DEPARTMENT OF MECHANICAL ENGINEERING

SCHEME OF INSTRUCTIONS AND SYLLABUS FOR POST GRADUATE STUDIES

M. Tech. in HEAT POWER Engineering

Visvesvaraya National Institute of Technology, Nagpur

February 2016

MISSION AND VISION
OF
VISVESVARAYA NATIONAL INSTITUTE OF TECHNOLOGY, NAGPUR

MISSION

The Mission of VNIT is to achieve high standards of excellence in generating and propagating knowledge in engineering and allied disciplines. V.N.I.T. is committed to providing an education that combines rigorous academics with joy of discovery. The Institute encourages its community to engage in a dialogue with society to be able to effectively contribute for the betterment of humankind.

VISION

To contribute effectively to the national endeavour of producing quality human resource of world class standard by developing a sustainable technical education system to meet the changing technological needs of the Country, incorporating relevant social concerns and to build an environment to create and propagate innovative technologies for the economic development of the Nation.

MISSION AND VISION
OF
DEPARTMENT OF MECHANICAL ENGINEERING, V. N. I. T. Nagpur

VISION

The vision of the department is to produce quality human resources of high standard in mechanical engineering who can contribute favorably to the technological and socio economic development of the nation.

MISSION

Mission of the Department of Mechanical Engineering is

1. **To develop state of the art facilities related to mechanical engineering**
2. **To attract highly qualified faculty to the department**
3. **To promote participation of industries in academics, research and consultancy**
4. **To undertake research at regional and national level**

Department of Mechanical Engineering offers three M. Tech program, namely, ***M. Tech. in CAD-CAM Engineering, Heat Power Engineering and Industrial Engineering***. These are four semester program, wherein student has to complete certain number of credits as indicated in Table 1. Each subject (or course) has certain number of credits. There are two types of subjects: Core and elective. Core courses are compulsory and some courses from electives are to be taken to complete the required credits.

TABLE 1. CREDIT REQUIREMENTS FOR HEAT POWER ENGINEERING

Postgraduate Core (PC)		**Postgraduate Elective (PE)**	
Category	Credit	Category	Credit
Departmental Core (DC)	39	Departmental Electives (DE)	14
Basic Science (BS)	00	Other Courses (OC)	00
Total	39	Total	14
Grand Total PC + PE			53

The number of credits attached to a subject depends on number of classes in a week. For example a subject with 3-1-0 (L-T-P) means it has 3 Lectures, 1 Tutorial and 0 Practical in a week. This subject will have eight credits (3x1 + 1x1 + 0x1 = 4). If a student is declared pass in a subject, then he/she gets the credits associated with that subject. Depending on marks scored in a subject, student is given a Grade. Each grade has got certain grade points as follows:

Grades	AA	AB	BB	BC	CC	CD	DD	FF
Grade Points	10	09	08	07	06	05	04	Fail

The performance of a student will be evaluated in terms of two indices, viz. the Semester Grade Point Average (SGPA) which is the Grade Point Average for a semester and Cumulative Grade Point Average (CGPA) which is the Grade Point Average for all the completed semesters at any point in time. SGPA & CGPA are:

$$\boldsymbol{SGPA} = \frac{\sum_{semester}(Course\ credits\ X\ Grade\ points) for\ all\ courses\ except\ audit}{\sum_{semester}(Course\ credits\ ) for\ all\ courses\ except\ audit}$$

$$\boldsymbol{CGPA} = \frac{\sum_{All\ semester}(Course\ credits\ X\ Grade\ points) for\ all\ courses\ with\ pass\ grade\ except\ audit}{\sum_{All\ semester}(Course\ credits\ ) for\ all\ courses\ except\ audit}$$

Students can Audit a few subjects. i.e., they can attend the classes and do home work and give exam also, but they will not get any credit for that subject. Audit subjects are for self enhancement of students.

