechanical vibrations starting from single degree of system (K2)
CO2: Solve two degrees of Freedom system (K3)
CO3: Solve Multi degree freedom systems (K3)
CO4: demonstrate vibrations of continuous systems (K2)
CO5: demonstrate the various experimental methods (K2)

UNIT I INTRODUCTION TO VIBRATIONS 9

Free and Forced Vibration analysis of single degree of freedom- Undamped and viscously damped vibrations-Measurement of damping-Response to Periodic, Harmonic and Non-periodic Excitations.

UNIT II TWO DEGREE OF FREEDOM SYSTEM 9

Free and Forced vibration analysis-Coordinate transformation and linear superposition-Vibration Absorption and Vibration Isolation.

UNIT III MULTI DEGREE OF FREEDOM SYSTEM 9

Stiffness and Flexibility matrix- Eigen Value formulation- Lagrange’s method-Principle of Orthogonality- Modal matrix and modal analysis of multi DOF. Numerical Methods - Rayleigh’s Method, Matrix inversion method, Stodola's method, Holzer's method.

UNIT IV VIBRATIONS OF CONTINUOUS SYSTEMS 9

Vibration analysis of strings- Vibration of bar- Vibration of beams by Euler's equation-Effect of rotary inertia and shear deformation effects-Effect of axial force.

UNIT V EXPERIMENTAL METHODS 9

Vibration exciters and measuring instruments- Free and forced vibration tests- Signal analysis- Industrial case studies.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. S. S. Rao, "Mechanical Vibrations"Pearson India, 6th Edition, 2016.
2. Kelly SG "Mechanical Vibrations" CL Engineering 1st Edition, 2011.

REFERENCES

1. Dukkipati RV, "Advanced Mechanical Vibrations", Narosa Publications, 2008.
2. Benson H. Tongue, "Principles of Vibrations", Oxford University Press, Delhi, 2012.
3. W.T. Thomson, M.D. Dahleh, "Theory of Vibrations with applications", Pearson New International 5th Edition, 2013.
4. Meirovitch L, "Fundamental of Vibration", Waveland, Pr.Inc., 2010
5. William J Boltega, "Engineering Vibrations", CRC Press, 2nd Edition, 2014.
6. Paolo L. Gatti, "Applied Structural and Mechanical Vibrations: Theory and Methods", 2nd Edition, CRC Press, 2017.

19GD18E	MACHINERY FAULT DIAGNOSIS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

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

CO1: Explain the various maintenance methods (K2)
CO2: Demonstrate the fault identification using vibration signals (K2)
CO3: Describe the various wear monitoring methods (K2)
CO4: Describe the various temperature monitoring methods (K2)
CO5: Explain the concepts of Acoustic emission testing (K2)

UNIT I INTRODUCTION TO CONDITION MONITORING 9

Maintenance strategies, criticality index, various techniques for fault detection, Introduction to condition monitoring, Introduction to non-destructive testing, role of non-destructive testing in condition monitoring.

UNIT II VIBRATION ANALYSIS OF ROTATING MACHINES 9

Basics of Machine Vibration, Identification of machine faults and frequency range of symptoms, Signal Analysis, and Computer aided data acquisition, Time Domain Signal Analysis, Frequency Domain Signal Analysis, Fault Detection Transducers and instrumentation , Vibration Monitoring, Noise monitoring.

UNIT III WEAR MONITORING 9

Wear mechanisms, wear particles, wear process monitoring techniques, spectrometric oil analysis program, Ferrography.

UNIT IV TEMPERATURE MONITORING 9

Need of temperature monitoring, IR thermography, Passive and active thermography, applications.

UNIT V ACOUSTIC EMISSION TESTING AND CASE STUDIES 9

Theory of AE sources and Waves, Equipment, Signal Features, Data display, source location, Applications. Fault detection – Gearbox vibration, rolling element bearings and induction motors.

L:45; TOTAL:45 PERIODS

TEXT BOOK

1. A. Davies, "Handbook of Condition Monitoring: Techniques and Methodology", Springer Science & Business Media, 2017.

REFERENCES

1. C. Sujatha, "Vibration and Acoustics",Measurement and Signal Analysis, McGraw Hill Education (India) Private Limited, 2010.
2. Isermann.R, "Fault diagnosis applications", Springer – Verlag, Berlin, 2011.
3. Fakherchaari, Radoslaw Zimroz Walter Bartelmus, "Advances in Condition Monitoring ofMachinery in Non-Stationary Operations", 1st Edition, Springer, 2015.
4. Baldevraj, Jayakumar T., Thavasimuthu M., "Practical Non-Destructive Testing", Narosa Publishers, India, 2008.
5. Luiz Octavio Amaral Affonso, "Machinery Failure Analysis Hand Book", Gulf Publishing Company, Austin, United States, 2013.

