Department of Mechanical Engineering

The department of Mechanical Engineering offers the following programs:

1. Graduate Diplomas

1.1 Specialized Graduate Diploma in Mechanical Engineering

The student must complete 30 credit hours.
Compulsory courses: The student must pass the following courses: (07 08 611, 07 08 625, 07 08 631, 07 08 645) in addition to the "diploma project" (07 08 601)
Elective courses: The student can choose the remaining 15 credit hours from the diploma courses 07 08 6xx.

2. Master Degrees

2.1 Master of Engineering in Mechanical Engineering

The student must complete 30 credit hours in the form of courses and an additional 3 credit hours in the form of a scientific report.
Compulsory courses: The student must pass 6 courses (18 credit hours) from one of the following four groups 07 08 71x, 07 08 72x, 07 08 73x, 07 08 74x
Elective courses: The student can choose the remaining 4 courses (12 credit hours) from the other 3 groups of courses in the Master's course list.
The student is allowed to study a maximum of 6 credit hours as selective courses from other departments.

2.2 Master of Science in Mechanical Engineering

The student must complete 24 credit hours in the form of courses and an additional 8 credit hours in the form of a thesis.
Compulsory courses: The student must pass 5 courses (15 credit hours) from one of the following four groups 07 08 71x, 07 08 72x, 07 08 73x, 07 08 74x
Elective courses: The student can choose the remaining 3 courses (9 credit hours) from the other 3 groups of courses in the Master's course list.
The student is allowed to study a maximum of 6 credit hours as selective courses from other departments.

3. Doctor of Philosophy- Ph.D. Degree

3.1 Doctor of Philosophy in Mechanical Engineering

The student must complete 18 credit hours in the form of courses and an additional 24 credit hours in the form of a dissertation.

Compulsory courses: The student must pass 4 courses (12 credit hours) from one of the following four groups 07 08 81x, 07 08 82x, 07 08 83x, 07 08 84x

Elective courses: The student can choose the remaining 2 courses (6 credit hours) from the other 3 groups of courses in the Master's course list.

The student is allowed to study a maximum of 6 credit hours as selective courses from other departments.

List of Diploma, Master and Ph.D. courses

No.	Course Code	Course Name	Credit Hours	Exam Duration	Prerequisite
1	07 08 611	Applied Heat and Mass Transfer	3	3	
2	07 08 612	Thermal Power Plants	3	3	
3	07 08 613	Heat Exchangers	3	3	
4	07 08 614	Power Plant Operation and Management	3	3	
5	07 08 615	Design of Refrigeration Equipment and Cycles	3	3	
6	07 08 616	Design of Central Air Conditioning Systems	3	3	
7	07 08 617	Industrial Ventilation and Smoke Management	3	3	
8	07 08 618	Special and Industrial Air Conditioning Systems	3	3	
9	07 08 621	Modern Automotive Engines	3	3	
10	07 08 622	Fuel Fires: Prevention and Extinguishing	3	3	
11	07 08 623	Fundamentals of Diesel Engineering	3	3	
12	07 08 624	Performance and Maintenance of Diesel Engines	3	3	
13	07 08 625	Fundamentals of Fuel Combustion	3	3	
14	07 08 626	Fundamentals of Gas Turbines	3	3	
15	07 08 627	Environmental Studies in Combustion Engineering	3	3	
16	07 08 631	Fluid Machinery	3	3	
17	07 08 632	Pipeline Design	3	3	
18	07 08 633	Hydraulic and Pneumatic Control Systems	3	3	
19	07 08 641	Sensors	3	3	

