OFFICE OF THE REGISTRAR :: DIBRUGARH UNIVERSITY :: DIBRUGARH

Ref. No. DU/DR-A/Syllabus-M.Tech (DUIET)/23/**583**   Date: .**05**..07.2023

NOTIFICATION

The 128th Meeting of the Academic Council, Dibrugarh University held on 30.06.2023 vide Resolution No. 18 has approved the syllabus of M. Tech. Programme in Mechanical Engineering (Specialization in : Fluids and Thermal Engineering) with effect from the academic session 2023-2024.

A copy of the Syllabus is attached herewith.

Issued with due approval.

Deputy Registrar (Academic)
Dibrugarh University.

Copy to:
1. The Hon'ble Vice-Chancellor, Dibrugarh University for favour of information.
2. The Deans, Dibrugarh University, for favour of information.
3. The Registrar i/c, Dibrugarh University for favour of information.
4. The Director, Dibrugarh University Institute of Engineering and Technology (DUIET), Dibrugarh University, for kind information and necessary action.
5. The Chairperson, Board of Studies in Mechanical Engineering, Dibrugarh University Institute of Engineering and Technology (DUIET), Dibrugarh University, for kind information and necessary action.
6. The Controller of Examinations, Dibrugarh University for kind information and necessary action.
7. The Programmer, Dibrugarh University for information and with a request to upload the notification and syllabus in the Dibrugarh University Website.
8. File.

Deputy Registrar (Academic)
Dibrugarh University

Post Graduate Degree Courses in
Fluids and Thermal Engineering
[Proposed Syllabus – 2023 onwards]

Department of Mechanical Engineering,DibrugarhUniversity
InstituteofEngineeringandTechnology
Dibrugarh University
Dibrugarh,
Assam-786004
India

General course structure
&
Credit distribution

AllIndia Council for Technical Education

Model curriculum for Postgraduate Degree Courses in Engineering&Technology

MECHANICAL ENGINEERING

A. Definition of Credit:

1Hr.Lecture(L)per week	1credit
1Hr.Tutorial(T)per week	1credit
1 Hr. Practical (P)per week	0.5credit
2 Hours Practical (Lab)/week	1credit

B. Range of credits-A student will be awarded **M.Tech Degree in Thermal and Fluid Engineering,** if he/she completes 69 credits.

C. Structureof PGPrograminME: ThestructureofPGprograminMechanicalEngineering shall have essentially the following categories of courses with the breakupofcreditsasgiven:

Sl.No.	Category	Credit Breakup for ME students
1	Professional Core Courses	21
2	Professional Elective courses relevant to chosen specialization/branch	12
3	Laboratory courses	4
4	Project work	32
	Total	

Minor variation is allowed as per need of the respective disciplines

Course code and definition:

Coursecode	Definitions
L	Lecture
T	Tutorial
P	Practical
C	Credits
PG-MEC	Professional core courses
PG-MEE	Professional Elective courses
PG-MEL	Laboratory courses

Mechanical PG Course Curriculum

Semester-1	Credits	Semester-2	Credits
1. Advanced Engineering Mathematics (**PG-MEC-101**)	3:0:0=3	1. Convective Heat & Mass Transfer (**PG-MEC-201**)	3:0:0=3
2. Advanced Thermodynamics(**PG-MEC-102**)	3:0:0=3	2. Heat Exchanger Design(**PG-MEC-202**)	3:0:0=3
		3. Experimental Methods (**PG-MEC-203**)	3:0:0=3
3. Advanced Fluid Mechanics (**PG-MEC-103**)	3:0:0=3	4. Elective-III (Optimization Techniques in Engineering(**PG-MEE-201**) /Energy Conservation and Waste Heat Recovery) (**PG-MEE-202**)	3:0:0=3
4. Conduction and Radiation(**PG-MEC-104**)	3:0:0=3		
5. Elective-I (Refrigeration& Air conditioning(**PG-MEE-101**)/ Renewable Energy Engineering (**PG-MEE-102**))	3:0:0=3	5. Elective-IV (Gas Turbines(**PG-MEE-203**)/ Aerodynamics (**PG-MEE-204**))	3:0:0=3
6. Elective II (Computational Fluid Dynamics (**PG-MEE-103**)/ Wind Energy (**PG-MEE-104**)	2:1:0=3	6. Advanced Heat transfer Lab (**PG-MEL-201**)	0:0:4=2
7. Advanced Computational Fluid Dynamics Lab (**PG-MEL-101**)	0:1:2=2		
TotalCredits	**20**	**TotalCredits**	**17**
Semester-3	Credits	Semester-4	Credits
1. PG Project-1 (**PG-PROJ-301**)	0:0:30=14	1. PG Project-2 (**PG-PROJ-401**)	0:0:36=18
TotalCredits	**14**	**TotalCredits**	**18**

