OFFICE OF THE REGISTRAR :: DIBRUGARH UNIVERSITY :: DIBRUGARH

Ref. No. DU/DR-A/Syllabus(Modified)M.Tech.-ME/2024/016 Date: 04.01.2024

NOTIFICATION

As recommended by the meeting of the Board of Studies (BoS) in Mechanical Engineering held on 26.07.2023, the 129th Meeting of the Academic Council, Dibrugarh University held on 08.12.2023 vide ***Resolution No. 05*** has approved the ***modified syllabus of M. Tech. Programme*** in Mechanical Engineering (***Specialization in: Fluids and Thermal Engineering***) w.e.f. 2024-2025 academic session.

A copy of the Syllabus is attached herewith.

Issued with due approval.

Sadiq Hussain

Deputy Registrar (Academic) *i/c*
Dibrugarh University

Copy for kind information and necessary action to:

1. The Hon'ble Vice-Chancellor i/c, Dibrugarh University.
2. The Deans, Dibrugarh University.
3. The Registrar, Dibrugarh University.
4. The Director, Dibrugarh University Institute of Engineering & Technology (DUIET), Dibrugarh University.
5. The Head i/c, Department of Mechanical Engineering, DUIET, Dibrugarh University.
6. The Controller of Examinations i/c, Dibrugarh University.
7. The Joint / Deputy Controller of Examinations – 'B', 'C' & 'A', Dibrugarh University.
8. The Programmer, Dibrugarh University with a request to upload the notification in the Dibrugarh University Website.
9. File.

Sadiq Hussain

Deputy Registrar (Academic) *i/c*
Dibrugarh University

Post Graduate Degree
Courses in
Fluids and Thermal Engineering
[Proposed Syllabus – 2024 onwards]

Department of Mechanical Engineering, Dibrugarh University
Institute of Engineering and Technology
Dibrugarh University, Dibrugarh,
Assam-786004
India

General course structure
&
Credit distribution

All India Council for Technical Education

Model curriculum for Postgraduate Degree Courses

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. **StructureofPGProgramin ME:**ThestructureofPGprograminMechanicalEngineering shall have essentially the following categories of courses with the breakup of credits as given:

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	**69**

**Minor variation is allowed as per need of the respective disciplines*

Course code and definition:

Course code	**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

Course Code	Course Name	Credits
PG-MEC-101	Advanced Mathematics	3:0:0=3
PG-MEC-102	Advanced Thermodynamics	3:0:0=3
PG-MEC-103	Advanced Fluid Mechanics	3:0:0=3
PG-MEL-101	Engineering Computing Lab	0:0:4=2
Elective I	Computational Fluid Dynamics (PG-MEE-101)/ Elements in Aerospace Engineering (PG-MEE-102)	3:0:0=3
Elective II	Experimental Methods (PG-MEE-103)/ Energy Conservation and Waste Heat Recovery (PG-MEE-104)	3:0:0=3
Elective III	Refrigeration and Air conditioning (PG-MEE-105)/ Introduction to Micro fluidics (PG-MEE-106)/ Renewable Energy Engineering (PG-MEE-107)	3:0:0=3

List of Electives for Semester – 1

Course Code	**Course Name**
PG-MEE-101	Computational Fluid Dynamics
PG-MEE-102	Elements in Aerospace Engineering
PG-MEE-103	Experimental Methods
PG-MEE-104	Energy Conservation and Waste Heat Recovery
PG-MEE-105	Refrigeration and Airconditioning
PG-MEE-106	Introduction to Micro fluidics
PG-MEE-107	Renewable Energy Engineering

Semester – 2

Course Code	Course Name	Credits
PG-MEC-201	Convective Heat Transfer	3:0:0=3
PG-MEL-201	Advanced Heat Transfer Lab	0:0:4=2
Electives -IV	Conduction and Radiation (PG-MEE-201)/ Automobile Engineering (PG-MEE-202)	3:0:0=3
Electives -V	Optimization Methods in Engineering (PG-MEE -203) / Nuclear Engineering(PG-MEE-204)	3:0:0=3
Electives -VI	Gas Dynamics (PG-MEE-205) / Foundations in Aerodynamics (PG-MEE-206)	3:0:0=3
Electives -VII	Gas Turbine Technology (PG-MEE -207) / Heat Exchanger Design (PG-MEE-208)	3:0:0=3