20	07 08 642	Robot Dynamics	3	3	
21	07 08 643	Vibration Problems in Industry	3	3	
22	07 08 644	Condition Monitoring and Diagnosis	3	3	
23	07 08 645	Engineering Materials	3	3	
24	07 08 646	Computer Aided Design	3	3	
25	07 08 647	Experimental Design and Error Analysis	3	3	
26	07 08 711	Industrial Ventilation	3	3	
27	07 08 712	Heat and Mass Transfer	3	3	
28	07 08 713	Thermal Design of Air Conditioning and Refrigeration Equipment	3	3	07 08 712
29	07 08 714	Humidification and Drying	3	3	
30	07 08 715	Advanced Power Plants	3	3	
31	07 08 716	Analysis and Design of Heat Exchangers	3	3	
32	07 08 717	Two-Phase Flow Heat Transfer	3	3	
33	07 08 718	Applications of Numerical Methods to Transport Phenomena	3	3	07 08 712
34	07 08 719	Heat and Mass Transfer II	3	3	
35	07 08 720	Cryogenic and Gas Liquefaction	3	3	
36	07 08 721	Design and Solar Energy Conversion Systems	3	3	
37	07 08 722	Fuels and Fundamentals of Combustion	3	3	
38	07 08 723	Environmental Topics in Combustion Engineering	3	3	
39	07 08 724	Thermodynamics of Combustion	3	3	
40	07 08 725	Combustion Phenomena in Spark–ignition Engines	3	3	07 08 722 or 07 08 724
41	07 08 726	Combustion Phenomena in Compression–ignition Engines	3	3	07 08 722 or 07 08 724

42	07 08 727	Gas Turbines	3	3	
43	07 08 728	Advanced Topics in Combustion Engineering I	3	3	07 08 725 or 07 08 726
44	07 08 729	Combustion Diagnostics and Measurements	3	3	
45	07 08 730	Novel Engines	3	3	
46	07 08 731	Mechanics of Continuous Media	3	3	
47	07 08 732	Advanced Fluid Mechanics	3	3	
48	07 08 733	Computational Fluid Dynamics I	3	3	
49	07 08 734	Measurements in Fluid Mechanics	3	3	
50	07 08 735	Turbulent Flow	3	3	
51	07 08 736	Flow Transients	3	3	
52	07 08 737	Multiphase Flow	3	3	
53	07 08 738	Hydraulic Machines	3	3	
54	07 08 739	Selected Topics in Fluid Mechanics I	3	3	
55	07 08 741	Modelling and Simulations	3	3	
56	07 08 742	Theory of Vibrations	3	3	
57	07 08 743	Digital Control	3	3	
58	07 08 744	Linear Control	3	3	
59	07 08 745	Composite Materials	3	3	
60	07 08 746	Finite Element Analysis	3	3	
61	07 08 747	Theory of Elasticity	3	3	
62	07 08 748	Theory of Lubrication	3	3	
63	07 08 749	Bearing Analysis	3	3	
64	07 08 811	Advanced Thermodynamics	3	3	

65	07 08 812	Numerical Analysis	3	3	
66	07 08 813	Advanced Turbulent Heat and Mass Transfer	3	3	07 08 712
67	07 08 814	Advanced Cooling Load Methods and Energy Management	3	3	
68	07 08 815	Advanced Topics in Thermal Engineering	3	3	07 08 712
69	07 08 816	Thermal Engineering Research	3	3	Approval of the supervisor
70	07 08 817	Advanced Conductive Heat Transfer	3	3	
71	07 08 818	Advanced Convective Heat Transfer	3	3	
72	07 08 819	Advanced Radiative Heat Transfer	3	3	
73	07 08 821	Heterogeneous Combustion	3	3	07 08 726
74	07 08 822	Advanced Gas Dynamics	3	3	
75	07 08 823	Advanced Topics in Combustion Engineering II	3	3	07 08 725 or 07 08 726
76	07 08 824	Applications of Unsteady Flow in Combustion	3	3	07-08-822
77	07 08 825	Doctoral Directed Research in Combustion Engineering	3	3	Approval of the supervisor
78	07 08 831	Viscous Flow	3	3	07 08 731
79	07 08 832	Advanced Experimental Methods for Fluid Systems	3	3	07 08 734
80	07 08 833	Computational Fluid Dynamics II	3	3	07 08 733
81	07 08 834	Simulation and Modeling of Turbulent Flows	3	3	07 08 732
82	07 08 835	Externally Pressurized Bearings	3	3	
83	07 08 836	Electro-hydraulic and Electro-pneumatic Systems	3	3	
84	07 08 837	Selected Topics in Fluid Mechanics II	3	3	
85	07 08 841	Theory of Plasticity	3	3	