M. Tech 1st Semester

Course Code	Course Name		L-T-P-Credits
PG-MEC-101	**Advanced** **Engineering** **Mathematics**		3-0-0-3

Course contents:

Linear Algebra: Introduction to vector space, linear independence, solution of simultaneous linear systems, uniqueness and existence, Algebraic eigen-value problem, similarity transformation, Introduction of linear transformation, Gram-Schmidt orthonormalization

Multivariate Calculus: Differential geometry, parametric representation, Frenet-Serret frame, directional derivative, Grad, Div and Curl, introduction to tensor algebra, equation of line, plane, surface, Line integral, path independence, Divergence theorem, Stokes' theorem, Green's theorem in a plane

Ordinary Differential Equation: First order equations, integrating factor, orthogonal trajectories, Existence and uniqueness, Second order equations with constant coefficients, The Cauchy-Euler equation, Method of undetermined coefficients, variation of parameters,matrix method, Sturm-Liouville problems, trigonometric Fourier series.

Integral Transform: Fourier series, Fourier integral, Fourier and Laplace transform, standard rules, Dirac-delta and Heaviside function, convolution, solution of ODEs
Partial differential equation: Linear equations, superposition, separation of variable, Second order wave equation, Unsteady heat conduction equation, Laplace equation
Standard discrete and continuous distributions like Binomial, Poisson, Normal, Exponential etc. Central Limit Theorem and its significance. Some sampling distributions like c2, t, F.

ANOVA: One – way, Two – way with/without interactions, Latin
Squares ANOVA technique, Principles of Design Of Experiments, some standard designs such as CRD, RBD, LSD.

Texts/References:

1. Kreyszig, E. (2011). Advanced engineering mathematics (10th ed.). Wiley.
2. Jain, R. K., &Iyengar, S. R. K. (2016). Advanced engineering mathematics (5th ed.). Narosa Publishing House.
3. Strang, G. (2006). Linear algebra (4th ed.). Cengage Learning.
4. Ross, S. L. (1989). Differential equations (4th ed.). Wiley.
5. Poole, D. (2019). Linear algebra: A modern introduction (4th ed.). Thomson.
6. Thomas, G. B., & Finney, R. L. (2010). Calculus and analytic geometry. Narosa Publishing House.
7. Tolstov, G. P. (2012). Fourier series. Dover Publications, Inc.
8. Bracewell, R. N. (2004). The Fourier transform and its applications. McGrawHill.
9. Greenberg, M. (1998). Advanced engineering mathematics (2nd ed.). Pearson.

Course Code	Course Name	L-T-P-Credits
PG-MEC-102	AdvancedThermodynamics	3-0-0-3

Course contents:

First law and State postulates, Second law and Entropy, Availability and Irreversibility, Transient flow analysis

Nonreactive Ideal-Gas Mixture, PvT Behavior of Real gases and Real Gas mixture

Generalized Thermodynamic Relationship

Combustion and Thermo-chemistry, Second law analysis of reacting mixture, Availability analysis of reacting mixture,Chemical equilibrium

Statistical thermodynamics, statistical interpretations of first and second law and Entropy
Third law of thermodynamics, Nerst heat theorem.

Texts/References:

1. Cengel, Y. A. (1980). Thermodynamics. Tata McGraw Hill Co. (1st ed.).
2. Howell, J. R., &Dedcius, T. A. (1987). Fundamentals of engineering thermodynamics. McGraw Hill Inc. (1st ed.).
3. Van Wylen, G. J., & Sonntag, R. E. (1985). Thermodynamics. John Wiley and Sons Inc. (1st ed.).
4. Jones, J. B., & Hawkins, G. A. (2004). Engineering thermodynamics. John Wiley and Sons Inc. (1st ed.).
5. Holman, J. P. (2002). Thermodynamics. McGraw Hill Inc. (1st ed.).
6. Faires, V. M., &Simmang, T. J. (1984). Thermodynamics. Macmillan Publishing Co. Inc. (1st ed.).
7. Rao, Y. V. C. (1994). Postulational and statistical thermodynamics. Allied Publishers Inc. (1st ed.).

