NATIONAL ENGINEERING COLLEGE

(An Autonomous Institution Affiliated to Anna University Chennai)

K.R.NAGAR, KOVILPATTI

www.nec.edu.in

DEPARTMENT OF
MECHANICAL ENGINEERING

REGULATIONS – 2023

CURRICULUM AND SYLLABUS OF

M.E. – ENERGY ENGINEERING

REGULATIONS 2023

CURRICULUM AND SYLLABUS

SEMESTER – I

S. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact Hours	Credits
				L	T	P		
Theory Courses								
1	23EN11C	Advanced Thermal Engineering	PCC	3	1	0	4	4
2	23EN12C	Research Methodology and IPR	GEN	2	0	0	2	2
3	23EN13C	Renewable Energy Sources	PCC	3	0	0	3	3
4	23EN14C	Fuels & Combustion	PCC	3	0	0	3	3
5	-	Elective – I	PEC	3	0	0	3	3
6	-	Elective – II	PEC	3	0	0	3	3
7	-	Audit Course – 1	AC	2	0	0	2	0
Practical Courses								
8	23EN15C	Energy Laboratory-I	PCC	0	0	4	4	2
						Total	**24**	**20**

SEMESTER – II

S. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact Hours	Credits
				L	T	P		
Theory Courses								
1	23EN21C	Solar Energy and Utilization	PCC	3	0	0	3	3
2	23EN22C	Energy Storage Technologies	PCC	3	0	0	3	3
3	23EN23C	Green Buildings	PCC	3	0	0	3	3
4	23EN24C	Energy Conservation and Management	PCC	3	1	0	3	4
5	-	Elective – III	PEC	3	0	0	3	3
6	-	Elective - IV	PEC	3	1	0	4	4
7	-	Audit Course – 2	AC	2	0	0	2	0
Practical Courses								
8	23EN25C	Energy Laboratory-II	PCC	0	0	4	4	2
9	23EN26C	Seminar	PCC	0	0	4	4	2
						Total	**30**	**24**

SEMESTER – III

S. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact Hours	Credits
				L	T	P		
Theory Courses								
1		Elective – V	PEC	3	1	0	4	4
2		Elective – VI	PEC	3	0	0	3	3
3		Elective – VII	PEC	3	0	0	3	3
4		Elective – VIII	PEC	3	0	0	3	3
Practical Courses								
5	23EN31C	Project Work - I	PCC	0	0	12	12	6
						Total	28	**19**

SEMESTER – IV

S. No.	Course Code	Course Title	Category	Periods Per Week			Total Contact Hours	Credits
				L	T	P		
Practical Courses								
1	23EN41C	Project Work - II	PCC	0	0	24	24	12
						Total	24	**12**

PROGRAMME ELECTIVE COURSES

S. No.	Course Code	Course Title	Course Category	L	T	P	C
1.	23EN01E	Advanced Power Plant Engineering	PEC	3	0	0	3
2.	23EN02E	Advanced Thermal Storage Technologies	PEC	3	0	0	3
3.	23EN03E	Alternative Fuels	PEC	3	0	0	3
4.	23EN04E	Cogeneration and Waste Heat Recovery Systems	PEC	3	0	0	3
5.	23EN05E	Design of Heat Exchangers	PEC	3	0	0	3
6.	23EN06E	Wind Energy Technology	PEC	3	0	0	3
7.	23EN07E	Materials for Energy Applications	PEC	3	0	0	3
8.	23EN08E	Electrical Technology for Energy Systems	PEC	3	0	0	3
9.	23EN09E	Design of Experiments	PEC	3	0	0	3
10.	23EN10E	Fluidized Bed Systems	PEC	3	0	0	3
11.	23EN11E	Bio Energy Engineering	PEC	3	0	0	3
12.	23EN12E	Instrumentation and Control for Energy Systems	PEC	3	1	0	4
13.	23EN13E	Energy System Modeling and Project Management	PEC	3	0	0	3
14.	23EN14E	Solar Energy Conversion Technologies	PEC	3	0	0	3

15.	23EN15E	Thermal Energy Systems for Electrical Engineers	PEC	3	0	0	3
16.	23EN16E	Design and Optimization of Energy Systems	PEC	3	1	0	4
17.	23EN17E	Fuel Cells and Hydrogen Energy	PEC	3	0	0	3
18.	23EN18E	Electric Vehicles	PEC	3	0	0	3
19.	23EN19E	Energy Auditing	PEC	3	1	0	4
		Courses offered by other PG programs	PEC	3	0	0	3