86	07 08 842	Viscoelasticity	3	3	07 08 747
87	07 08 843	Selected Topics in Mechanical Design	3	3	
88	07 08 844	Advanced Dynamics	3	3	
89	07 08 845	Nonlinear Control	3	3	07 08 744
90	07 08 846	Selected Topics in Dynamic Systems	3	3	
91	07 08 601	Diploma Project in Mechanical Engineering	3	Presentation	
92	07 08 701	M.Eng. Scientific Report in Mechanical Engineering	3	Defense	
93	07 08 702	M.Sc. Thesis in Mechanical Engineering	8	Defense	
94	07 08 801	Ph.D. Dissertation in Mechanical Engineering	24	Defense	

Description of Courses for Graduate Programs (Diploma- Master- Doctor of Philosophy)

07 08 611 Applied Heat and Mass Transfer
Application of conduction heat transfer in designing insulated walls. Finned surfaces design. Transient conduction. Heat transfer by radiation. Factors affecting convective heat transfer. Laminar and turbulent convection over surfaces of different shapes and inside tubes and tube banks. Laminar and turbulent free convection over surfaces and inside enclosures. Mixed convection. Boiling and condensation. Evaporation.

07 08 612 Thermal Power Plants
Types of thermal power plants. Combined power plants. Mechanical design of power plants. Heat recovery boilers. Performance and operation of combined cycle. Advantages of combined cycle. Comparison between conventional and combined power plants.

07 08 613 Heat Exchangers
Types of heat exchangers. The overall heat transfer coefficient. Analysis of heat exchangers. Selection of heat exchangers. Thermal design of heat exchangers using TEMA code. Heat exchangers: materials, construction and corrosion. Flow induced vibration phenomena. Testing and inspection.

07 08 614 Power Plant Operation and Management

Safety laws and safety requirements in power plants. Environmental laws and environmental control systems. Boiler start up. Boiler normal and abnormal operations. Boiler idling and storage. Maintenance and inspection of steam generators. Turbine startup (cold and hot). Turbine lubricating and control circuits. Steam condensers and cooling tower operations. Part load problems. Load distribution between units and plants and economical load operation of power plants. Daily, weekly, and monthly power plants maintenance. The preventive maintenance for the power stations.

07 08 615 Refrigeration Equipment and Design
Air cooler. Compressor. Condenser. Cooling tower. Expansion devices. Control systems. Multi pressure systems. Flooded systems and refrigerant pumps.

07 08 616 Design of Central Air Conditioning Systems
Building survey. Cooling and heating load calculations. System selection. Equipment selection. Duct design. Water piping design. Ventilation and smoke management. Control systems. Block building load and diversity factor.

07 08 617 Industrial Ventilation and Smoke Management
Heat generation. Moisture accumulation. Displacement ventilation. Pressure control. Zone pressurization. Control of gaseous indoor and air contaminants applications.

07 08 618 Special and Industrial Air Conditioning Systems
Temperature control, humidity control, zone pressure control, air change and filtration codes requirements, clean rooms encompasses, textile manufacturing, candy processing, industrial drying, hospitals, museums, libraries, industrial and military control rooms.

07 08 621 Modern Automotive Engines
Modern trends in engine design. Combustion chambers. Valve train. Electronic injection in gasoline engines. Mixture control. Cooling and lubrication. Emission control requirements.

07 08 622 Fuel Fires: Prevention and Extinguishing
Fire causes. Flammable substances. Stoichiometric combustion. Fire prevention and extinguishing. International codes.

07 08 623 Fundamentals of Diesel Engineering
Types of diesel engines. Fuel pumps. Injectors. Governors.

07 08 624 Performance and Maintenance of Diesel Engines
Combustion chambers. Operating conditions. Performance maps. Emissions. Turbochargers. Engine testing. Maintenance.

07 08 625 Fundamentals of Fuel Combustion
Stoichiometry. Combustion kinetics. Energy balance. Flame propagation. Emissions.

07 08 626 Fundamentals of Gas Turbines
Types of gas turbines. Fuels. Ignition systems. Combustion chambers. Diffusers and nozzles. Compressors. Turbines. Emissions.

07 08 627 Environmental Studies in Combustion Engineering
Combustion products. Emission formation. Effects of operating conditions on emissions. Emission dispersion. Emission measurements and testing. Environmental regulations.

