SEMESTER – III

21SE71 PROJECT WORK – I
vide Automotive Engineering 21AE71

SEMESTER – IV

21SE81 PROJECT WORK – II
Vide Automotive Engineering 21AE81

PROFESSIONAL ELECTIVE THEORY COURSES (Four to be opted)

COMMON FOR MECHANICAL AND ELECTRICAL ENGINEERING STREAMS

21SE21 ADVANCED POWER PLANT ENGINEERING

3 0 0 3

INTRODUCTION: Energy scenario: India Vs. World - Load curves and – Thermodynamic analysis of Conventional Power Plants (Coal, Gas Turbine and Diesel) - Advanced Power Cycles - Kalina Cycle, IGCC-Integrated gasification combined cycle (9)

COAL BASED THERMAL POWER PLANTS: Basics of typical power plant utilities – Boilers, Nozzles, Turbines, Condensers, Cooling Towers, Water Treatment and Piping system – steam rate and heat rate – mean temperature of heat addition - Rankine cycle improvements – Superheat, Reheat, Regeneration, Super critical, ultracritical AFBC/PFBC – computation of per unit cost of power generation from coal/biomass (9)

GAS TURBINE AND DIESEL POWER PLANTS: Brayton cycle – Open and Closed – Improvements - Intercooler, Reheating and Regeneration. Diesel power plant – Layout - Performance analysis and improvement – Techniques for starting, cooling and lubrication of diesel engines - computation of per unit cost of power generation (9)

CHP AND MHD POWER PLANTS: Cogeneration systems – types - heat to power ratio - Thermodynamic performance of steam turbine, gas turbine and IC engine-based cogeneration systems – Polygeneration - Binary Cycle - Combined cycle. MHD-magneto hydrodynamic power plants – Open cycle and closed cycle- Hybrid MHD& steam power plants (9)

HYDROELECTRIC & NUCLEAR POWER PLANTS: Hydroelectric Power plants – classifications - essential elements – pumped storage systems – micro and mini hydel power plants. General aspects of Nuclear Engineering – Components of nuclear power plants - Nuclear reactors & types – PWR, BWR, CANDU, Gas Cooled, Liquid Metal Cooled and Breeder reactor - nuclear safety – Environmental issues - Computation of per unit cost of power generation (9)

Total L: 45

REFERENCES:

1. Nag, P.K., Power Plant Engineering, Tata McGraw Hill Publishing Co Ltd, New Delhi, 2017.
2. Haywood, R.W., Analysis of Engineering Cycles, 4th Edition, Pergamon Press, Oxford, 1991.
3. Wood, A.J., Wollenberg, B.F., Power Generation, operation and control, John Wiley, New York, 2013.
4. Gill, A.B., Power Plant Performance, Butterworths, 2016.
5. Lamarsh, J.R., “Introduction to Nuclear Engineering”, Pearson, 2001

21SE22 GREEN BUILDINGS

3 0 0 3

GREEN BUILDING CONCEPTS: High-performance green buildings - Impacts of building construction, operation, and disposal - Methods and tools for building assessment, LEED, Green Globes, Living Building Challenge, Green Building Coalition. (10)

BUILDING ASSESSMENT AND THE GREEN BUILDING PROCESS: Design and construction relationships -project management- BREEAM, CASBEE, green star, DGNB - site and landscape strategies, building energy system strategies, low energy buildings, renewable energy systems, building hydrologic cycle strategies, case studies on energy assessment. (11)

GREEN MATERIALS AND STRATEGIES: Materials selection strategies - multi-attribute standards (MAS) - life cycle assessment - indoor environmental quality (IEQ) analysis and strategies - construction team responsibilities and controls - building commissioning strategies - site operations. (12)

COST ANALYSIS AND STANDARDS: Carbon Accounting - economic issues and analysis - life cycle costing - business case for green buildings - green building codes and standards - International Green Construction Code ASHRAE 189P, ANSI/GG 01 - green building specifications - future directions in green high performance building technologies. (12)

Total L: 45

REFERENCES:

1. Abe Kruger, Carl Seville, “Green Building: Principles and Practices in Residential Construction”, Wiley, 2012.
2. Francis D. K. Ching, Ian M. Shapiro, “Green Building Illustrated” Wiley-2014.
3. Charles J. Kibert,” Sustainable Construction: Green Building Design and Delivery” John Wiley and Sons 2016.
4. The World Business Council on Sustainable Development (WBCSD) website: http://www.wbcsd.org.