List of Electives for Semester – 2

Course Code	**Course Name**
PG-MEE-201	Conduction and Radiation
PG-MEE-202	Automobile Engineering
PG-MEE-203	Optimization Methods in Engineering
PG-MEE-204	Nuclear Engineering
PG-MEE-205	Gas Dynamics
PG-MEE-206	Foundations in Aerodynamics
PG-MEE-207	Gas Turbine Technology
PG-MEE-208	Heat Exchanger Design

Semester – 3

Course Code	Course Name	Credits
PG-PROJ-301	PG Project-1	0:0:30=14

Semester – 4

Course Code	Course Name	Credits
PG-PROJ-401	PG Project-2	0:0:36=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. McGraw Hill.
9. Greenberg, M. (1998). Advanced engineering mathematics (2nd ed.). Pearson.

Course Code	Course Name	L-T-P-Credits
PG-MEC-102	**Advanced Thermodynamics**	**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**
PCC-MEE-101	**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**
PG-MEE-102	**Elements in Aerospace Engineering**	**3-0-0-3**

Contents:

Introduction to aerospace vehicles: Brief history of aerospace engineering, Aerospace industry and its role in the economy.

Standard atmosphere: Definition of standard atmosphere, geometric, absolute, geo-potential altitudes, pressure, temperature and density altitudes.

Aerodynamics: Wind tunnels and their application, measurement of airspeed, airfoils and wings; airfoil nomenclature, lift, drag and moment coefficients, infinite and finite wings, critical Mach number, induced drag, swept wings, high-lift devices.

Aircraft performance: Drag polar, cruising, climbing, and gliding flight; range and endurance; takeoff and landing flights; turning performance and V-n diagram.

Propulsion: Aircraft propulsion – piston-prop, turbojet, turboprop, turbofan, turbo-shaft and ramjet engines; general thrust equation, propulsive efficiency; two and three spool configurations.

Aircraft Structures and Materials: Introduction to aircraft structures, Types of loads on aircraft structures, Stress and strain analysis, Failure criteria, Structural materials and their properties,

Space Flight and Rocket Propulsion: Basics of space flight, Chemical, electrical and nuclear rockets; Applications of rockets in launch vehicles, spacecraft, and missiles.

Text /Reference Books:

1. Anderson, J. D. (2017). Introduction to Flight (8th ed.). McGraw Hill Education.
2. Shevell, R. A. (1989). Fundamentals of Flight, Pearson Education.
3. Newman, D. (2002). Interactive Aerospace Engineering and Design, McGraw-Hill.
4. Roskam, J. (2018). Airplane Design, Part I-VIII. Darcorporation.
5. Sutton, G. P. and Biblarz, O. (2001). Rocket Propulsion Elements, Wiley.
6. Ward, T. A. (2010). Aerospace Propulsion Systems, Wiley.

Course Code	Course Name	L-T-P-Credits
PG-MEE-103	**Experimental Methods**	**3-0-0-3**

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-104	**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-105	**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-106	**Introduction to Microfluidics**	**3-0-0-3**

Course contents:

Fundamentals of kinetic theory-molecular models, Micro and macroscopic properties, Concept of miniaturization, scaling laws for micro-domains, Fundamentals of microscale flow physics, Deviations from the continuum hypothesis.

Basic concepts on gas flows: Transitional and free molecular regimes, Maxwell first order slip model and accommodation coefficients, Effects of compressibility, Analysis of thermo-fluidic transport in microscale gas flows and its applications.

Low Reynolds number hydrodynamics, different scales, Effect of apparent slip: Navier slip effects, Physics of near- wall microscale liquid flows, Unsteady microflows and different time scales, Oscillatory flow problem through microfluidic confinements, Effect of confinements, Implication of low Reynolds number hydrodynamics on energy equation and species conservation equation.

Surface tension driven flows and microcapillary transport, Young Laplace equation and concept of contact angle, Dynamics of Capillary rise, Capillary filling dynamics.