07 08 631 Fluid Machinery
Types of pumps. Positive-displacement and rotodynamic pumps. Theory of centrifugal pumps. Design, selection, operation, and maintenance of pumps. Methods of gas compression. Types of compressors, fans and blowers. Positive-displacement compressors. Theory of centrifugal and axial-flow compressors. Design, selection, operation, and maintenance of compressors, fans and blowers .

07 08 632 Pipeline Design
Basic equations of liquid and gas flows in pipes. Water piping systems and branches. Design of pipe networks. Hydraulic and mechanical design of oil pipelines. Natural gas pipelines. Compressed air piping systems. Economic considerations. Construction, operation, maintenance, and applications. Unsteady flow in pipeline.

07 08 633 Hydraulic and Pneumatic Control Systems
Generation, transmission, and utilization of power in systems in which the working fluid is oil or air. Analysis and design of pumps, cylinders, motors, valves, and other fluid components. Dynamic analysis and control of fluid power systems. Design and analysis of basic and advanced hydraulic and pneumatic circuits. Construction of some hydraulic equipment (hydraulic cranes, fork lifts, graders, shovels, or excavators). Hydraulic and pneumatic systems operation, troubleshooting techniques, and procedures of maintenance.

07 08 641 Sensors
Electromechanical transducers. Error and accuracy. Motion sensors, (resistance inductance, proximity, piezoelectric, eddy current). Force, torque and tactile sensors. Flow sensors (differential pressure, hotwire, electromagnetic, Laser Doppler). Temperature sensors (resistive, thermocouples, fiber optics, interferometrics). Ultrasonic, fiber optics and range sensors.

07 08 642 Robot Dynamics
Basics of Robotics. Homogeneous transformation. Arm kinematics. Inverse kinematics. Arm dynamics. Trajectory planning. Robot control system. Position, speed and force control of robot grippers. Practical examples.

07 08 643 Vibration Problems in Industry
Basic principles and sources of vibrations. Vibrations in buildings. Isolator selection. Plant room design and installation techniques and instrumentations of vibration measurement. Vibration control.

07 08 644 Condition Monitoring and Diagnosis
Vibrations concept. Causes of vibration. Maintenance, transmissibility, and impedance. Sideband frequencies. Fourier analysis. Vibration sensors. Data acquisition. Vibration monitoring. Preventive maintenance program. Vibration limits. Machine performance criteria.

07 08 645 Engineering Materials
Main types and properties of metals and alloys. Heat treatment. Polymers. Elastomers. Ceramics. Composites.

07 08 646 Computer Aided Design
Using computer in engineering design process, graphics, and numerical solutions. The finite element method. Using SIMULINK for the solution of the equations of motion. Using graphics for the design of mechanical parts. Programming project.

07 08 647 Experimental Stress Analysis
Basic equations and plane elasticity theory. Brittle coating methods. Electrical resistance strain gages. Semiconductor strain gages. Analysis of strain gage data. Optical methods and basic optics. Moire method. Photoelasticity .

07 08 711 Industrial Ventilation
Heat generations. Moisture accumulation. Displacement ventilation. Pressure control. Zone pressurization. Control of gaseous indoor and air contaminants. Smoke management. Applications.

07 08 712 Heat and Mass Transfer I
Conduction heat equation. 1-D conduction applications. Mathematical and numerical methods in 2-d conduction. Heat transfer by radiation through participating and non-participating media. Applications on combined conduction and radiation. Ficks law for mass transfer. Mass diffusion in gases and liquids.

07 08 713 Thermal Design of Air Conditioning and Refrigeration Equipment
Prerequisite: 07 08 712
Advanced topics on the design of heaters and humidifiers. DX coils. Chilled water coils. Evaporators. Air cooled condenser. Water cooled condenser. Expansion devices. Chillers and cooling towers.

07 08 714 Humidification and Drying
Humidification system components. Theoretical analysis and performance of humidification systems. Classification and selection of dryers. Drying mechanism. Calculation of drying rates and periods. Practical dryer design.

07 08 715 Advanced Power Plants
Steam boilers. Steam turbines. Gas turbines. Nuclear power plants. Advanced power plants. Effect of power stations on environment.

07 08 716 Analysis and Design of Heat Exchangers
Classification of heat exchangers. Advanced study on heat exchangers analysis of types: shell and tube, finned tubes, finned plates. Overall heat transfer and pressure drop. Thermal design of heat exchangers.