Course Code	Course Name	L-T-P-Credits
PG-MEC-103	Advanced Fluid Mechanics	3-0-0-3

Course contents:

Governing equations in Fluid Dynamics: Derivation of Continuity and Momentum equations using integral and differential approach, dimensionless form of governing equations, special forms of governing equations, integral quantities

Exact Solutions of Navier-Stokes Equations: Fully developed flows, parallel flow in straight channel, Couette flow, Creeping flows

Potential Flow: Kelvin's theorem, Irrotational flow, Stream function-vorticity approach,

Laminar Boundary layers: Boundary layer equations, flow over flat plate, Momentum integral equation for boundary layer, approximate solution methodology for boundary layer equations

Turbulent Flow: Characteristics of turbulent flow, laminar turbulent transition, time mean motion and fluctuations, derivation of governing equations for turbulent flow, shear stress models, and universal velocity distribution

Experimental Techniques: Role of experiments in fluid, layout of fluid flow experiments, sources of error in experiments, data analysis, design of experiments, review of probes and transducers, Introduction to Hot wire Anemometry, Laser Doppler Velocimetry and Particle Image Velocimetry.

Texts/References:

1. Muralidhar, K., & Biswas, G. (2005). Advanced engineering fluid mechanics (1st ed.). Alpha Science International.
2. Shames, I. H. (2003). Mechanics of fluids (4th ed.). McGraw Hill.
3. Fox, R. W., & McDonald, A. T. (1985). Introduction to fluid mechanics (3rd ed.). John Wiley and Sons Inc.
4. Kundu, P. K., Cohen, I. M., & Dowling, D. R. (2005). Fluid mechanics (5th ed.). Academic Press.

Course Code	Course Name	L-T-P-Credits
PG-MEC-104	**Conduction and Radiation**	**3-0-0-3**

Course contents:

Introduction:Basicmodesofheattransfer,heattransfermechanismsandthegoverninglaws.
Steady-stateConduction:**OneDimensionalProblems**
Fourier's law of heat conduction in Cartesian, cylindrical and spherical coordinates, heat conduction equations in isotropicand anisotropic materials: in Cartesian, cylindrical and spherical coordinate system, Initial and boundary conditions, 1-Dconductionproblemswithoutandwithheatgeneration:planewall,hollowcylinder,compositetube,hollowsphere,etc.
Steady-stateConduction:**TwoandThreeDimensionalProblems**
Steady 2-D problem in Cartesian, analytical methods, problems in cylindrical and spherical coordinate system, steady 3-DconductioninCartesiancoordinate,graphicalmethodsandconductionshapefactor.,Methodofsuperposition,Stationaryandmovingheatsources
andsinks,Movingboundaryproblems,Duhamel'stheorem.
Unsteady-StateConduction:
Onedimensionaltransientproblems,solutionmethods,Lumpedsystemanalysis,Semi-

infinitemedia,Laplacetransform, Duhamel'stheorem,exampleproblems.

Radiation:
Mechanism of energy transport in thermal radiation, laws of radiation: Planck's law, Wien's displacement law, Stefan-Boltzmann law, Intensity of radiation, Irradiation vs. radiosity, Diffuse vs. specular surfaces, absorptivity, reflectivity,transmissivity,blackbodyradiation,greybody,Kirchhoff'slaw,viewfactor,radiationi npresenceofparticipatingmedium,solid angle, radiation in infinite parallel planes with and without participating medium, Radiation exchange among graydiffuse surfaces, Two surface network, three surface network,Derivation of radiation transport equations (RTE), Radiativeequilibrium,Divergenceof radiativeheatflux.

Texts/References:
1. F.P.IncroperaandD.P.Dewitt,"FundamentalsofHeatandMassTransfer",JohnWileyandS ons.
2. M.N.Ozisik,"HeatTransfer-ABasicApproach",McGrawHill.
3. M.F.Modest,"RadiativeHeatTransfer",AcademicPress.

Course Code	Course Name	L-T-P-Credits
PG-MEE-101	Refrigeration & Air conditioning	3-0-0-3

Course contents:

Psychrometry; Heating- and cooling-load calculations;

Air-conditioning systems; Fan and duct systems; Pumps and pumping; Cooling and dehumidifying coils; Air-conditioning controls;

Vapour-compression cycles; Compressors; Condensers and evaporators; Expansion devices;

Vapour-compression-system analysis; Refrigerants

Multipressure systems; Absorption refrigeration; Heat pumps; Cooling towers and evaporative condensers.