Electroosmotic flows-EDL phenomena, electrosmosis, electrophoresis, dielctrophoresis, analysis of hydro-dynamically and thermally fully developed electro-osmotic flows, ac electro-osmosis, electroosmotic flow of non-Newtonian fluids.

Basics of bio-microfluidics, modeling of electrically actuated microscale two phase flows.

Texts/References:

1. Tabelin, P., (2011). Introduction to Microfluidics, Oxford University Press.
2. Chakraborty, S., (2010). Microfluidics and Microfabrication, First Edition, Springer.
3. Bruus, H., (2007). Theoretical Microfluidics, Volume 18 of Oxford master series in condensed matter physics.
4. Leal, L. G., (2007). Advanced Transport Phenomena Fluid Mechanics and Convective Transport Processes, First Edition, Cambridge Series in Chemical Engineering.
5. Happel, J., and Brenner, H., (1983). Low Reynolds number hydrodynamics, Springer.

Course Code	Course Name	L-T-P-Credits
PG-MEE-107	**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
PG-MEL-101	**Engineering Computing 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 WithMATLab: 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:

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-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.

Course Code	Course Name	L-T-P-Credits
PG-MEE-201	**Conduction and Radiation**	**3-0-0-3**

Course contents:

Introduction: Basic modes of heat transfer ,heat transfermechanismsandthegoverninglaws.

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:Two- and Three-DimensionalProblems:Steady 2-D problem in Cartesian, analytical methods, problems in cylindrical and spherical coordinate system, steady 3-DconductioninCartesiancoordinate,graphicalmethodsandconductionshape factor, Method of superposition, Stationary and moving heat sources and sinks, Moving boundary problems, Duhamel’s theorem.

Unsteady-State Conduction: One dimensional transient problems, solution methods, Lumped system analysis, Semi-infinite media, Laplace transform, Duhamel’s theorem, example problems.
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), Radiative equilibrium, Divergence of radiative heat flux.

Texts/References:

1. F.P.IncroperaandD.P.Dewitt,“FundamentalsofHeatandMassTransfer”,JohnWileyandS ons.

2. M.N.Ozisik,“Heat Transfer-A Basic Approach”, McGrawHill.
3. M.F.Modest,“Radiative Heat Transfer”, Academic Press.

Course Code	Course Name	L-T-P-Credits
PG-MEE-202	**Automobile Engineering**	**3-0-0-3**

Contents:

History of automobiles; Classification of automobiles; Power plant classification; Engine terminology; Types of cycles; Working principle of an IC engine; Advanced classification of engines and multi cylinder engines; Engine balance and firing order.

Fuel System, Ignition System and Electrical system:*Spark Ignition engines* – fuel tank, fuel filter,fuel pump, air filter, carburetor, direct injection of petrol engines;MPFI, *Compression Ignition engines* –fuel injection (air and solid), pressure charging, super charging and turbo charging; *Ignition systems*– components, battery ignition, magneto ignition, electronic ignition and ignition timing; *Mainelectrical circuits* – generating & starting circuit, lighting, indicating devices, Catalytic convertor, pollution controls norms in BS-VI.

Lubricating System and Cooling System: Functions & properties of lubricants, methods of lubrication; Oil filters, oil pumps, oil coolers; Characteristics of an effective cooling system; types ofcooling systems; Radiator, thermostat, air cooling & water cooling.

Chassis & Transmission: Parts of automobile body; *Automobile frames* – functions, constructions, sub frames, materials and defects; *Transmission* – axles, clutches, propeller shafts, differential, gear boxes, automatic transmission, electronic transmission control, functions and types of front and rear axles, types and functions of clutches, Hotchkiss drive torque tube drive, traction control.

Steering mechanism, steering gear box types, wheel geometry; Brakes – principle, functions, types, construction, operation and parking brake; *Suspension* - types ofspring shock absorbers, objectives and types of suspension system, rear axle suspension, electroniccontrol and proactive suspension system.

Automotive Air Conditioning: Ventilation, heating, air condition, refrigerant, compressor and evaporator.

Wheels and Tyres: Wheel quality, assembly, types of wheels, wheel rims. Construction of tyresandtyre specifications.

Recent Trends: E-vehicles; Satellite-based navigation; Automated steering; Environment effect and mitigation.