07 08 717 Two-Phase Flow Heat Transfer
Generalized constitutive equations for various two-phase flow regimes. Interfacial heat and mass transfer. Equilibrium and non-equilibrium flow models. Two-phase flow instability. One dimensional wave propagation. Two-phase heat transfer applications: convective boiling, pressure drop, critical and oscillatory flows.

07 08 718 Application of Numerical Methods to Transport Phenomena
Prerequisite: 07 08 712
Numerical techniques for solving selected problems in heat and mass transfer. Applications include free convection, boundary layer flow, two-phase flow, separated flow, flow in porous media. Effects of concentration and temperature gradients, chemical reactions, radiation and electric and magnetic fields.

07 08 719 Heat and Mass Transfer II
Mass, momentum, and energy equations, boundary layers, laminar and turbulent convection over surfaces and inside tubes, free convection, laminar and turbulent mass transfer, mass diffusion coefficient.

07 08 720 Cryogenic and Gas Liquefaction
Thermodynamics properties of gases mixture – Cycles and Equipment (separators - Columns – Compressors – Expanders) – Air fractionation – Nitrogen liquefaction –

Oxygen liquefaction – Hydrogen liquefaction – Helium liquefaction – Industrial LNG processes – Energy consumption

07 08 721 Design of Solar Energy Conversion Systems
Principles of solar energy _ The basic concepts and implementation of conversion processes._ Properties and availability of solar radiation and geometric relationship of sun/collecto_- procedures for solar thermal engineering calculations,_ Solar thermal power plants for electricity generation. Sensible and phase change energy storage.

07 08 722 Fuels and Fundamentals of Combustion
Types of fuels. Stoichiometry. Thermodynamics of combustion. Equilibrium. Flame propagation and flame quench. Droplet group combustion. Emissions.

07 08 723 Environmental Topics in Combustion Engineering
Combustion fundamentals. Emission formation. Effects of operating conditions. Emission dispersion. Emission standards, measurements, and testing. Emission control systems.

07 08 724 Thermodynamics of Combustion
Thermodynamic relations. Real-gas equations. Mixtures and solutions. Chemical reactions. Stoichiometry and adiabatic flame temperature. Gas tables and JANAF tables. Phase and chemical equilibrium. Association and dissociation. Simultaneous reactions.

07 08 725 Combustion Phenomena in Spark Ignition Engines
Prerequisite: 07 08 722 or 07 08 724
Modern fuel-injection systems. Electronic ignition. Heat release analysis. Knocking phenomena. Octane requirements. Chemical equilibrium of combustion. Emission formation.

07 08 726 Combustion Phenomena in Compression Ignition Engines
Prerequisite: 07 08 722 or 07 08 724
Injection transients. Spray atomization and ignition delay. Heat release analysis. Temperature fields in piston and combustion-chamber walls. Frictional losses. Flow through exhaust manifold and silencer design. Turbocharging and part-load problems.

07 08 727 Gas Turbines
Types of gas turbines. Types of diffusers. Design of turbine blades and compressor blades. Stage losses and multi-staging. Performance charts. Matching considerations.

07 08 728 Advanced Topics in Combustion Engineering I
Prerequisite: 07 08 725 or 07 08 726
The course covers new topics at Master's level in the areas of combustion and gas dynamics.

07 08 729 Combustion Diagnostics and Measurements
Experimental design and error analysis. Sensors. Digital signal processing and analysis. Flow visualization techniques. Combustion measurements. Wind tunnels.

07 08 730 Novel Engines
Stirling engines. Fuel–cell operated vehicles. Hydrogen-operated engines. Cryogenic engines. Hybrid vehicles. Solar-energy driven cars. Natural gas engines. Latest advances in the field.

07 08 731 Mechanics of Continuous Media
Cartesian tensor analysis. Stress. Traction vectors. Small and finite strain. Kinematics of continuous media. Conservation equations in Lagrangian and Eulerian coordinates. Constitutive equations for elastic solids and viscous fluids. Viscoelasticity and plasticity.