Texts/References:
1. Stoecker, W. F., & Jones, J. W. (1982). Refrigeration and air conditioning (2nd ed.). McGraw- Hill International Editions.
2. Threkeld, J. L. (1970). Thermal environmental engineering (2nd ed.). Prentice Hall Inc.
3. Arora, C. P. (1996). Refrigeration and air conditioning (1st ed.). Tata McGraw-Hill.
4. Stoecker, W. F. (1992). Refrigeration & air conditioning (2nd ed.). McGraw Hill.

Course Code	Course Name	L-T-P-Credits
PG-MEE-102	Renewable Energy Engineering	3-0-0-3

Course contents:

Renewable Energy – Various renewable energy sources, overview of global and Indian energy scenario, classification and systems, environmental aspects,

Biomass Energy - Resources of biomass energy, learning the concepts of conversion of biomass energy to useful energy sources through, gasification, biogas, liquefaction & ethanol production and also developing skills to solve real life problems.

Solar Energy - Photovoltaics, application of solar thermal systems such as solar flat plate collectors and concentrators for heating needs, developing skills to determine the efficiency of the systems, harnessing solar energy from rooftop solar panel.

Hydro Energy - Micro and Small hydro plants, big dams and small hydro schemes, concept on water turbine, turbine classification, characteristics and selection of turbine and generators.

Geothermal Energy: Geothermal resources, advantages of geothermal energy, geothermal power generation, global status of electricity generation.

Ocean Energy: Ocean thermal power generation, global status of electricity generation, advantages of ocean thermal energy.

Wind Energy – Wind resource assessment, effect of terrain on wind characteristics; Classes of wind; Energy in the wind–Betz limit; Aerodynamic models, blade element theory; Evolution and progress of wind turbines; Lift and drag based wind turbines, horizontal-axis and vertical-axis wind turbines–Savonius and Darrieus turbines, Geometric and aerodynamic parameters.

Fuel Cells and Hydrogen Energy Systems - Methods of hydrogen production, Range of applications for renewable hydrogen consumption, Hydrogen storage and safety issues, Operation of fuel-cell, components and characterization.

Hybrid Energy systems - Need for hybrid systems, Types of hybrid systems, Electric and hybrid electric vehicle, Hydrogen power electric vehicle.

Text/Reference:

1. Khan, B. H. (2016). Non-Conventional Energy Resources (2nd ed.). Tata McGraw Hill.
2. Saeed, S. H., & Sharma, D. K. (2017). Non-Conventional Energy Resources (4th ed.). S.K. Kataria& Sons.
3. Singh, S. N. (2018). Non-Conventional Energy Resources (3rd ed.). Pearson.

4. Begamudre, R. D. (2000). Energy Conversion Systems. New Age International Publishers.
5. Smith, B. C. (1981). Energy Management Principles. Pergamon Press.

6. J F Walker J. F. and Jenkins, N., (1997). Wind Energy Technology, John Wiley and Sons.

Course Code	Course Name	L-T-P-Credits
PCC-MEE-103	Computational Fluid Dynamics	2-1-0-3

Course contents:

Introduction to CFD: Computational approach to Fluid Dynamics and its comparison with experimental and analytical methods, Basics of PDE: Elliptic, Parabolic and Hyperbolic Equations.

Governing Equations: Review of Navier-Stokes Equation and simplified forms, Solution Methodology: FDM and FVM with special emphasis on FVM, Stability, Convergence and Accuracy.

Finite Volume Method: Domain discretization, types of mesh and quality of mesh, SIMPLE, pressure velocity coupling, Checkerboard pressure field and staggered grid approach
Geometry Modeling and Grid Generation: Practical aspects of computational modeling of flow domains, Grid Generation, Types of mesh and selection criteria, Mesh quality, Key parameters and their importance

Methodology of CFDHT: Objectives and importance of CFDHT, CFDHT for Diffusion Equation, Convection Equation and Convection-Diffusion Equation

Solution of N-S Equations for Incompressible Flows: Semi-Explicit and Semi-Implicit

Algorithms for Staggered Grid System and Non Staggered Grid System of N-S Equations for Incompressible Flows.