Details about Faculty members teaching to M.Tech. HEAT POWER ENGINEERING

Name of Faculty Member	**Designation**	**Qualifications**	**Areas of specialization**
S.B.Thombre	Professor	Ph.D.	Heat and Mass Transfer
J.G. Suryawanshi	Associate Professor	Ph.D.	I.C. Engines
D.B. Zodpe	Associate Professor	Ph.D.	Refrigeration and Cryogenics
V.R. Kalamkar	Associate Professor	Ph.D.	CFD, Advanced turbo machinery
A.S. Dhoble	Assistant Professor	Ph.D.	Power plant engineering
A.K.Singh	Assistant Professor	Ph.D.	Contact Mechanics
T.B. Gohil	Assistant Professor	Ph.D.	Advanced CFD

Scheme of Instructions for M. Tech. in HEAT POWER Engineering

I Semester				II Semester			
CORE				**CORE**			
Code	**Course**	**L-T-P**	**Cr**	**Code**	**Course**	**L-T-P**	**Cr**
MEL512	Engineering Thermodynamics and Combustion	3-0-0	3	MEL430	Advanced IC Engines	3-0-0	3
MEL511	Fluid Dynamics	3-0-0	3	MEP430	Advanced IC Engines Lab	3-0-0	3
MEL438	Advanced Refrigeration and Air Conditioning	3-0-0	3	MEL508	Energy Management	3-0-0	3
MEP438	Advanced Refrigeration and Air Conditioning Lab	0-0-2	1	MEL444	Solar Energy Utilization	3-0-0	3
MEL417	Power Plant Engineering	3-0-0	3	MEL513	Advanced Heat Transfer	3-0-0	3
				MEP513	Heat and Mass Transfer Lab	3-0-0	3
ELECTIVE (Any One)				**ELECTIVE (Any One)**			
MEL435 MEL422 MEL504	1. Computational Fluid Dynamics 2. Mechatronics 3. Gas Dynamics	3-0-0	3	MEL449 MEL443	1. Advanced Turbo Machinery 2. Air Pollution and Control	3-0-0	3
MEP435 MEP422 MEP504	1. Computational Fluid Dynamics Lab 2. Mechatronics Lab 3. Gas Dynamics Lab	0-0-2	1				
		17					**16**
III Semester				**IV Semester**			
	Core				Core		
MED401	Project Phase-I	-	3	MED503	Project Phase-II	-	9
ELECTIVE (Any one from each group)							
MEL520 MEL509 MEL507	1. Bio Energy Conversion 2. Design & Optimization of Thermal Energy Systems 3. Advanced CFD	3-0-0	3				
MEL516 MEL519	1 Fuel Cell Technology 2 Cryogenics	3-0-0	3				
MEP516 MEP519	1 Fuel Cell Lab 2 Cryogenics Lab	0-0-2	**1**				
			10				**9**

Programme Educational Objectives of M. Tech. in HEAT POWER Engineering

1. To impart concepts of HEAT POWER Engineering through the use of analytical techniques, experiments, computer simulation methods, and other modern engineering tools in the analysis and design of variety of mechanical engineering systems and their industrial applications effectively.
2. Spreading the recent developments in HEAT POWER Engineering field through educating the students using new technologies, softwares and recent trends in HEAT POWER Engineering .
3. To develop habit of individual critical thinking in analyzing a complex problem in the HEAT POWER Engineering.
4. Student's capacity building in up-coming areas of research in HEAT POWER Engineering.

Programme Outcomes of M. Tech. in HEAT POWER Engineering

a. Acquire knowledge of HEAT POWER Engineering and be able to discriminate, evaluate, analyze and integrate existing and new knowledge
b. Be able to critically analyze and carry out independent research on complex problems of HEAT POWER Engineering
c. Be able to carry out systematic research, design appropriate experiments and tools, and interpret experimental and analytical data for development of technological knowledge in HEAT POWER Engineering
d. Be able to function productively with others as part of collaborative and multi-disciplinary team
e. Be able to communicate effectively with written, oral and visual means, the design and research outcomes to the stakeholders
f. Be able to recognize state-of-the-art need and will be able to engage in life-long learning
g. Be able to understand professional and ethical responsibility while carryout out research and design activities
h. Be able to critically analyze, scrutinize and rectify one's decisions and actions and apply self corrective measures

COURSE SYLLABUS FOR M.TECH. (HEAT POWER Engineering)

Course Name: MEL512- Engineering Thermodynamics and Combustion

Offered in: I Semester (Odd Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Core

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments (10%), End Semester exam (60%).