07 08 732 Advanced Fluid Mechanics
Navier-Stokes equations and constitutive theory. Exact solutions of the Navier-Stokes equations. Viscous flow fundamentals. Vorticity dynamics. Solution of the Navier-Stokes equations in their approximate forms. Thin shear layers and free surface flows. Boundary layer theory. Integral momentum methods. Introduction to turbulence.

07 08 733 Computational Fluid Dynamics I
Emphasis on finite-volume and finite-difference techniques for numerical solution of elliptic, parabolic and hyperbolic partial differential equations. Stability analysis. Applications to heat transfer, and internal and external flow problems.

07 08 734 Measurements in Fluid Mechanics
Design and analysis of engineering experiments with an emphasis on measurement methods and standards. Data analysis. Regressions. General and detailed uncertainty analysis, including statistical intervals, propagation of bias and precision errors. Correlated bias approximations, and using jitter programs.

07 08 735 Turbulent Flow
Basic turbulent flow concepts. Origin of turbulence. Introduction to turbulence measurements. Review of experimental results on the statistics and structure of turbulent flows. Methods for calculation of turbulent flows. The problem of closure, semi-empirical, phenomenological and analytical theories of turbulence. Large-eddy and direct simulations of turbulence. Introduction to turbulence modeling. Eddy viscosity/diffusivity concept. Zero-equation models. One-equation models. Two-equation models. Introduction to second-moment closures. Applications to boundary layers, shear layers, jets, plumes, wakes and separated flows.

07 08 736 Pipeline Systems
Review of steady flow in pipes. Imperial pipe friction formulas. Networks of pipes. Non-linear network analysis. Pumps in systems. Fundamental concepts of unsteady flow. Solution by method of characteristics. Problems resulting from unsteady flow in pipe systems. Surge protection devices and techniques. Pipe modelling and simulations.

07 08 737 Multiphase Flow
Selected topics in multiphase flow including nucleation and cavitation. Dynamics of stationary and translating particles and bubbles. Basic equations of homogeneous two-phase gas/liquid, gas/solid, and vapor/liquid flows. Kinematics and acoustics of bubbly flows. Instabilities and shock waves in bubbly flows, stratified, annular, and granular flow.

07 08 738 Hydraulic Machines
Pump types and constructions. Pumps Performance curves. Pump drive. Pump controls and valves. Intakes and suction piping. Hydraulic loads. Pump testing. Special problems of pump design, and operating conditions. Selecting and purchasing pumps.

07 08 739 Selected Topics in Fluid Mechanics I
This course is intended to focus on one or more topics of interest to fluid engineers such as; industrial noise, cavitation, hydraulic transients, air pollution. Non-newtonian fluids. Drag reduction. Specifications and bids evaluation of hydraulic equipment. Mechanical seals for compressors and pumps. Lubrication. Aerodynamics. Compressible flow.

07 08 741 Modelling and Simulation
Basics of mathematical modeling. Experimental methods for modeling and identification. Physical analogies. Simulation and basics of parameter estimation methods. Recent simulation software and packages. Practical applications.

07 08 742 Theory of Vibrations
Continuous systems. Transient response of lumped parameter systems – Critical speeds of shafts & rotor dynamics – Gyroscopic effects of discs and rotor balance.

07 08 743 Digital Control
Discretization of continuous systems. Z-transforms. Closed loop performance and stability. Digital controllers and filters. State-space analysis. Pole placement and optimal regulators for discrete systems. Applications.

07 08 744 Linear Control

State-space system analysis. Controllability. Observability. Lyapunov stability. Pole placement. Design of servo systems. State observer. Quadratic optimal control. Design of control system with observer. Applications with MATLAB.

07 08 745 Composite Materials

Types and applications of composite materials. Macro-mechanical and micro-mechanical properties of lamina. Macro-mechanical behaviour of laminate. Stresses in metal-matrix fibrous composites. Experimental methods for measuring the properties of composite materials

07 08 746 Finite Element Analysis

Finite element analysis of beams. Element and interpolation functions. Plane stress. Finite element analysis of plates. Finite element analysis for elastic stability. Broader aspects of the finite element method. The finite element method in lubrication problems.

07 08 747 Theory of Elasticity

Analysis of stress and strain in three dimensions. Equations of equilibrium. Conditions of compatibility. Displacements. Plane stresses and strains in rectangular, polar, and curvilinear coordinates. Applications.