Text /Reference Books:

1. Babu, A.K. & Sharma, S.C. (2019). Automobile Mechanics. Khanna Book Publishing.
2. Babu, A.K. & Sharma, S.C. (2019). Automobile Engines. Khanna Book Publishing.
3. Singh, K. (1997). Automobile Engineering (7th ed.). Standard Publishers.
4. Jain, K.K. & Asthana, R.B. (2002). Automobile Engineering. Tata McGraw Hill.
5. Heitner, J. (1999). Automotive Mechanics (2nd ed.). East-West Press.
6. Heisler, H. (1998). Advanced Engine Technology. SAE International Publ.

Course Code	Course Name	L-T-P-Credits
PG-MEE-203	**Optimization Methods 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-204	**Nuclear Engineering**	**3-0-0-3**

Contents:

Introduction to Nuclear Engineering: Historical development of nuclear engineering, Basics of nuclear physics, Nuclear reactions and radiation.

Nuclear Reactors: Types of nuclear reactors, Reactor materials and fuels, Reactor cooling systems, Reactor instrumentation and control.

Reactor Design and Operation: Reactor core design and analysis, Reactor startup and shutdown procedures, Reactor safety analysis.

Radiation Protection: Sources of radiation exposure, Radiation detection and measurement, Radiation shielding.

Nuclear Waste Management: Types of nuclear waste, Waste disposal methods, Environmental impact assessment.

Advanced Topics in Nuclear Engineering: Fusion reactors and their principles, Emerging nuclear reactor designs and technologies, Nuclear non-proliferation and international safeguards.

Text /Reference Books:

1. Glasstone, S. &Sesonske, A. (2013). Nuclear Reactor Engineering: Reactor Design Basics (1st ed.). CRC Press.
2. Lamarsh, J.R. &Baratta, A.J. (2018). Introduction to Nuclear Engineering (4th ed.). Pearson.
3. Todreas, N.E. & Kazimi, M.S. (2013). Nuclear Systems Volume I: Thermal Hydraulic Fundamentals (2nd ed.). CRC Press.

Course Code	Course Name	L-T-P-Credits
PG-MEE-205	**Gas Dynamics**	**3-0-0-3**

Course Content:

Compressible flow, historical background and its importance.

Continuity equation, momentum equation and energy equation in conservative flow.

One-dimensional flow equation, Mach number, speed of sound in perfect and real gas, normal shock relations, Hugoniot equation, Basics of Shock Tube and Shock Tunnel.

Governing equations for Quasi-One-Dimensional flow, area-velocity relation, isentropic flow relations for perfect gas through variable ducts, diffuser, wave reflection from a free boundary, Fanno and Rayleigh Flows.

Source of oblique shock, oblique shock relation, supersonic flow over wedge and cone, shock polar, normal shock reflection, pressure deflection diagram, interaction of shocks, Mach reflection, detached shock, Prandtl-Meyer expansion waves, shock-expansion theory.

Basics of Hypersonic Flows.

Texts/References:

1. Anderson, J. D. (1989). Modern compressible flow (2nd ed.). McGraw Hill.

2. Zucker, R. D., and Biblarz, O. (2002). Fundamentals of Gas Dynamics, Wiley.
3. Liepmann H. W., and Roshko, A., (1960). Elements of Gas Dynamics, John Wiley, 1960.
4. Anderson, J. D., (2006). Hypersonic and High-Temperature Gas Dynamics (2nd ed.). McGraw-Hill, 2006.

Course Code	Course Name	L-T-P-Credits
PG-MEE-206	**Foundations in Aerodynamics**	**3-0-0-3**

Course contents:

Fundamentals; Aerodynamic forces and moments; continuity, momentum and energy equations; Inviscid incompressible flow – incompressible flow in a low speed wind tunnel, source and doublet flows, nonlifting flow over a circular cylinder, Kutta-Joukowski theorem;

Incompressible flow over airfoils and finite wings – Kutta condition, Kelvin's circulation theorem, Biot-Savart law, Helmholtz vortex theorem, Prandtle's classical lifting line theory;

Thin aerofoil theory; Three dimensional source and doublet; Inviscid compressible flow – normal and oblique shocks, expansion waves, supersonic wind tunnels; Elements of hypersonic flow, Newtonian theory; Equations of viscous flow; Laminar and turbulent boundary layers; Panel methods in aerodynamics.