21SE23 DESIGN OF SOLAR SYSTEMS

3 0 0 3

DESIGN OF SOLAR COLLECTORS: Solar constant, penetration depth, characteristics of radiation, classification - air, liquid heating collectors, testing of flat plate collectors, analysis of concentric tube collector, concentrator collectors – classification, concentrator mounting, focusing solar concentrators, heliostats, parabolic and dish. (12)

SELECTION OF PHOTO-VOLTAIC SYSTEMS: Physics, material, characteristics, cell arrays, power electric circuits for output of solar panels, choppers, inverters, batteries, charge regulators, thermoelectric, stand alone, off/on grid, hybrid systems and construction concepts, performance analyzer and applications. (11)

ANALYSIS OF SOLAR THERMAL SYSTEMS: Steady state and dynamic analysis, solar pond, modeling of solar thermal systems and simulations in process design of active systems by f-chart and utilization methods. Water heating systems: active and passive, passive heating and cooling of buildings, solar distillation, solar drying. (10)

SOLAR ENERGY UTILIZATION: Solar powered vapor absorption air condition system, solar cooler, solar power station, water pump, chimney, dryer, dehumidifier, still, desalination, furnaces, cooker, swimming pool, and solar energy economic analysis, performance analysis and system design. (12)

Total L: 45

REFERENCES:

1. Sukhatme S. P., “Solar Energy - Principles of thermal collection and storage” Tata McGraw-Hil, 2017.
2. Duffie J. A. and Beckman W. A., “Solar Engineering of Thermal Processes”, John Wiley, 2013.
3. Goswami D. Y., Kreith F. and Kreider J. F., “Principles of Solar Engineering”, Taylor and Francis, 2000.
4. Sodha M. S., Bansal N. K., Bansal P. K., and Malik M. A. S., “Solar Passive Building: science and design”, Pergamon Press, 2012.
5. Malik M. A. S., Tiwari G. N., Kumar A. and Sodha M.S., “Solar Distillation”, Pergamon Press, 1982.

21SE24 DESIGN AND ANALYSIS OF TURBO MACHINES

3 0 0 3

TURBO MACHINERY FUNDAMENTALS: Recap of basic terminologies and fluid theory, Fundamental governing principles, Performance calculations. (12)

DESIGN PROCESS: An overview of different conventional design methodologies, Modules of design guidelines for each process, Discussion on the empirical relations and the new methodologies to overcome the assumptions. (11)

ENERGY CONSERVATIONS METHODS: Detailed theoretical performance study, Analyze the energy recovery methods by design principles, Introduction to optimization techniques (10)

SIMULATION TECHNIQUES AND EXPERIMENTAL METHODS: Basics of blade modeling and meshing using CAD tools, Geometry Similarity, Simulation Techniques Moving Mesh, Dynamic meshes, Multiple frame of references, Introduction to measurement instruments related to fluid machinery, Experimental methods and uncertainty analysis. (12)

Total L: 45

REFERENCES:

1. H. I.H. Saravanamuttoo, G. F. C. Rogers and H. Cohen, “Gas Turbine Theory”, Prentice Hall,7th Edition, 2017
2. S. L. Dixon, “Fluid Mechanics and Thermodynamics of Turbomachinery”, Pergamon Press, 6th Edition, 2010
3. R. I. Lewis and Arnold, “Turbomachinery Performance Analysis”, 1996
4. R. K. Turton, “Principles of Turbomachinery” , Chapman and Hall, 1995
5. Murty V D, “Turbomachinery”, Concepts Applications And Design, Taylor and Francis Ltd, 2018