07 08 748 Theory of Lubrication

Modes of lubrication (hydrodynamic and hydrostatic lubrication). Reynolds' equation. Lubrication of mechanical components (plain bearings, rolling bearings, gears, chains, sliders, and wire ropes). Lubricants (types of lubricating oils and greases, solid lubricants, gas lubricants, and selection of lubricant type). Lubrication systems.

07 08 749 Bearing Analysis

Hydrodynamic and hydrostatic bearings. Gas bearings. Turbulence, inertia, and thermal effects. Dynamically loaded bearings. Bearing stability. Porous bearings. Antifriction bearings. Bearing materials. Lubricants.

07 08 811 Advanced Thermodynamics

Analysis of classical thermodynamics from the microscopic viewpoint. Topics include: ensemble methods, partition functions, translational, rotational and vibrational energy modes of an ideal gas, chemical equilibrium, imperfect gases, dense fluids, critical-point theories, mean free path concepts, Boltzmann equation, hydrodynamic equations from kinetic theory and properties of disordered composite media.

07 08 812 Numerical analysis

Arrangement of equations of the quantitative heat and the energy and moving of the lump. The marginal cases for the vines and the cases connected. Numerical analysis methods.

07 08 813 Advanced Turbulent Heat and Mass Transfer
Prerequisite: 07 08 712
Models of turbulence. Heat and mass transfer in turbulent external flows over plates and rounded surfaces. Turbulent flow inside ducts and tubes. Turbulent convection in compressible flow.

07 08 814 Advanced Cooling Load Methods and Energy Management
Transfer function method. CLTD/SCL/CLF method. Classical BIN method. Modified BIN method. Overall modeling strategies and building explorer. Computer system architecture. Hardware options. Software options. Computer-aided design. Artificial intelligence. Data acquisition. Building dynamics. Control of thermal storage systems.

07 08 815 Advanced Topics in Thermal Engineering
Prerequisite: 07 08 712

07 08 816 Thermal Engineering Research
The research includes the design of experiments and selecting the suitable numerical methods to perform scientific research for the Ph.D. degree.

07 08 817 Advanced Conductive Heat Transfer
Methods of solving multidimensional transient and steady heat conduction, approximate and exact methods of solving nonlinear conduction problems and heat conduction in composite media and anisotropic solids.

07 08 818 Advanced Convective Heat Transfer
Advanced topics in steady and transient, natural and forced convective heat transfer for laminar and turbulent flow through conduits and over surfaces, mass transfer in laminar and turbulent flow and inclusion of topics on compressible flow with heat and mass transfer.

07 08 819 Advanced Radiative Heat Transfer
Comprehensive and unified treatment of basic theories; exact and approximate methods of solution of radiative heat transfer in participating media, and the interaction of radiation with conductive and convective modes of heat transfer in participating and non-participating media.

07 08 821 Heterogeneous Combustion
Prerequisite: 07 08 726
Diesel injectors and nozzle types. Spray characteristics and droplet sizing. Spray penetration and air entrainment. Heat transfer and mass diffusion. Droplet burning and film combustion. Group combustion. Soot formation and particulate growth. Filters and trap regeneration. NO_x formation and catalytic converters.

07 08 822 Advanced Gas Dynamics
Basic concepts. Multi-dimensional compressible flow. Small perturbation theory. Method of characteristics. Waves in compressible flows. Unsteady flow in ducts. Numerical procedures of solution. Case studies.

07 08 823 Advanced Topics in Combustion Engineering II
Prerequisite: 07 08 724 or 07 08 725
The course will cover new topics not covered at Master's level in the areas of combustion and gas dynamics.

07 08 824 Applications of Unsteady Flow in Combustion
Prerequisite: 07 08 822
Fundamentals of unsteady flow. Dynamic-pressure exchangers. Pressure-wave utilization in reciprocating-engine manifolds. Supercharging. Pulsating combustors. Pulse ejectors. Passive wave-energy converters.

07 08 825 Doctoral Directed Research in Combustion Engineering
Prerequisite: Advisor's approval

07 08 831 Viscous Flow
Prerequisite: 07 08 731
Mechanics of viscous flow. Kinematics and dynamics of viscous flow. Exact and approximate solutions of the Navier-Stokes equations. Vorticity. The vorticity transport equation. Boundary layer theory. Laminar boundary layers. Boundary layer separation. Hydrodynamic stability.