Text/Reference:

1. Anderson, J. D. (1989). Modern compressible flow (2nd ed.). McGraw Hill.
2. Bertin, J. J., (2002). Aerodynamics for Engineers, Pearson Education.
3. Clancy, L. J., (1996). Aerodynamics, Himalayan Books.
4. Houghton, E. L., and Carruthers, N. B. (1988). Aerodynamics for Engineering Students, Arnold.
5. Kuethe, A. M., and Chow, C-Y, (1998). Foundations of Aerodynamics, Wiley.
6. Zucker, R. D., &Biblarz, O. (2002). Fundamentals of Gas Dynamics, Wiley.

Course Code	Course Name	L-T-P-Credits
PG-MEE-207	**Gas Turbine Technology**	**3-0-0-3**

Course contents:

Introduction:Simple gas turbines, Open-cycle single-shaft, twin-spool and multi-spool arrangements, Closed cycles, Industrial applications and land transportation, Aircraft and marine propulsion, Auxiliary power units.

Shaft Power Cycles: Ideal cycles, Cycles with intercooling, reheating, regeneration, Component losses, Stage and overall efficiency, Polytropic efficiency.

Aircraft Propulsion Cycles:Simple turbojet, turboprop, turbofan and turboshaft engines; Performance analysis-Thrust equation, Specific Thrust, Specific Fuel Consumption;

Propulsive, Thermal and Overall efficiencies, Bypass Ratio, Ideal and actual T-s diagrams of aircraft engines.

Principles of Turbomachines: Categories of Turbomachines, Classification of Fans, Blowers, Compressors and Turbines, Extended Turbomachines, Incompressible and compressible flow machines; Axial, Radial and Mixed flow stages, Components of Compressors and Turbines, Impulse and Reaction stages, Angular momentum principle, Euler turbomachine equation; Forces in Rotor blades and their effect.

Centrifugal Compressors: Elements of compressor stage, Velocity triangles and efficiencies, T-s diagram, Blade passage design, Stanitz formula Diffuser and pressure recovery, Slip factor, Vaned and vaneless diffuser, Volute casing, Aerodynamic losses, Compressor performance - Stall and surge, Performance characteristics.

Cascade Aerodynamics**:** Blade design and blade profile, cascade theory, cascade notations, cascade tunnel and typical results.

Axial Flow Compressors:Elementarytheory,Velocity triangles, Efficiencies, T-s diagram, Stage pressure rise, Degree of reaction, Stage loading, Free and forced vortex blades, Effect of axial velocity and incidence on velocity triangles, Aerodynamic losses, Performance characteristics.

Combustion Systems:Operational requirements, Factors affecting combustion, Combustion process, Types of combustors, Emission related issues.

Axial Flow Gas Turbines**:** Elementary theory,Velocity triangles and efficiencies; T-s diagram, degree of reaction, Free-vortex blades, Blade angles for variable degree of reaction, Matching of compressor and turbine.

Gas Turbine Cooling: Effect of high gas temperature, Methods of cooling-internal and external, Convective, Film, Impingement and Transpiration cooling.

Text/Reference:

1. Cohen, H., Rogers, G. F. C., and Saravanamuttoo, (2001). H. I. H., Gas Turbine Theory, Pearson, 2001.
2. Flack, R. D., (2005). Fundamentals of Jet Propulsion with Applications, CUP, 2005.
3. Ganesan, V. (2010). Gas Turbines, Tata McGraw Hill.
4. Yahya, S. M. (2001). Turbines, Compressors and Fans, Tata McGraw Hill.
5. Farokhi, S., (2014). Aircraft Propulsion, Wiley, 2014.
6. Wilson DG, and Korakianitis, (2014), The Design of High-Efficiency Turbomachinery and Gas Turbines, MIT Press, Cambridge, Massachusetts.
7. P. G. Hill and C. R. Peterson, Mechanics and Thermodynamics of Propulsion, Addison Wesley, 1965.

Course Code	Course Name	L-T-P-Credits
PG-MEC-208	**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.

3rd Semester

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.

4th Semester

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.