Course Objectives:

1. To understand various laws of thermodynamics
2. To understand combustion mechanics
3. To learn about pollutants and their estimation

Syllabus:

First law of thermodynamics

Equation of state, properties of gas mixtures, first law of thermodynamics, enthalpy of formation and heat of reaction, adiabatic flame temperature

Second law of thermodynamics

Second law of thermodynamics and concept of chemical equilibrium, Gibbs free energy and the equilibrium constant of chemical reaction.

Combustion

Combustion, determination of flame velocity and length. Empirical correlations. Models of ignition and quenching. Flammability limits and their use. Burning of solid particles, diffusion and kinetically controlled combustion. Combustion in fluidized beds.

Pollution

Estimation of pollutants emission (CO, NOx, HC), emission indices & control measures.

REFERENCES

1. Van Wylen, G.J, “Fundamentals of classical thermodynamics”, Wiley Eastern, 1978.
2. HolmanJ.P, “Thermodynamics”, Mc-Graw Hill International,Kogakusha, 3rd Ed, 1980.
3. Cengel, Y.A.,Boles M.A , “Thermodynamics”, McGraw Hill, 3rd Ed,

Course outcomes:

1. Learn the concept of energy availability and analysis of thermodynamic systems.
2. Apply basic laws of thermodynamics in analysis and design of thermodynamic cycles including vapor and gas power cycles, refrigeration cycles, and heat-pump.
3. Develop understanding how thermodynamic relations are used in evaluation of thermodynamic properties.
4. Learn how to apply the fundamentals of conservation of mass and energy, and properties of ideal gas mixtures in design and analysis of psychrometric systems.
5. Learn the thermodynamic analysis of reacting mixtures and the applications in analysis of combustion processes

Course Name: MEL511-Fluid Dynamics

Pre-requisites: Nil

Offered in: I Semester (Odd Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Core

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course Objectives:

1. Explain the physical properties of a fluid and the consequence of such properties on fluid flow
2. Identify the fundamental kinematics of a fluid element
3. State the conservation principles of mass, linear momentum, and energy for fluid flow
4. Apply the basic applied-mathematical tools that support fluid dynamics

Syllabus:

Boundary Layer Theory

Concept of boundary layer, flow over a flat plate, Navier-Stokes's equations and it's use. Von-Karmann Momentum Equation. General properties of boundary layer. Exact solution of two-dimensional methods. Correlation coefficient.

Compressible Flows

Concept of compressible flow, one dimensional isentropic flow, normal shock, flow with frictional heat transfer, Reyleigh and fanno lines..

Reference Books/ Material:

1. Kumar D.S., "Fluid Mechanics and Fluid Machines", S.K.Kataria & Sons, 4th Ed, 1992
2. Bansal R.K, "Fluid Mechanics and Fluid Machines", Laxmi Publications, 2002.
3. Massey B.S., "Mechanics of Fluids", Van Nostrand Reinhold Co., 1989.
4. Yahya S.M., "Fundamentals of Compressible Flow," New Age Int., 3rd Ed., 2004

Course Outcomes: Upon successful completion of this course you should be able to:
• Classify and exploit fluids based on the physical properties of a fluid
• Compute correctly the kinematical properties of a fluid element
• Apply correctly the conservation principles of mass, linear momentum, and energy to fluid flow systems

Course Name: MEL438- Advanced Refrigeration and Air Conditioning

Pre-requisites: Nil

Offered in: I Semester (Odd Semester)

Scheme and Credit: [(0-0-2); Credits: 1]

Type of Course: Core

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course Objectives:

1. To impart knowledge about principles of producing low temperatures by using multi-pressure systems and cascade systems.
2. To provide concepts about designing, installation and servicing of air conditioning systems in residential, commercial and industrial buildings.
3. To educate about various system components and accessories of refrigeration and air-conditioning systems

Syllabus:

Refrigeration Cycles

Refrigeration Cycles analysis, refrigerants, gas cycle refrigeration systems;

Ammonia-water and Lithium-Bromide vapor absorption refrigeration system

Load estimation.

Air-conditioning systems: central and unitary systems, design of various components, humidification and dehumidification equipments, automatic controls. Energy conservation and air conditioning for special applications.

Waste heat recovery, industrial air-conditioning, textile processing.

Course Outcomes:

Upon successful completion students will be able to:

1. Design refrigeration systems that can produce low temperatures required in many industrial applications.
2. Acquire enough knowledge to design the air conditioning systems for residential, commercial and industrial buildings.
3. Acquire expertise and develop confidence to install and retrofit HVACR equipment.