21SE25 HYDROGEN ENERGY AND FUEL CELLS

3 0 0 3

SUSTAINABLE DEVELOPMENT: Definition of sustainable development, factors affecting sustainable development like air pollution, water source degradation, population explosion, agriculture and land degradation, global warming and climate change, strategies for sustainability, energy and climate change. (11)

HYDROGEN ENERGY: Introduction to hydrogen economy, production, storage and transportation systems, hydrogen from fossil fuels, electrolysis of water, thermo chemical cycles, transmission and infrastructure requirements, safety and environmental impacts, economics of transition to hydrogen systems. (11)

FUEL CELLS: Concept, key components, physical and chemical phenomena in fuel cells, advantages and disadvantages, different types of fuel cells and applications, characteristics, Nernst equation, relation of the fuel consumption versus current output. (11)

FUEL CELL DESIGN AND PERFORMANCE: Stoichiometric coefficients and utilization percentages of fuels and oxygen, mass flow rate calculation for fuel and oxygen in single cell and fuel cell stack, total voltage and current for fuel cells in parallel and serial connection, over-potential and polarizations, DMFC operation scheme, general issues-water flooding and water management, polarization in PEMFC. (12)

Total L: 45

REFERENCES:

1. John Wiley and sons., “Fuel cell fundamentals”, Willey 2016.
2. Viswanathan B and Aulice Scibioh, “Fuel cells: Principles and Applications”, University Press, 2008.
3. Peter Hoffman, “Tomorrow’s Energy – Hydrogen Fuel Cells and the Prospects for Cleaner Planet”, MIT, 2012.
4. Prashukumar G P, “Hydrogen – A fuel for Automatic Engines”, ISTE, 2013.
5. Hart A B and Womack G J, “Fuel Cells: Theory and Applications”, Chapman and Hall, 1967.

21SE26 BIO-ENERGY CONVERSION TECHNOLOGIES

3 0 0 3

ANALYSIS OF BIOMASS: Biomass resources and biomass properties, biomass classification, availability, estimation of availability, consumption and surplus biomass; energy plantations, proximate analysis, ultimate analysis, thermo gravimetric analysis and summative analysis of biomass and briquetting. (12)

PYROLYSIS: A pyrolysis plant, pyrolysis products, pyrolyser types, pyrolysis product yields and its influencing factors, pyrolysis kinetics, kinetic models. (10)

GASIFICATION: Biomass gasification plant, gasifiers, fixed bed system, downdraft and updraft gasifiers, fluidized bed gasifiers design, construction and operation, gasifier burner arrangement for thermal heating, gasifier engine arrangement and electrical power, equilibrium and kinetic consideration in gasifier operation, gasifier product yields and its influencing factors. (12)

COMBUSTION: Biomass combustion, fixed bed combustors, inclined grate combustors fluidized bed combustors, design, construction and operation and operation of all the above biomass combustors, biomass stoves, improved challahs, types. (11)

Total L: 45

REFERENCES:

1. Prabir Basu, “Biomass Gasification and pyrolysis, a practical guide”, Academic press, 2018.
2. Desai and Ashok V, “Non Conventional Energy”, Wiley Eastern Ltd., 2008.
3. Khandelwal K C and Mahdi S S, “Biogas Technology - A Practical Hand Book - Vol. I and II”, Tata McGraw Hill Publishing Co. Ltd., 2002.
4. Challal D S, “Food, Feed and Fuel from Biomass”, IBH Publishing Co. Pvt. Ltd., 2010.
5. WereKo-Brobby C Y and Hagan E B, “Biomass Conversion and Technology”, John Wiley and Sons, 1996.