AUDIT COURSES

S. No	Course Code	COURSE TITLE	Course Category	L	T	P	C
1.	23AC01E	Technical Report Writing	AC	2	0	0	0
2.	23AC02E	Disaster Management	AC	2	0	0	0
3.	23AC03E	Sanskrit for Technical Knowledge	AC	2	0	0	0
4.	23AC04E	Value Education	AC	2	0	0	0
5.	23AC05E	Constitution of India	AC	2	0	0	0
6.	23AC06E	Pedagogy Studies	AC	2	0	0	0
7.	23AC07E	Stress Management by Yoga	AC	2	0	0	0
8.	23AC08E	Personality Development through Life Enlightenment Skills.	AC	2	0	0	0

23EN11C ADVANCED THERMAL ENGINEERING L T P C
3 1 0 4

COURSE OUTCOMES

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

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

REVIEW OF THERMODYNAMICS AND SECOND LAW ANALYSIS 12

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.

THERMODYNAMIC RELATIONS 12

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; Clausiusclapeyron equation; Joule-Thomson and Joule coefficients; applications of thermodynamic relations.

CONDUCTION HEAT TRANSFER 12

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.

VISCOUS FLOW AND BOUNDARY LAYER THEORIES 12

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.

CONVECTION AND RADIATION HEAT TRANSFER 12

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:15; TOTAL:60 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.

23EN12C **RESEARCH METHODOLOGY AND IPR** **L T P C**
2 0 0 2

COURSE OUTCOMES

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

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

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.
CASE STUDY

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 - Data Mining - Case Studies

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.

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.

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, Art 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.

23EN13C **RENEWABLE ENERGY SOURCES** **L T P C**
3 0 0 3

COURSE OUTCOMES

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

CO 1 : develop knowledge on solar radiation principles and its conversion
CO 2 : interpret the concepts of extraction of Wind Energy
CO 3 : reveal the various forms of Bio-Energy and Conversion techniques
CO 4 : familiarize with the concepts of Hydrogen Energy
CO 5 : recognize the basic principles of concept of various other forms of renewable energy

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.

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.

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 – Bio Diesel

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.

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.

23EN14C **FUELS & COMBUSTION** **L T P C**
3 0 0 3

COURSE OUTCOMES

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

CO1: explain the various sources of energy and fuels.
CO2: distinguish between various types of fuels and combustion methods and balancing the combustion equation.
CO3: choose correct stoichiometric ratio for combustion process

INTRODUCTION **9**

General, Conventional Energy Sources, Solar Energy, Nuclear Power, Energy from Biomass, Wind Power, TidalPower, Geothermal Energy, Energy Survey of India , Rocket Fuels.

SOLID& LIQUID FUELS **9**

Coal - Analysis and Properties of Coal, Classification of Coal, Oxidation of Coal, Hydrogenation of Coal, Efficient use of Solid Fuels, Manufactured Fuels, Agro Fuels, Solid Fuel Handling, Properties Related to Combustion, Handling Storage,

GASEOUS FUELS **9**

Origin and Classification of Petroleum, Refining and Other Conversion Processes, Composition of Petroleum Various Petroleum Products, Storage and Handling of Liquid Fuels, Liquid Fuel Combustion Equipment, Gaseous Fuels, Through Non-Thermal Route-Biogas, Refinery Gas, LPG, Cleaning and Purification of Gaseous Fuels.

THEORY OF COMBUSTION PROCESS **9**

Stoichiometry and Thermodynamics, Combustion Stoichiometry General, Rapid Methods of Combustion Stoichiometry, Combustion Thermodynamics, Problem, Combustion Problems with Chemical reactions burners.

STOICHIOMETRY **9**

Stoichiometry Relations, Theoretical Air Required for Complete Combustion, Calculation of Minimum Amount of Air Required for a Fuel of Known Composition, Calculation of Dry Flue Gases If Fuel Combustion is Known, Calculation of the Composition of Fuel and Excess Air Supplied from Exhaust Gas Analysis, Dew Point of Products, Flue Gas Analysis (OM, COM, CO, NOx, SOx).