Course Name: MEP438-Advanced Refrigeration and Air Conditioning Lab

Pre-requisites: Nil

Offered in: I Semester (Odd Semester)

Scheme and Credit: [(0-0-2); Credits: 1]

Type of Course: Core

Course Assessment Method: Continuous evaluation

Course Objectives:

1. To make student understand working of various machines related to refrigeration and their energy efficiency related performance
2. To explain student working of various components of refrigeration systems

List of Experiments:

1-Experiment on Determination of COP of Refrigeration trainer-CO-1

2-Experiment on Determination of COP for Heat pump-CO-1

3- Experiment of Determination of COP for Vapour absorption Refrigeration-CO-1

4-Experiment of Determination of COP for Thermoelectric Refrigeration-CO-1

5-Experiment on Determination of COP for Room air conditioner-CO-1

6-Demonstration of frost free refrigerator-CO-1

7-Demonstration of conventional Refrigerator-CO-1

8-Study and demonstration of types of compressors-CO-2

9- Study and demonstration of types of condensers-CO-2

10- Study and demonstration of types of evaporators-CO-2

11- Study and demonstration of types of expansion devices -CO-2

Course Name: MEL417-Power Plant Engineering

Pre-requisites: Nil

Offered in: I Semester (Odd Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Core

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course Objectives:
1. To analyze different types of steam cycles and estimate efficiencies in a steam power plant
2. To describe basic working principles of gas turbine and diesel engine power plants.
3. Define terms and factors associated with power plant economics. Calculate present worth depreciation and cost of different types of power plants.
4. To Estimate the cost of producing power per kW

Syllabus:
Steam Power Plant: Reheat-regenerative cycle, binary cycle, topping and superimposed cycle.
Steam generators: Modern generators, once through and fluidized bed boilers design. Consideration of modern steam generators, furnace, fuel firing methods, fuel and ash handling systems, various accessories of steam generators, steam temperature control.
Steam Turbines: Details of construction, accessories, governing, turbine blades, power calculations, arrangement of turbines, industrial turbines.
Condensers and Cooling Towers: Performance, heat transfer design, calculations, efficiencies, detail construction, cooling water circuit, environmental aspects.
Hydro Electric Plant: Hydrology, rainfall measurement hydrographs, flow duration curves, site selection, classification of hydro stations, capacity of hydro stations, selection of prime movers, governing of water turbines, operation of different components of hydro station reservoirs, dam, spillway, canals, penstock, water hammer surge tank, Draft-tubes, specific speeds of turbines, Advantages of hydro station.
Gas Turbine Power Plant: General features and characteristics and their application power plants, Analysis of different cycles, components of gas turbine power plants, governing system of gas turbine plant, advantages of G. T. plant, Gas and steam turbines, combined cycles – Thermodynamic analysis for optimum design, advantages and performance of combined cycles, economics of combined cycle. Combined cycle with nuclear power plants, Diesel electric power plant: Thermodynamic cycle analysis, supercharge of diesel engines, different systems of diesel power plant, environmental aspects.
Power Plant Economics: Fluctuating load on power plants, load curves, various performance factors of power station. Effect of variable load power plant design and operation. Economic analysis of power plants, tariffs, load division, combined operation of different power plants, heat rate, incremental heat rate, selection of power plant and station equipments.

Reference Books/ Material:

1. Stroteki, Vopat, "Power Station Engineering & Economy", Tata Mc Graw Hill, 1977
2. Domkundawar, "Power Plant Engineering", Dhanpat Rai & Sons,1980
3. Nagpal G. R , "Plant Engineering", Khunna Publications, 1978

Course Outcomes: On Successful completion of this course, The student will :
1. Know the various types of power plants used in Jordan.
2. Have Knowledge of the various types of conventional and non-conventional power plants.
3. Have Knowledge of the operation, construction and design of various components of power plants.
4. Able to calculate the performance parameters of various power plants.

Course Name: MEL435- Computational Fluid Dynamics

Pre-requisites: Nil

Offered in: I Semester (Odd Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Elective

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course Objectives:
1.To develop an understanding for the major theories, approaches and methodologies used in CFD
2.To build up the skills in the actual implementation of CFD methods (e.g. boundary conditions, turbulence modelling etc.) in using commercial CFD codes
3.To gain experience in the application of CFD analysis to real engineering designs.