21SE27 INSTRUMENTATION FOR ENERGY SYSTEMS

3 0 0 3

INSTRUMENTATION SYSTEM AND ELECTRICAL ENERGY MEASUREMENT: Measurement terminologies, precision, range, accuracy, span, linearity, sensitivity, resolution, random errors, systematic errors, relative and absolute errors, uncertainty analysis of single and multiple measurements – calibration of instruments – range –resolution – span – linearity, sensitivity- signal conditioning system; Electrical Energy Measurement: Power factor, load factor, harmonic analyzer, lighting and lamination measurement, digital data processing and data acquisition system. (12)

TEMPERATURE AND PRESSURE MEASUREMENT: Working principle of various temperature devices, thermocouples, thermistor, RTD, measurement analysis, infrared camera; Working principle of pressure transducers and laser induced

fluorescence (LIF), quantification, basics of algorithm used for quantification- calibration of Pressure measuring equipment, principles and operation of various vacuum pumps and gauges. (12)

FLOW MEASUREMENT: Variable head flow meters- rota meters-working principle of hot wire/film anemometry and particle image velocimetry, quantification, electromagnetic flow meters, ultrasonic flow meters. (11)

AIR QUALITY MEASUREMENT: Particulate sampling techniques, SO_2, Combustion Products, opacity, odour measurements - Measurement of liquid level, Humidity, O_2, CO_2 in flue gases- pH measurement, moisture analyzer. (10)

Total L: 45

REFERENCES:

1. Sawhney A K and Puneet Sawhney, "A Course in Mechanical Measurements and Instrumentation"Dhanpat Raiand Co 2017.
2. Doebelin EO, "Measurement Systems - Application and Design", McGraw-Hill, 2017.
3. Rangan C S, Sharma G R and Mani V S V, "Instrumentation Devices and Systems", Tata McGraw-Hill, 2016.
4. Holman JP, "Experimental methods for engineers", McGraw-Hill, 2011.
5. Bechwith, Marangoni and Lienhard, "Mechanical Measurements" Addison-Wesley, 2009.

21SE28 ENERGY STORAGE DEVICES AND SYSTEMS

3 0 0 3

BATTERY PRINCIPLES: Introduction, battery types, Electrochemical reaction thermodynamics, Battery reaction kinetics, Charge transfer, Mass transport, Battery modeling, Battery characterization. (8)

FUEL CELL PRINCIPLES: Introduction, fuel cell types, Fuel cell thermodynamics, Fuel cell reaction kinetics, Charge transfer in fuel cells, Mass transport in fuel cells, Fuel cell modeling, Fuel cell characterization. (7)

BATTERY ENGINEERING: Overview of battery types, Lead acid battery systems, Nickel-Cadmium battery systems, Zinc battery systems, Ni-MH battery systems, Li-metal battery systems, Li-Ion battery systems, Li-polymer battery systems, Battery safety. (10)

FUEL CELL ENGINEERING: Overview of fuel cell types, Proton exchange membrane and solid oxide fuel cell materials, Overview of fuel cell systems, Fuel processing subsystem design, Thermal management, Fuel cell system design, Environmental impact of fuel cells (10)

APPLICATIONS AND CHALLENGES: Capacitor and super capacitor, Fuel cells and fuel cell application for electric vehicles, Energy storage systems for electric vehicles (design criteria, retention, cooling and management, battery management system), challenges infuel cell engineering (performance, durability and cost), Application of nanostructured materials in fuel cells, Micro-fuel cells, Modeling of catalyst design, Anion exchange membrane fuel cells. (10)

Total L: 45

REFERENCES:

1. Thomas Reddy, "Linden's Handbook of Batteries", 4th Edition, 2015
2. Ryan O'Hayre, Suk-Won-Cha, Whitney Colella and Fritz B. Prinz, "Fuel Cell Fundamentals", John Wiley, 2006.
3. Christopher D. Rahn and Chao-Yang Wang, "Battery System Engineering", Wiley, 2013
4. Robert A. Huggins, "Energy Storage", 1st Edition, 2012
5. D.A.J. Rand, "Batteries for Electric Vehicles", 1st Edition, 2014
6. Karl Kordesch and Gunter Simander, "Fuel Cells and Their Applications", VCH Publishers Inc, 2001.