L:45; TOTAL:45 PERIODS

REFERENCES

1. Samir Sarkar, Fuels & Combustion, Hrd Edition, Orient Logman, latest Edition 2009.
2. Bhatt, Vora Stoichiometry, 5th Edition, Tata Mcgraw Hill, 2010.
3. Blokh AG, Heat Transfer in Steam Boiler Furance, Hemisphere Publishing Corpn, 2000.
4. Civil Davies, Calculations in Furance Technology, PergamonPress,Oxford,2000
5. Sharma SP, Mohan Chander, Fuels & Combustion, Tata Mcgraw Hill,1987.

23EN15C **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
CO 2: familiarize with the parameters that affect the performance of energy systems
CO 3: analyze the characteristics of various fuels

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
    - Determination of Density and Viscosity of oil
    - Determination of Calorific value of fuel
    - Proximate Analysis
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 **6**

1. Thermal Storage Systems

P:60; TOTAL:60 PERIODS

23EN21C	**SOLAR ENERGY AND UTILIZATION**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

COURSE OUTCOMES

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

CO 1 : predict and estimate solar energy potential and its availability.
CO 2 : examine various collecting techniques of solar thermal systems.
CO 3 : interpret PV technology principles, and conversion of solar energy into Electricity.
CO 4 : familiarize with the basic applications of photovoltaic system.
CO 5 : reveal the variety of thermal energy storage systems.

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.

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.

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.

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.

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”, 1st Edition, CRC Press, 2009.
3. SoterisKalogirou, “Solar Energy Engineering: Processes and Systems”, 3rd Edition, Academic Press, 2023.
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, Reprint 2016.
6. H.P. Garg and J. Prakash, “Solar Energy- Fundamentals & Applications”, 1st Edition, Tata McGraw Hill Education, 2017.

23EN22C **ENERGY STORAGE TECHNOLOGIES** **L T P C**

3 0 0 3

COURSE OUTCOMES

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

CO1: understand the working principles of the most important energy storage technologies, including thermal, chemical, electromagnetic, and electro chemical storage.

CO2: acknowledge the most recent developments on the integration of energy storage technologies and solutions in sustainable energy production.

ENERGY STORAGE SYSTEMS **9**

Scope of energy storage, needs and opportunities in energy storage, Technology overview and key disciplines, comparison of time scale of storages and applications, Energy storage in the power and transportation sectors. Importance of energy storage systems in electric vehicles, Current electric vehicle market.

THERMAL STORAGE SYSTEM **9**

Heat pumps, hot water storage tank, solar thermal collector, application of phase change materials for heat storage-organic and in organic materials, efficiencies, and economic evaluation of thermal energy storage systems.

CHEMICAL STORAGE SYSTEM **9**

Hydrogen, methane, concept of chemical storage of solar energy, application of chemical energy storage system, advantages and limitations of chemical energy storage, challenges, and future prospects of chemical storage systems.

ELECTROMAGNETIC STORAGE SYSTEMS **9**

Double layer capacitors with electro statically charge storage, superconducting magnetic energy storage (SMES), concepts, advantages and limitations of electromagnetic energy storage systems, and future prospects of electrochemical storage systems.

ELECTROCHEMICAL STORAGE SYSTEM **9**

Batteries: Working principle of battery, primary and secondary (flow) batteries, battery performance evaluation methods, major battery chemistries and their voltages- Li-ion battery & Metal hydride battery vs. lead-acid battery.

Fuel cell: Operational principle of a fuel cell, types of fuel cells, hybrid fuel cell-battery systems, hybrid fuel cell-super capacitor systems.

L:45; TOTAL:45 PERIODS

REFERENCES

1. Frank S. Barnes and Jonah G. Levine, "Large Energy Storage Systems Handbook", 1st Edition, CRC press, 2011.
2. Ralph Zito, Haleh Ardebili, "Energy storage: A new approach", 2nd Edition, Wiley, 2019.
3. Pistoia, Gianfranco, and Boryann Liaw, "Behaviour of Lithium-Ion Batteries in Electric Vehicles: Battery Health, Performance, Safety, and Cost", 1st Edition, Springer International Publishing AG, 2018.
4. Robert A. Huggins, "Energy storage", 2nd Edition, Springer Science & Business Media, 2015.