Texts/References:
1. Anderson, J. D. (1995). Computational fluid dynamics: The basics with applications (1st ed.). McGraw Hill International editions, Mechanical Engineering series.
2. Patankar, S. V. (1980). Numerical methods in fluid flow & heat transfer. Hemisphere Publishing Corporation.
3. Versteeg, H. K., &Malalasekera, W. (1995). An introduction to computational fluid flow (finite volume method). Prentice Hall.
4. Ferziger, J. H., &Peric, M. (2002). Computational methods for fluid dynamics (3rd ed.). Springer.
5. Chow, C. Y. (2002). An introduction to computational fluid mechanics. Wiley.
6. Muralidhar, K., &Sundarrajan, T. (2010). Computational fluid flow & heat transfer. Narosa Publishing House.

Course Code	Course Name	L-T-P-Credits
PCC-MEE-104	Wind Energy	2-1-0-3

Content:

General Introduction to Wind Turbines, Evolution of wind turbines, classification & status, Basic anatomy of wind turbines. Thermo-aero dynamics analysis and Betz theory. Fluid dynamic analysis of wind source and classification of sources. 2-D aerodynamics of wind turbine & and blade, 3-D aerodynamics of blade.
Aerodynamics of rotor wakes and selection of number of blades & speed; Analysis of rotor design and selection of capacity; Design of horizontal axis wind turbines; Design of vertical axis wind turbines; Controls for wind turbines; Auxiliary systems; Special designs for micro wind turbines.

Texts/Refernces:
1. Martin O. L. Hansen, Aerodynamics of Wind TurbinesTurbine Aerodynamics: Second edition, Earthscan, UK, 2008.
2. Tony Burton, David Sharpe, Nick Jenkins, Ervin Bossanyi Wind Energy Handbook, John Wiley and Sons, 2010.
3. Abbot, H. and von Doenhoff, A. E., Theory of Wing Sections, Dover Publications, New York.
4. WIND TURBINE TECHNOLOGY : Fundamental ConCepts oF Wind turbine engineering, David A. Sper. ASME,2009.

Course Code	Course Name	L-T-P-Credits
PG-MEL-101	Advanced Computational Fluid Dynamics Lab	0-1-2-2

Content:

Introduction to CFD through Ansys / Open foam/ Matlab/ COMSOL, Governing equations for fluid flow, Numerical methods for solving fluid flow problems, Commercial CFD, software packages, Mesh generation techniques, Boundary conditions for fluid flow , problems, Post-processing of CFD results
Flow over a cylinder, Flow through a pipe, Flow over an airfoil, Flow over a wing

Texts/References:

1. Anderson, J. D. (1995). Computational fluid dynamics: The basics with applications (1st ed.). McGraw Hill International editions, Mechanical Engineering series.
2. Patankar, S. V. (1980). Numerical methods in fluid flow & heat transfer. Hemisphere Publishing Corporation.
3. Versteeg, H. K., & Malalasekera, W. (1995). An introduction to computational fluid

flow (finite volume method). Prentice Hall.
4. Ferziger, J. H., & Peric, M. (2002). Computational methods for fluid dynamics (3rd ed.). Springer.
5. Chow, C. Y. (2002). An introduction to computational fluid mechanics. Wiley.
6. Muralidhar, K., & Sundarrajan, T. (2010). Computational fluid flow & heat transfer.
Narosa Publishing House.

Texts/References:

1. E. Balagurusamy, "Programming in ANSI C", Tata McGraw-Hill Education
2. H.K. Versteeg and W. Malalasekera, "An Introduction to Computational Fluid Dynamics: The Finite Volume Method", Pearson.
3. R. Pratap, "Getting Started With MATLab: A Quick Introduction for Scientists and Engineers", Oxford University Press
4. Y.Kanetkar, "Let us C", Bpb Publications.
5. J. D. Anderson Jr., "Computational Fluid Dynamics", McGraw-Hill.
6. J. D. Anderson Jr., "Fundamentals of Aerodynamics", McGraw Hill.

M. Tech 2ndSemester

Course Code	Course Name	L-T-P-Credits
PG-MEC-201	Convective Heat & Mass Transfer	3-0-0-3

Course contents:

Convective Heat & Mass Transfer (PG-MEC-201)

Transport equations and boundary conditions; Order of magnitude analysis, Reynolds analogy.