MECHANICAL ENGINEERING STREAM

21SE29 FUNDAMENTALS OF TURBULENCE AND BOUNDARY LAYER THEORY

3 0 0 3

BOUNDARY LAYER THEORY: Boundary layer concept, displacement thickness, momentum thickness, laminar boundary layer on a flat plate, turbulent boundary layer on a flat plate, boundary layer thickness using Blasius solution and Von Karman approach, effect of pressure gradient and separation, Flow past bluff bodies and airfoil, concept of lift and drag. (11)

TURBULENT BOUNDARY LAYERS: Fully developed turbulent flow in a pipe, turbulent shear stress, turbulent velocity profile, internal flows – couette flow – two-layer structure of the velocity field – universal laws of the wall– friction law – channel flow, couette – poiseuille flows. (11)

TURBULENCE AND TURBULENCE MODELS: Nature of turbulence – averaging procedures – characteristics of turbulent flows – scales of turbulence, integral length scale, energy spectra, Kolmogorov's theory, Kolmogorov's scales, eddy viscosity and Prandtl's mixing length, Reynolds Average Navier Stokes equation (RANS), Two-equation models, low – reynolds number models, large eddy simulation. (11)

STATISTICAL THEORY OF TURBULENCE AND TURBULENT FLOWS: Ensemble average – isotropic turbulence and homogeneous turbulence – kinematics of isotropic turbulence – Taylor's hypothesis – dynamics of isotropic turbulence –grid turbulence and decay – turbulence in stirred tanks.

Turbulent flows: Wall Turbulent shear flows – structure of wall flow – turbulence characteristics of boundary layer – free turbulence shear flows – jets and wakes – plane and axi-symmetric flows. kinetic energy budget in a turbulent flow, turbulence production and cascade. (12)

Total L: 45

REFERENCES:

1. Biswas G. and Eswaran E., "Turbulent Flows, Fundamentals, Experiments and Modelling", Narosa Publishing House, 2002.
2. Schlichting H and Klaus Gersten, "Boundary Layer Theory", Springer 2017.
3. Garde R.J. "Turbulent Flow", New Age International (p) Limited, Publishers, 2013.
4. Rajaratnam N. "Turbulent Jets", Elsevier Scientific Publishing Company, 1976.
5. Hinze J.O., "Turbulence", McGraw-Hill Book Company, 1975.
6. Launder B. E. and Spalding D. B., "Mathematical Models of Turbulence", Academic Press, 1972.

21SE30 ENERGY CONSERVATION IN HVACR SYSTEMS

3 0 0 3

REFRIGERATION EQUIPMENT: Refrigerants-refrigeration cycles-refrigeration equipments-reciprocating, rotary, scroll, screw, centrifugal systems –refrigeration system components expansion coils and valves, evaporators, condensers and other auxiliary elements- sizing and selection of components. (12)

AIR CONDITIONING AND AIR SYSTEMS: Psychrometrics -thermal comfort-air conditioning process, classification, systems and sub systems, components selection- air systems, fans, coils, filters and humidifiers, air handling units(AHU),air ducts and space diffusion systems. (13)

HEATING AND VENTILATING SYSTEMS: Heat pumps and heat recovery systems, air-source heat pump, ground water heat pump systems, ground water coupled surface water heat pump, gas cooling and cogeneration, basics and constant-volume systems- variable-air-volume systems, VAV systems- fan combination, system pressure and smoke control- minimum ventilation and VAV systems controls- indoor air quality. (10)