23EN23C	GREEN BUILDINGS	L	T	P	C
		3	0	0	3

COURSE OUTCOMES

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

CO1: understand and apply the concepts and factors influencing green building concepts, systems and energy management.
CO2: apply the thermal and solar energy concepts to improve the building comfort
CO3: use low embodied energy industrial and building materials and cost effective building technologies.

INTRODUCTION **9**

Energy use, carbon emissions, water use, waste disposal; Building materials: sources, methods of production and environmental Implications. Embodied Energy in Building Materials: Transportation Energy for Building Materials; Maintenance Energy for Buildings.

IMPLICATIONS OF BUILDING TECHNOLOGIES EMBODIED ENERGY OF BUILDINGS **9**

Primary and Secondary Energy, Embodied Energy, Role of Materials, Emission and pollution, Resources for Building Materials, Life Cycle Assessment, Life Cycle Costing, Key considerations regarding sustainable materials, High-Performance Building Energy Design Strategy and Goal Settings Methods to reduce embodied energy in building materials, Energy efficiency in a green building.

COMFORTS IN BUILDING **9**

Thermal comfort in Buildings – Issues, Passive Cooling concepts, Heat transfer, Characteristic of Building Materials and Building Techniques, Properties of Atmospheric air, Psychometric properties of Air, Chart, Analyzing Air-conditioning Processes; Heating, Cooling, Dehumidification and Humidification, Evaporative Cooling, Adiabatic mixing of two moist air streams, Cooling towers, energy efficient appliances for heating and air conditioning systems.

SOLAR ENERGY IN BUILDINGS **9**

Utility of Solar energy in buildings concepts of Solar Passive Cooling and Heating of Buildings. Low Energy Cooling. Case studies of Solar Passive Cooled and Heated Buildings.

GREEN COMPOSITES FOR BUILDINGS **9**

Concepts of Green Composites. Water Utilisation in Buildings, Low Energy Approaches to Water Management. Management of Solid Wastes. Management of Sullage Water and Sewage. Urban Environment and Green Buildings. Green Cover and Built Environment.

L:45; TOTAL:45 PERIODS

REFERENCES

1. K.S.Jagadish, B.U.Venkataramareddy and K.S.Nanjundarao, “Alternative Building Materials and Technologies”, 2nd Edition, New Age International, 2021.
2. Ursula Eicker, “Low Energy Cooling For Sustainable Buildings”, 1st Edition, John Wiley and Sons Ltd, 2009.
3. Catalan Institute for Energy, “Sustainable Building Design Manual. Vol 1 and 2”, TERI, New Delhi, 2004.
4. Osman Attmann, “Green Architecture Advanced Technologies and Materials”, McGraw Hill, 2010.
5. Jerry Yudelson, “Green building Through Integrated Design”, 1st Edition, McGraw Hill, 2009.

23EN24C	**ENERGY CONSERVATION AND MANAGEMENT**	**L**	**T**	**P**	**C**
		3	**1**	**0**	**4**

COURSE OUTCOMES

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

CO 1 : understand and analyse the energy data of industries.
CO 2 : carryout energy accounting and balancing.
CO 3 : conduct energy audit and suggest methodologies for energy savings andutilise the available resources in optimal ways.

INTRODUCTION **12**

Energy - Power – Past & Present scenario of World; National Energy consumption Data – Environmental aspects associated with energy utilization – Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing.

ELECTRICAL SYSTEMS **12**

Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors - Motor Efficiency Computation, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination.

THERMAL SYSTEMS **12**

Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and encon measures. Steam: Distribution &U sage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories.

ENERGY CONSERVATION IN MAJOR UTILITIES **12**

Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems – Cooling Towers – D.G. sets.

ECONOMICS **12**

Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concept.

L:45; T:15; TOTAL:60 PERIODS

REFERENCES

1. Energy Manager Training Manual (4 Volumes), Bureau of Energy Efficiency (BEE), 2004. https://aipnpc.org/Guidebooks.aspx
2. Philip S. Schmidt Larry C. Witte David R. Brown; Philip S. Schmidt; David R. Brown, "Industrial Energy Management and Utilisation", 1st Edition, Srpinger, 1988.
3. Callaghn, P.W. "Design and Management for Energy Conservation", 1st Edition, Pergamon Press, Oxford, 1981.
4. Dryden. I.G.C., "The Efficient Use of Energy" 2nd Edition, Butterworths, London, 1982.
5. Stephen A. Roosa, Steve Doty, Wayne C. Turner, "Energy Management Hand book", 9th Edition, Wiley, New York, 2018.
6. Murphy. W.R. and G. Mc KAY, "Energy Management", Butterworth, 2009.