Forced Convection: Convective heat transfer in external flows: Boundary layer Approximations to momentum and energy equations, Similarity solution techniques,

Momentum and energy integral methods and their applications in flow over flat plates with low and high Prandtl number approximations. Convective heat transfer in Laminar internal flow: (a) Exact solutions to N-S equations for flow through channels and circular pipe,

Fully developed forced convection in pipes with different wall boundary conditions, Forced convection in the thermal entrance region of ducts and channels (Graetz solution), heat transfer in the combined entrance region, (b) Integral method for internal flows with different wall boundary conditions. Elements of turbulent heat transfer.

Natural convection: Introduction to natural convection; Boussinesq approximation and scaling analysis; Similarity solution of natural convection equations for boundary layers; Laminar and turbulent free convection;

Fundamentals of boiling and condensation; Deviations from continuum: wall slip and thermal creep, an introduction to convective transport of heat in micro-scales; Conjugate heat transfer problems.

Text/Reference:

1. Kays, W. M., Crawford, E. M., &Weigand, B. (2012). Convective heat and mass transfer (4th ed.). Tata McGraw Hill.
2. Burmeister, L. C. (1993). Convective heat transfer (2nd ed.). John Wiley and Sons.
3. Bejan, A. (2013). Convective heat transfer (4th ed.). John Wiley and Sons.
4. Oostuizen, P. H., & Naylor, D. (1999). Introduction to convective heat transfer analysis. McGraw-Hill.
5. Incropera, F. P., DeWitt, D. P., Bergman, T. L., &Lavine, A. S. (2018). Incropera's principles of heat and mass transfer (8th ed.). Wiley.

Course Code	Course Name	L-T-P-Credits
PG-MEC-203	Heat Exchanger Design	3-0-0-3

Course contents:

Heat Exchangers – Classification according to transfer process, number of fluids, surface compactness, and construction features. Tubular heat exchanger, plate type heat exchangers, extended surface heat exchangers, heat pipe, Regenerators. Classification according to flow arrangement: counter flow, parallel flow, cross flow exchanger.
Heat exchanger design methodology, assumption for heat transfer analysis, problem formulation, e-NTU method, P-NTU method, Mean temperature difference method, fouling of heat exchanger, effects of fouling, categories of fouling, fundamental processes of fouling.

Double Pipe Heat Exchangers: Thermal and Hydraulic design of inner tube, Thermal and hydraulic analysis of Annulus, Total pressure drop

Compact Heat Exchangers: Thermal and Hydraulic design of compact heat exchanger
Shell and Tube heat exchangers – Tinker's, kern's, and Bell Delaware's methods, for thermal and hydraulic design of Shell and Tube heat exchangers

Mechanical Design of Heat Exchangers – design standards and codes, key terms in heat exchanger design, material selection, and thickness calculation for major components such as tube sheet, shell, tubes, flanges and nozzles. Introduction to simulation and optimization of heat exchangers, flow induced vibrations.

Text/Reference:

1. Shah, R. K., &Sekulic, D. P. (2003). Fundamentals of heat exchanger design (1st ed.). John Wiley & Sons Inc.
2. Kern, D. C. (1950). Process heat transfer (1st ed.). McGraw Hill.

3. Kakac, S., & Liu, H. (1998). Heat exchangers: Selection, rating and thermal design (2nd ed.). CRC Press.
4. Frass, A. P., &Ozisik, M. N. (1984). Heat exchanger design (1st ed.). McGraw Hill.
5. Afgan, N., &Schlinder, E. V. (1983). Heat exchanger design and theory source book (1st ed.). Hemisphere Publishing Corporation.
6. Kuppan, T. (2000). Handbook of heat exchanger design (1st ed.). Begell House.
7. Tubular Exchanger Manufacturers Association. (1999). T.E.M.A. standard (8th ed.). TEMA.
8. Walkers, G. (1982). Industrial heat exchangers: A basic guide (1st ed.). McGraw Hill.

Course Code	Course Name	L-T-P-Credits
PG-MEC-204	Experimental Methods	1-1-0-2

Course contents:

Theory and Experimentation in Engineering: Problem solving approaches, Types of engineering experiments, computer simulation and physical experimentation; Generalized measuring system, types of inputs, analog and digital signals, standards, calibration and uncertainty,

Measurement System: Performance characteristics, static performance characteristics-static calibration-linearity, static sensitivity, repeatability, hysteresis- threshold- resolution, readability and span;

Analysis of Experimental Data: Causes and types of experimental error, un-certainty analysis, statistical analysis of data, probability distributions and curve fitting; Dynamic performance characteristics; Input types; Instrument types- zero order instrument, first order instrument, second order instrument;

Experiment Plans: Model building; Measurement Methods and Applications : Measurement of force and torque; Measurement of strain and stress; Measurement of pressure; Flow measurement and flow visualization; measurement of temperature; optical methods of measurements;

Data Acquisition and Processing: Types and configurations of DAS, signal conditioning, A/D, D/A conversion; Design, Planning, Execution and Analysis of experimental projects.