19GD19E	ROTOR DYNAMICS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

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

CO1: Demonstrate the basics of Jeffcott rotor model (K2)
CO2: Solve the multi degree of freedom torsional vibration system (K3)
CO3: Determine the bending critical speed of simple rotors (K3)
CO4: Explain the process of balancing of rotors (K2)
CO5: Describe various condition monitoring techniques (K2)

UNIT I INTRODUCTION 9

Co-ordinate systems, steady state rotor motion, elliptical motion, single degree of freedom systems, free and forced vibrations, total motion. The Laval-Jeffcott rotor model: The two degrees of freedom rotor system, translational motion, natural frequencies and natural modes, steady state response to unbalance, the effect of flexible support.

UNIT II TORSIONAL VIBRATION IN ROTATING MACHINERY 9

Modeling of rotating machinery shafting multi degree of freedom systems. Determination of natural frequencies and mode shapes.

UNIT III BENDING CRITICAL SPEEDS OF SIMPLE SHAFTS 9

Whirling of an unbalanced simple elastic rotor, simple shafts with several disks, effect of axial stiffness, and determination of bending critical speeds.

UNIT IV BALANCING OF ROTORS 9

Single plane balancing, multi-plane balancing, balancing of rigid rotors, balancing of flexible rotors.

UNIT V CONDITION MONITORING 9

Noise spectrum, real time analysis, and knowledge based expert systems.

L:45; TOTAL:45 PERIODS

TEXT BOOKS

1. Rao J S, "Rotor Dynamics", New Age International Publishers, New Delhi, 2004.
2. Timoshenko S, Young D H and Weaver W, "Vibration Problems in Engineering", John Wiley, 1974.

REFERENCES

1. Weng Jeng Chen and Edger J Gunter, "Introduction to Dynamics of Rotor – Bearing Systems", Trafford Publishing Ltd., London, 2009.
2. Yamamoto T and Ishida Y, "Linear and Nonlinear Rotordynamics: A Modern Treatment with Applications", John Wiley and Sons Inc, New York, 2001.
3. Tondl A, "Some Problems of Rotor Dynamics", Chapman and Hall limited, New York, 1965.

19GD20E	OPTIMIZATION TECHNIQUES	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

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

CO1: Explain the basics of optimization (K2)
CO2: Perform the various unconstrained optimization techniques (K3)
CO3: Perform the various constrained optimization techniques (K3)
CO4: Perform advanced optimization techniques (K3)
CO5: Perform optimization in static and dynamic applications (K3)

UNIT I INTRODUCTION 9

Introduction to optimum design - General principles of optimization – Problem formulation & their classifications - Single variable and multivariable optimization.

UNIT II UNCONSTRAINED OPTIMIZATION TECHNIQUES 9

Techniques of unconstrained minimization – Golden section, Random, pattern and gradient search methods – Interpolation methods.

UNIT III CONSTRAINED OPTIMIZATION TECHNIQUES 9

Optimization with equality and inequality constraints - Direct methods – Indirect methods using penalty functions, Lagrange multipliers - Geometric programming.

UNIT IV ADVANCED OPTIMIZATION TECHNIQUES 9

Multi stage optimization – dynamic programming; stochastic programming; Multi objective optimization, Genetic algorithms and Simulated Annealing techniques; Neural network & Fuzzy logic principles in optimization.

UNIT V APPLICATIONS 9

Structural applications – Design applications – Design of simple axial, transverse loaded members for minimum cost. Dynamic Applications – Optimum design of single, two degree of freedom systems.

L:45; TOTAL:45 PERIODS

TEXT BOOK

1. Rao, Singaresu, S., “Engineering Optimization – Theory & Practice”, New Age International (P) Limited, New Delhi, 2000.

REFERENCES

1. Goldberg, D.E., “Genetic Algorithms in Search, Optimization and Machine Learning”, Pearson, 2008.
2. Johnson Ray, C., “Optimum design of mechanical elements”, Wiley, John & Sons, 1990.

M.E. – ENERGY 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.
CO2: To 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.

CO3: To 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.

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.