23EN25C **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.
CO 2: analyze the effect of constraints on the performance of energy systems.
CO 3: model and simulate various energy systems to optimize the performance.

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

23EN01E ADVANCED POWER PLANT ENGINEERING L T P C
3 0 0 3

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.
CO 2: analyze the gas power cycles and its improvements
CO 3: realize the advances in hydro power plants.
CO 4 : reveal the working of nuclear and MHD power plants
CO 5: identify the economic feasibility and issues related to the power plants.

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 - Combined Cycle, Cogeneration, Binary cycle

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.

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 - Pumped energy storage system, Small Hydro Plants

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.

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”, Dhanpat Rai 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”, 5th Edition, Laxmi Publications, 2016

23EN02E ADVANCED THERMAL STORAGE TECHNOLOGIES

L	T	P	C
3	0	0	3

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

CO 2: develop the model and analyze the sensible and latent heat storage units

CO 3: recognize various applications of thermal storage systems

INTRODUCTION **9**

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

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.

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.

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.

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”

23EN03E **ALTERNATIVE FUELS** **L T P C**
3 0 0 3

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.

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

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.

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.

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.

HYDROGEN 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.

BIOGAS **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”

23EN04E COGENERATION AND WASTE HEAT RECOVERY SYSTEMS L T P C
3 0 0 3

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

CO 2: analyze the basic energy generation cycles

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

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

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 - Heat to power ratio.

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.,

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 - Case studies

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.

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

23EN05E DESIGN OF HEAT EXCHANGERS

L	T	P	C
3	0	0	3

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
CO 2: classify various types of flows and disturbances
CO 3: design Shell& Tube and Double-Pipe Heat Exchanger, Compact and Plate Heat exchanger, Condenser and performance analysis of Cooling Towers

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.

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

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.

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.

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. SadikKakac 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”

23EN06E	**WIND ENERGY TECHNOLOGY**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

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
CO 2 : disseminate with the wind measurement techniques
CO 3 : summarize the concepts of aerodynamics, wind farms and cycles
CO 4 : analyze the economics of wind energy systems

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.

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

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).

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

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

23EN07E MATERIALS FOR ENERGY APPLICATIONS L T P C
3 0 0 3

COURSE OUTCOMES

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

CO1: 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.
CO2: characterize the synthesized materials.
CO3: recognize the different types of materials used in electronics.
CO4: gain fundamental understanding of electrical conduction (transport) in solids, major properties of bulk and nanostructured superconductors.
CO5: comprehend the scientific basis to ensure the safe and responsible development of engineered nanoparticles and nanotechnology-based materials and products.

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.

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)

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.

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.

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; T:0; TOTAL:45 PERIODS

REFERENCES

1. Mehta V K, Rohit Mehta, “Principle of Electronics”, 11th Edition, S.Chand Publications, 2020.
2. S.O.Kasap “Principles of Electronic Materials and Devices”, Tata McGraw-Hill Publication, 4thEdition, 2020.
3. C.N. Banwell, “Fundamentals of Molecular Spectroscopy”, Tata McGraw-Hill Education, 4thEdition, 2017.
4. Charles P. Poole Jr. , Horacio A.Farach, Richard J.Creswick, Ruslan Prozorov, “Super conductivity” Elsevier, 3rd Edition, 2018.
5. Thomas Varghese, Balakrishna K.M, “Nanotechnology: An Introduction to Synthesis, Properties and Applications of Nano materials” Reprint 2016, Atlantic Publisher, 2023.

23EN08E ELECTRICAL TECHNOLOGY FOR ENERGY SYSTEMS L T P C
3 0 0 3

COURSE OUTCOMES

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

CO 1 : realize the basic working principles of Generators.
CO 2 : classify the various types of Energy Saving Methods and storage concepts of electricity.
CO 3 : familiarize with the concepts of Electricity Transmission & Distribution.
CO 4 : recognize the concepts of Wheeling and Power Evacuation of Wind &Solar Power.