07 08 832 Advanced Experimental Methods for Fluid Systems
Prerequisite: 07 08 734
Design of experiments. Velocity, pressure, temperature, and flow measurements of liquids and gases. Fundamentals of electronic signal processing and optics. Advanced experimental techniques, including laser-Doppler velocimetry. Hot-wire anemometry and thermocouples.

07 08 833 Computational Fluid Dynamics II

Prerequisite: 07 08 733
Introduction to the methods and analysis techniques used in computational solutions of fluid mechanics and heat transfer problems. Model problems are used to study the interaction of physical processes and numerical techniques. Contemporary methods for boundary layers, incompressible viscous flows, and inviscid compressible flows are studied. Finite differences and finite volume techniques. Grid generation techniques.

07 08 834 Simulation and Modeling of Turbulent Flow
Prerequisite: 07 08 732
Introduction to turbulence. Concepts of numerical accuracy and bandwidth. Solutions in differential form and wave space. The numerical representation of turbulent transport, production, and dissipation. Techniques for the simulation and modeling of turbulent flows, including direct numerical simulation (DNS), large-eddy simulation (LES), Reynolds-averaged Navier-Stokes (RANS) and the probability-density-function (PDF) method .

07 08 835 Externally Pressurized Bearings
Equation of motion. Types of bearings. Geometries of hydrostatic gas bearings. Performance improvement. Pressure distribution. Load and discharge. Effect of different factors on bearing performance. Design procedure.

07 08 836 Electro-hydraulic and Electro-pneumatic Systems
Proportional valves. Servo valves. Components of electrical control. Electro-hydraulic control circuits. Electro-pneumatic control circuits. Applications of electro-hydraulic and electro-pneumatic controls. Programmable control equipment. Programmable control applications.

07 08 837 Selected Topics in Fluid Mechanics II
This course is intended to focus on one or more topics of interest to fluid engineers such as; industrial noise, cavitation, hydraulic transients, air pollution. Non-newtonian fluids. Drag reduction. Specifications and bids evaluation of hydraulic equipment. Mechanical seals for compressors and pumps. Lubrication. Aerodynamics. Compressible flow.

07 08 841 Theory of Plasticity
Fundamentals of continuum mechanics. Equations of plastic state. Equations of elastic plastic equilibrium. Plane stresses and strains. Behaviour of elastic plastic bodies under variable loads.

07 08 842 Viscoelasticity
Prerequisite: 07 08 747
Classification of viscoelastic materials. Creep and relaxation tests. Harmonic tests. Notation of time response. Analogous study of viscoelastic behaviour. Superposition principles of Boltzman.

07 08 843 Selected Topics in Mechanical Design
Design of smart machine elements – Design of continuously variable transmission systems – Design of elastomers for various applications – Design of magneto and electro reological clutches and brakes – Advanced techniques and software for optimum machine elements design.

07 08 844 Advanced Dynamics
Lagrange's equation. Ignorable coordinates. Hamiltonian mechanics. Canonical transformations (Hamilton – Jacobi). Theory of variational principles of mechanics. Stability of multi-degree-of-freedom autonomous systems. Non-autonomous systems. Perturbation techniques.

07 08 845 Nonlinear Control
Prerequisite 07 08 744
Nonlinearities in physical systems. Phase plane analysis. Transformation and scaling methods. Stability analysis (Lyapunov's first and second method, frequency domain methods. Equivalent linearization; harmonic response, K&B, Galerkin's method, describing functions. Controller synthesis. Riccatti approach. Absolute stability approach.

07 08 846 Selected Topics in Dynamic Systems
Dynamic systems and their various applications in engineering – Dynamic system stability – Advances in dynamic systems characteristics – Stability of discontinuous systems – Discrete and continuous nonlinear dynamic systems – Recent simulation software and pakages.

07 08 601 Diploma Project in Mechanical Engineering

07 08 701 M.Eng. Scientific Report in Mechanical Engineering

07 08 702 M.Sc. Thesis in Mechanical Engineering

07 08 801 Ph.D. Dissertation in Mechanical Engineering