Text/Reference:

1. Beckwith, T. G., Buck, N. A., &Marangoni, R. D. (1995). Mechanical measurements (1st ed.). Narosa Publishing House.
2. Doeblin, E. O. (1990). Measurement systems: Application and design (4th ed.). McGraw-Hill.
3. Holman, J. P. (1994). Experimental methods for engineers (6th ed.). McGraw-Hill.
4. Doeblin, E. O. (1995). Engineering experimentation (1st ed.). McGraw-Hill.

Course Code	Course Name	L-T-P-Credits
PG-MEE-201	Optimization Techniques in Engineering	3-0-0-3

Course contents:

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models

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

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

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models - Geometric Programming.
Competitive Models,Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation.

Text/Reference:

1. Taha, H. A. (2008). Operations research: An introduction (8th ed.). PHI.
2. Wagner, H. M. (1982). Principles of operations research (2nd ed.). PHI.
3. Pant, J. C. (2008). Introduction to optimisation: Operations research (1st ed.). Jain Brothers.
4. Lieberman, G. J., & Lieberman, H. (2009). Operations research (1st ed.). McGraw Hill.
5. Frass, A. P., &Ozisik, M. N. (1984). Heat exchanger design (1st ed.). McGraw Hill.
6. Afgan, N., &Schlinder, E. V. (1983). Heat exchanger design and theory source book (1st ed.). Hemisphere Publishing Corporation.
7. Kuppan, T. (2000). Handbook of heat exchanger design (1st ed.). Begell House.
8. Tubular Exchanger Manufacturers Association. (1999). T.E.M.A. standard (8th ed.). TEMA.

Course Code	Course Name	L-T-P-Credits
PG-MEE-202	Energy Conservation and Waste Heat Recovery	3-0-0-3

Course contents:

Energy resources and use. Potential for energy conservation. Optimal utilization of fossil fuels.
Total energy approach. Coupled cycles and combined plants. Cogeneration systems.

Exergy analysis. Utilization of industrial waste heat. Properties of exhaust gas. Gas-to-gas, gas-to-liquid heat recovery systems.

Recuperators and regenerators. Shell and tube heat exchangers. Spiral tube and plate heat exchangers. Waste heat boilers: various types and design aspects.

Heat pipes: theory and applications in waste heat recovery. Prime movers: sources and uses of waste heat.
bed heat recovery systems. Utilization of waste heat in refrigeration, heating, ventilation and air conditioning systems.

Thermoelectric system to recover waste heat. Heat pump for energy recovery. Heat recovery from incineration plants. Utilization of low-grade reject heat from power plants.

Need for energy storage: Thermal, electrical, magnetic and chemical storage systems. Thermo-economic optimization.

Text/Reference:

1. Harlock, J. H. (1987). Combined heat and power (1st ed.). Pergamon Press.
2. Kreith, F., & West, R. E. (1999). Energy efficiency (1st ed.). CRC Press.
3. Kays, W. M., & London, A. L. (1984). Compact heat exchangers (3rd ed.). McGraw-Hill.

Course Code	Course Name	L-T-P-Credits
PG-MEE-203	Gas Turbines	3-0-0-3

Course contents:

Introduction, Cycles, Performance characteristics and improvement,

Gas dynamics, Centrifugal, axial and mixed flow compressor, principles and characteristics,

Turbine construction, Blade materials, manufacturing techniques, blade fixing,

Problems of high temperature operation, blade cooling, practical air-cooled blades Combustion Systems, various fuels and fuel systems,

Jet propulsion cycles and their analysis, parameters affecting performance, thrust augmentation, environmental considerations and applications.

Text/Reference:

1. Cohen, H., Rogers, G. F. C., &Saravanamuttoo, H. I. H. (2000). Gas turbine theory (4th ed.). Pearson Education.
2. Ganesan, V. (2003). Gas turbines (2nd ed.). Tata McGraw Hill.
3. Yahya, S. M. (1992). Turbines, compressors and fans (1st ed.). Tata McGraw Hill.
4. Vincent, H. (1950). The theory and design of gas turbine and jet engines (1st ed.). McGraw Hill.