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.

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.

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.

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.

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.K. Thereja, “A Textbook of Electrical Technology”, S Chand Publishers, 25th Edition, 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”, 1st Edition, Prentice Hall of India, 2015.
4. C.L. Wadhwa “Generation Distribution and Utilization of Electrical Energy”, 3rd Edition, New Age International 2017.
5. H.A. Kiehne “Battery Technology Handbook”, 2nd Revised Edition, Taylor & Francis, 2007.

23EN09E DESIGN OF EXPERIMENTS L T P C
3 0 0 3

COURSE OUTCOMES

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

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

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.

EXPERIMENTAL METHODS **9**

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

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.

GENERAL METHODS OF DESIGNING EXPERIMENTS **9**

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

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

REFERENCES

1. Robert F. Brewer, "Design of Experiments for Process Improvement and Quality Assurance" Narosa Publishing House, 2009.
2. Dieter, George E., "Engineering Design - A Materials and Processing Approach", McGraw Hill, International Editions, Singapore, 2017.
3. Anita Goyal, Karl T Ulrich, Steven D Eppinger, "Product Design and Development", Tata McGraw-Hill Education**,** 7th Edition, 2020.

23EN10E **FLUIDIZED BED SYSTEMS** **L T P C**
3 0 0 3

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

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.

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.

COMBUSTION AND GASIFICATION **9**

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

DESIGN CONSIDERATIONS **9**

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

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.

23EN11E **BIO ENERGY ENGINEERING** **L T P C**
3 0 0 3

COURSE OUTCOMES

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

CO 1 : classify the types of biomass and its surplus availability.

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

INTRODUCTION **9**

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

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.

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.

GASIFICATION **9**

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

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 Pvt. Ltd., 2021.
5. Rezaiyan. J and N.P.Cheremisinoff, “Gasification Technologies, A Primer for Engineers and Scientists”, Taylor & Francis, 2005.

23EN12E INSTRUMENTATION AND CONTROL FOR ENERGY SYSTEMS **L T P C**
3 1 0 4

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.
CO 2 : familiarize with the instruments used for measuring thermo-physical properties.
CO 3 : recognize the advanced measurement techniques.
CO 4 : interpret the concepts of system control and process parameters.
CO 5 : reveal the concepts of data acquisition and intelligent instruments.

MEASUREMENT CHARACTERISTICS **12**

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.

MEASUREMENT OF PHYSICAL QUANTITIES **12**

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

ADVANCED MEASUREMENT TECHNIQUES **12**

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

CONTROL SYSTEMS **12**

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.

DATA ACQUISITION AND PROCESSING **12**

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;T:15; TOTAL:60 PERIODS

REFERENCES

1. Manabendra Bhuyan, “Intelligent Instrumentation”, CRC Press, 2017
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”, McGraw-Hill, 8th Edition, 2011
6. Rangan., “Instrumentation Devices and Systems”, Tata McGraw-Hill Education, 2017
7. John G.Webster., “The Measurement, Instrumentation, and Sensors Handbook”, Springer, 1999

23EN13E ENERGY SYSTEM MODELING AND PROJECT MANAGEMENT **L T P C**
3 0 0 3

COURSE OUTCOMES

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

CO 1: model and simulate energy systems.
CO 2: apply new generation optimization techniques for energy system simulation.
CO 3: perform economic analysis of various renewable energy systems.
CO 4: categorize management strategies for project evaluation.

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.

MODELING AND SYSTEMS SIMULATION **9**

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

OPTIMISATION 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

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.

PROJECT MANAGEMENT **9**

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

L:45; T:0; TOTAL:45 PERIODS

REFERENCES

1. Stoecker W.F., “Design of Thermal Systems”, McGraw Hill, 3rd Edition, 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 & W.Beckman “Solar Engineering of Thermal Processes” Wiley, 5th Edition, 2020.
4. Singiresu S. Rao, “Applied Numerical Methods for Engineers and Scientists”, Prentice Hall, 2002.

23EN14E 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.
CO3: Design PV system ranging from a residential rooftop system to a utility scale solar farm.

FLAT PLATE COLLECTORS **9**

Flat plate collector - Materials for flat plate collector and their properties - Thermal analysis of Flat-plate collector and useful heat gained by the fluid - fin efficiency - collector efficiency factor – Heat Removal Factor.