I S STANDARDS, ENERGY MANAGEMENT AND CONTROL: IS code and standards: Air-condition equipments, pipes and fittings, pumps and valves, refrigeration and lubricants, insulation, ventilation, International codes and practices, automatic control systems- control loop and control methods-control modes-sensors and transducers- controllers and actuators-system architecture-interoperability-artificial network-functional controls and fault detection and diagnostics, BMS. (10)

Total L: 45

REFERENCES:

1. Shan.K.Wang, "Handbook of air conditioning and refrigeration" McGraw-Hill,2000.
2. ISHRAE "HVAC Data book" ISHRAE 2017.
3. Arora C.P., "Refrigeration and Air Conditioning", Tata McGraw Hill Pub. Company, 2010.
4. Plant Engineers and Manager's Guide to Energy Conservation, Fair Mount Press, 2011.
5. Edward Hartmann, "Maintenance Management, Productivity and Quality Publishing Pvt. Ltd", 1995.
6. Carrier Air conditioning Co., "Hand Book of Air conditioning System Design", McGraw-Hill, 2001.

21SE31 AERODYNAMICS OF STREAMLINED AND BLUFF BODIES

3 0 0 3

INVISCID AND INCOMPRESSIBLE FLOW: Lift, Drag, Moment and related coefficients conservation equations, flow lines, velocity functions, boundary layer, Bernoulli's equation, low-speed wind tunnel flows; Governing equations and boundary conditions; Elementary flows (uniform, sources, sinks and vortex); Ideal flow past a cylinder, conformal mapping, Kutta-Joukowski theorem and lift generation; Source panel method for non-lifting flows; D'Alembert's paradox. (13)

INCOMPRESSIBLE FLOW OVER AIRFOILS: Kutta condition; Thin airfoil theory (symmetric, cambered); Aerodynamic centre; Vortex panel method for lifting flows; Effect of viscosity and Stokes' second problem. (10)

FINITE WING THEORY: Downwash and induced drag; Biot-Savart Law and Helmholtz's theorems; Prandtl's lifting line theory; Numerical lifting-line method. (10)

AERODYNAMICS AND WIND TUNNEL EXPERIMENTATION: Aerodynamics of horizontal-axis wind turbines, aerodynamics of bluff bodies, building aerodynamics, wind tunnel experiments, case studies. (12)

Total L: 45

REFERENCES:

1. Houghton E. L., Carpenter P. W. and Daniel T. Valentine, "Aerodynamics for Engineering students", Elsevier Ltd., 2013.

2. Lawson T, “Builing Aerodynamics”, Imperial College Press, 2010.
3. John D Anderson., "Fundamentals of Aerodynamics", McGraw Hill Book Co., 2011.
4. Hucho W H, “Aerodynamic of Road vehicles ", Butterworth Co. Ltd., 1998.
5. Pope A, “Wind Tunnel Testing ", John Wiley and Sons, 1974.
6. Tom L. Building Aerodynamics, World Scientific; 2010.

21SE32 STEAM GENERATION TECHNOLOGY

3 0 0 3

COMBUSTION MECHANISM, EQUIPMENT AND FIRING METHODS: Kinetics of combustion reactions, solid fuel combustion, mechanical stokers, coal firing mechanism, effectiveness of combustion reaction,goal gasification , chimney draught systems, effect of coal quality, pollution formation,Boiler Slagging and Fouling, pulversing mills. (12)

STEAM GENERATORS: Types of steam generators, fire and water tube boilers, energy efficient boilers, boiler optimization,Economisers,superheaters,reheaters, steam generation control,air preheaters, Fluidized bed boilers, thermodynamic design of fire tube boilers, ash handling system, feedwater treatment ,deaeration, evaporation, internal treatment, boiler blowdown and steam purity. (11)

STEAM CYCLES: Properties of steam, Rankine cycle, reheating and regeneration, , feed water heating, optimum degree of regeneration, supercritical pressure boilers, plant appraisal, cogeneration of power and heat. (10)