Course Code	Course Name	L-T-P-Credits
PG-MEE-204	Aerodynamics	3-0-0-3

Course contents:

Introduction to flights: Anatomy & Classification of aircraft and spacecraft; Atmosphere and flying weather.

Airfoil and wing aerodynamics; Aerodynamic forces, lift and drag, high lift devices, Aircraft performance–takeoff and landing, cruising, climbing, gliding and turning flights, range and endurance, ceiling, flight envelope

Concepts from thermodynamics; The basic equations of fluid motion; One-dimensional gas dynamics; Isentropic conditions, speed of sound, Mach number, area velocity relations, normal shock relations for a perfect gas, Fanno and Rayleigh flow, one-dimensional wave motion, the shock tube;

Waves in supersonic flow: oblique shock waves, supersonic flow over a wedge, Mach lines, piston analogy, supersonic compression by turning, supersonic expansion by turning, the Prandtl-Meyer function, reflection and intersection of oblique shocks, Mach reflection, shock expansion theory, thin aerofoil theory;

Flow in ducts and wind tunnels: area relation, nozzle flow, normal shock recovery, effects of second throat, wind tunnel pressure ratio, supersonic wind tunnels; Small perturbation theory; The method of characteristics; Methods of measurement; Elements of hypersonic flow.

Text/Reference:

1. Liepmann, H. W., &Roshko, A. (1960). Elements of gas dynamics (1st ed.). John Wiley.
2. Anderson, J. D. (1989). Modern compressible flow (2nd ed.). McGraw Hill.
3. Hodge, B. K., & Koenig, C. (1995). Compressible fluid dynamics (with P.C. applications) (1st ed.). Prentice Hall.
4. Shapiro, H. (1954). The dynamics and thermodynamics of compressible flow (1st ed.). Ronald Press.
5. Zucker, R. D., &Biblarz, O. (2002). Fundamentals of gas dynamics (2nd ed.). Wiley.
6. Anderson, J. D. (2000). Introduction to flight (4th ed.). McGraw Hill.
7. Shevell, R. A. (1989). Fundamentals of flight (2nd ed.). Pearson Education.
8. **Kermode, A. C. (1996). Mechanics of flight (10th ed.). Longman.**

Course Code	Course Name	L-T-P-Credits
PG-MEL-201	Advanced Heat transfer Lab	0-0-4-2

Course contents:
Experiment on Heat Transfer through Composite Walls, Experiment on Heat Transfer through Natural Convection, Experiment on Heat Transfer through Forced Convection, Experiment on Heat Transfer through Radiation, Experiment on Heat Exchangers, Experiment on Refrigeration and Air Conditioning Systems.

Text/Reference:

1. Kays, W. M., Crawford, E. M., & Weigand, B. (2012). Convective heat and mass transfer (4th ed.). Tata McGraw Hill.
2. Burmeister, L. C. (1993). Convective heat transfer (2nd ed.). John Wiley and Sons.
3. Bejan, A. (2013). Convective heat transfer (4th ed.). John Wiley and Sons.
4. Oostuizen, P. H., & Naylor, D. (1999). Introduction to convective heat transfer analysis. McGraw-Hill.
5. Incropera, F. P., DeWitt, D. P., Bergman, T. L., & Lavine, A. S. (2018). Incropera's principles of heat and mass transfer (8th ed.). Wiley.

3rdSemester

Course Code	Course Name	L-T-P-Credits
PG-PROJ-301	PG Project-1	0-0-30-14

Course contents:

Choose a relevant and interesting topic that aligns with the field of study or interest, conduct thorough research to understand the existing knowledge, trends, and methodologies related to your chosen topic, clearly define the objectives, create a detailed plan outlining the steps, Execute the plan systematically, Data Analysis and Interpretation and interpret the results to draw meaningful conclusions, Reporting and Presentation.

4thSemester

Course Code	Course Name	L-T-P-Credits
PG-PROJ-401	PG Project-2	0-0-36-18

Course contents:

Choose a relevant and interesting topic that aligns with the field of study or interest, conduct thorough research to understand the existing knowledge, trends, and methodologies related to your chosen topic, clearly define the objectives, create a detailed plan outlining the steps, Execute the plan systematically, Data Analysis and Interpretation and interpret the results to draw meaningful conclusions, Reporting and Presentation.