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

STAND ALONE PV SYSTEMS **9**

Stand-alone PV Systems – Schematics – Components – Batteries - Charge Conditioners - Balancing of system components for DC and AC Applications - Typical applications for lighting, water pumping.

GRID CONNECTED PV SYSTEMS **9**

Grid Connected PV Systems - Schematics, Components, Charge Conditioners, Interface Components – Balancing of system Components - PV System in Buildings.

DESIGN OF PV SYSTEMS **9**

Radiation and load data - Design of System Components for different PV Applications - Sizing and reliability - Simple Case Studies.

L:45; TOTAL:45 PERIODS

REFERENCES

1. CS Solanki: Solar Photovoltaics – Fundamentals, Technologies and Applications, PHI Learning Pvt. Ltd., 3rd Edition, 2015.
2. Sukhatme S P, "Solar Energy", Tata McGraw-Hill Education, 4thEdition, 2017
3. Martin A. Green, Solar Cells Operating Principles, Technology, and System Applications Prentice- Hall, 2008.
4. ArturV.Kilian, "Solar Collectors: Energy Conservation, Design and Applications", Nova Science Publishers Incorporated, 2009.
5. SoterisA.Kalogiru, "Solar Energy Engineering: Processes and systems", Academic press, 2ndedition, 2013.

23EN15E THERMAL ENERGY SYSTEMS FOR ELECTRICAL ENGINEERS **L T P C**
3 0 0 3

COURSE OUTCOMES

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

CO1: describe the fluid properties and concepts of fluid Mechanics.
CO2: explain the basic concepts and laws of thermodynamics.
CO3: apply the properties of steam in the analysis of steam power cycles.
CO4: discuss the working principles of various compressors, refrigeration and air-conditioning systems.

BASIC CONCEPTS OF FLUID MECHANICS **9**

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

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.

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.

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.

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, 2020.
2. S.Domkundwar, C.P.Kothandaraman & A.V.Domkundwar, “Thermal Engineering”, Dhanpatrai & Co., 2004
3. Rogers and Mayhew, “Engineering Thermodynamics – Work and Heat Transfer”, Pearson Education Private Limited, New Delhi, 2006.
4. Eastop and Mc Conkey, “Applied Thermodynamics”, Pearson Education Private Limited, New Delhi, 5th Edition, 2009.
5. P.K.Nag, “Engineering Thermodynamics” Tata McGraw Hill, New Delhi, 2017.
6. Modi and Seth, “Hydraulics and Fluid Mechanics Including Hydraulics Machines” Standard Book House, 22ndEdition, 2019

23EN16E DESIGN AND OPTIMIZATION OF ENERGY SYSTEMS **L T P C**
3 1 0 4

COURSE OUTCOMES

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

CO1: perform the Simulation and Modeling of typical energy system.
CO2: analyse the effect of constraints on the performance of energy systems.
CO3: design energy systems and perform Energy-Economic Analysis for typical applications.

INTRODUCTION **12**

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

BASIC CONSIDERATIONS IN DESIGN **12**

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

MODELING OF THERMAL SYSTEMS **12**

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

ECONOMIC CONSIDERATIONS **12**

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

OPTIMIZATION **12**

Basic Concepts- Optimization Methods- Optimization of Thermal Systems- Practical Aspects inOptimal Design.

L:45; T:15; TOTAL:60 PERIODS

REFERENCES

1. Jasbir Arora, Introduction to Optimum Design, 4th 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, Cengage Learning, 4th Edition, 2016.
5. Yogesh Jaluria, Design and Optimization of Thermal systems, CRC Press, 3rd Edition, 2019.
6. Kalyanmoy Deb, Optimization for engineering design: Algorithms and examples, PHI Learning Private Limited, 2nd Edition, 2012.

23EN17E **FUEL CELLS AND HYDROGEN ENERGY** **L T P C**
3 0 0 3

COURSE OUTCOMES

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

CO1: identify hydrogen production methodologies, possible applications and various storage options.

CO2: converse about the working of a typical fuel cell, its types and to elaborate on its thermodynamics and kinetics.

CO3: analyze the cost effectiveness and eco-friendliness of Fuel Cells.

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.