BOILERS PERFORMANCES: Design of boiler joints,Evaporation capacity, equivalence evaporation, factors of evaporation, heat loss calculations, boiler efficiency, feed water treatment. (12)

Total L: 45

REFERENCES:

1. Amiya Ranjan Mallick, “Practical Boiler Operation Engineering and Power Plant” , PHI Learning, 2015
2. Rayaprolu Kumar,” Boilers for Power and Process” , CRC Press Inc, 2009
3. Ganapathy V,“Steam Generators And Waste Heat Boilers: For Process and Plant Engineers”, Apple Academic Press, 2014
4. Esa Kari Vakkilainen, “Steam Generation From Biomass: Construction and Design of Large Boilers” , Butterworth-Heinemann, 2016
5. Paul Breeze, “Power Generation Technologies”, Newnes (Elsevier), 2019

21SE33 DESIGN OF WIND ENERGY SYSTEMS

3 0 0 3

DESIGN OF WIND TURBINE ROTOR: Basic aerodynamics-wind turbine model-blade element method-airfoil aerodynamics-boundary conditions-aerodynamic design of rotor-numerical simulation of wind turbine flow, rotor blades- polymer materials-processing technology-sandwich materials-material characterization**.** (11)

DESIGN OF MECHANICAL SYSTEMS: Rotor hub, blade pitch mechanism, rotor bearing concepts, rotor brake, gear box, nacelle, yaw system, assembly and performance testing, tower design. (11)

SELECTION OF ELECTRICAL AND CONTROL SYSTEMS: Synchronous and asynchronous generator, assessment criteria for electrical generators, fixed speed generators, variable speed generator systems, directly rotor-driven systems, total electrical system of wind turbine, control systems and operation sequence control, wind measurement system, yaw control, power and speed control by blade pitching, power limiting by aerodynamic stall, supervisory control and operational states, simulation and hardware of control systems. (11)

WIND TURBINE OPERATION, MAINTENANCE AND ECONOMICS: Wind farms, project development, planning, transportations, erection, grid connection, commissioning, operation and monitoring, safety aspects, maintenance and repair offshore wind energy, power optimization, power curve, annual energy yield, environmental impact, economics: factors influencing the wind energy, the present worth approach, cost of wind energy, benefits of wind energy, Case studies; yard sticks and tax advantages, carbon credit. (12)

Total L: 45

REFERENCES:

1. Hau E, von Renouard H, “Wind turbines: fundamentals, technologies, application, economics”. Springer,2003.
2. Burton T, Jenkins N, Sharpe D, Bossanyi E. “Wind energy handbook” John Wiley and Sons,2011 .
3. Mathew S, Philip GS, “Advances in wind energy and conversion technology” Berlin, Springer, 2013.
4. Johnson GL. Wind energy systems, Englewood Cliffs (NJ): Prentice-Hall,1985
5. Hansen MO,”Aerodynamics of wind turbines”, Routledge, 2015.

ELECTRICAL ENGINEERING STREAM

21SE34 // Vide 21ED28 SOFT COMPUTING TECHNIQUES FOR RENEWABLE ENERGY SYSTEMS

21SE35 // Vide 21ED34 OPTIMIZATION TECHNIQUES

21SE36 // Vide 21ED38 HYBRID ELECTRIC VEHICLES

21SE37 // Vide 21ED37 DISTRIBUTED GENERATION AND MICRO GRIDS

21SE38 // Vide 21ED36 SMART GRID TECHNOLOGIES

21SE39 // Vide 21ED29 FLEXIBLE AC TRANSMISSION SYSTEM

OPEN ELECTIVE THEORY COURSES (One to be opted)

21SE91 // Vide 21MC91 BUSINESS ANALYTICS IN PRACTICE

21SE92 // Vide 21MC92 LIFE CYCLE ASSESSMENT AND ECO - DESIGN

21SE93 // Vide 21MC93 SYSTEMS ENGINEERING AND MANAGEMENT