FUEL CELL TYPES **9**

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

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.

HYDROGEN PRODUCTION METHODS **9**

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

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.

23AC01E **TECHNICAL REPORT WRITING**

L	T	P	C
2	0	0	0

COURSE OUTCOMES

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

CO1: Enhance the knowledge of the research objectives and research process
CO2: Develop the level of readability for formulating rationale and improve writing skills
CO3: Formulate suitable sentences and key words for the research paper
CO4: Develop the skill of chapterisation and research writing
CO5: Interpretation of data through various strategies
CO 6: Implementation of basic rules and methods of citation

INTRODUCTION TO RESEARCH **5**

Research – Writing Definitions – Framing Objectives – Research process - Formulating Research problem – Technical terms and extended definition - Breaking up long sentences--structuring paragraphs and sentences - being concise and removing redundancy avoiding ambiguity and vagueness.

IDENTIFICATION & COLLECTION OF SOURCES **5**

Preparing manuscript – Skimming and Scanning – Review of literature- Identifying the problem - writing problem statements – writing hypothesis- Formulating Rationale – Research Design - linking phrases – Observation and Interview method – Framing Questionnaire – Case study

WRITING AND DRAFTING ABSTRACT **5**

Processing and data analysis – Identifying threats and challenges to Good Research - key skills needed to write a title - writing abstracts writing key words and introduction- Introductory phrases - Clarity in imperative sentences instruction writing – useful phrases to draft a perfect paper

CHAPTERISATION **5**

Main divisions and Subdivisions – Paragraph writing - coherence - Highlighting the findings - Analyzing Data collection - hedging and criticizing sections - Topic sentence --Paraphrasing and framing key points – Suitable section wise headings

INTERPRETATION OF DATA **5**

Non-verbal interpretation – Interpretation of Data - Abbreviations – Symbols Tables – graphs – charts - deriving result – Phrases used to Compare and Contrast -result and discussion-- skills needed to write the conclusions – avoiding common mistakes.

BIBLIOGRAPHY **5**

Citation methods – Writing Foot note – End note - bibliography – citation rules Basic reference format - plagiarism – acknowledgement – IEEE Research format – Research review Research paper Publication

L: 30; TOTAL: 30 PERIODS

REFERENCES

1. Brent, Doug. Reading as Rhetorical Invention: Knowledge, Persuasion, and the Teaching of Research-based Writing. Urbana, National Council of Teachers of English, 1992.
2. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht, 2016
3. Robert A. Day and Barbara Gastel, How to Write and Publish a Scientific Paper‖, Cambridge University Press, 7th Edition, 2012
4. Thiel, David V. Research Methods for Engineers. United Kingdom, Cambridge University Press, 2014.

23AC02E **DISASTER MANAGEMENT**

L	T	P	C
2	0	0	0

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.

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

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

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.

INTRODUCTION **4**

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

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.

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.

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 Agencies'-Media Reports Governmental and Community Preparedness.

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 Managementǁ, Laxmi Publications, ISBN-10: 9380386427 ISBN-13: 978-9380386423, 2010
2. Tushar Bhattacharya, —Disaster Science and Managementǁ, 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

23AC03E SANSKRIT FOR TECHNICAL KNOWLEDGE L T P C
2 0 0 0

COURSE OUTCOMES

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

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

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.

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

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.

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

23AC04E VALUE EDUCATION L T P C
2 0 0 0

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
CO2: Become aware of role of education in building value as dynamic social reality.

CO3: Know the importance of value education towards personal, national and global development.

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.

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.

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

23AC05E CONSTITUTION OF INDIA L T P C
2 0 0 0

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: 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: 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.

HISTORY AND PHILOSOPHY OF INDIAN CONSTITUTION 6

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

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.

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**.**

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.

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.

23AC06E **PEDAGOGY STUDIES** **L T P C**
2 0 0 0

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

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

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

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.

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.

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.

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.

23AC07E STRESS MANAGEMENT BY YOGA **L T P C**
2 0 0 0

COURSE OUTCOMES

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

CO1: achieve overall health of body and mind

CO2: overcome stress

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.

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.

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

23AC08E	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	L T P C 2 0 0 0

COURSE OUTCOMES

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

CO1: learn to achieve the highest goal happily

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

CO3: awaken wisdom in students

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.

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.

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.