Syllabus:
Equations of fluid dynamics
Basic concepts Eulerarian and Lagrangian methods of describing fluid flow motion, acceleration and deformation of fluid particle, vorticity. Laws governing fluid motion, continuity, Navier – stokes & energy equations. Boundary layer equation, Euler equations, potential flow equations, Bernoulli's equation and vorticity transport equation.Initial and boundary conditions. Classification of equation of motions – hyperbolic, parabolic, elliptic.
Mathematical Preliminaries
Numerical integration. Review of linear algebra, solution of simultanilus linear algebric equations – matrix inversion, solvers – direct methods, elimination methods, ill conditioned systems; Gauss-Sidel method, successive over relaxation method.
Grid Generation
Transformation of coordinates.General principles of grid generation – structured girids in two and three dimensions, algebric grid generation, differential equations based grid generation; Elliptic grid generation, algorithm, Grid cluistering, Grid refinement, Adaptive grids, Moving grids. Algorithms, CAD interfaces to grid generation. Techniques for complex and large problems: Multi block methods.
Finite difference discretisation
Elementary finite difference coefficients, basic aspects of finite difference equations, consistency, explicit and implicit methods, errors and stability analysis. Stability of elliptic and hyperbolic equations. Fundamentals of fluid flow modeling-conservative property, upwind scheme, transporting property, higher order upwinding. Finite difference applications in heat transfer – conduction, convection.
Finite Volume Method
Introduction, Application of FVM in diffusion and convection problems, NS equations – staggered grid, collocated grid, SIMPLE algorithm. Solution of discretised equations using TDMA.Finite volume methods for unsteady problems – explicit schemes, implicit schemes. Finite Element Method: Introduction. Weighted residual and variational formulations. Interpolation in one-dimensional and two-dimensional cases. Application of FEM to ID and 2D problems in fluid flow and heat transfer

Reference Books/Material:

1. Ferziger J. H., Springer P.M, "Computational Methods for fluid Dynamics", Verlag Berlin
2. Anderson J. D. JR, "Computational fluid Dynamics", Mc Graw Hill Inc, 1995
3. Patankar S. P, " Numerical Heat Transfer & Fluid flow"
4. Sunderarajan M.K., "Computational Fluid Flow and Heat Transfer", 2nd Ed, Narosa Publishing

Course Outcomes:

At the end of this course, the student will be able to:

1. Understand and be able to numerically solve the governing equations for fluid flow
2. Understand and apply finite difference, finite volume and finite element methods to fluid flow problems
3. Understand how grids are generated
4. Understand how to assess stability and conduct a grid-convergence assessment
5. Understand and apply turbulence models to engineering fluid flow problems
6. Understand and apply compressible flow solvers
7. Understand the issues surrounding two-phase flow modelling
8. Be able to numerically solve a heat transfer problem
9. Be able to use ANSYS CFX to an acceptable standard for a graduate engineer.

Course Name: MEL422-MECHATRONICS

Pre-requisites: Nil

Offered in: I Semester (Odd Semester)

Scheme and Credit:[(3-0-0); Credits: 3]

Type of Course: Elective

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course Objectives :
1.This course is designed to understand key elements of mechatronics systems, to identify various inputs and output devices in an automated system.
2.To understand and draw ladder diagrams, to understand interfacing of input and output devices
3.To get awareness about actuating systems, microprocessors & microcontroller

Syllabus :
Introduction to Mechatronics :Mechatronic system, measurement systems, control systems and response of systems. Measurement systems : static characteristics
Flow measurement: Rotameter, anemometer and comparison of characteristics of different flow meters.
Pressure measurement: McLeod gauges, comparison of characteristics of different pressure measuring devices. Level measurement, strain measurement – strain gauges, theory, types, strain gauge circuits, temperature compensation, load cells. Temperature measurement: RTD, Thermocouples, pyrometers. Displacement and position sensors: LVDT, optical encoders – transnational and rotary.
System Models: Mathematical models, introduction to mechanical, electrical, fluid and thermal systems. Rotational and transnational systems, electro – mechanical, hydraulic – mechanical systems. Control Systems: open loop, closed loop systems, transfer functions, feed back and feed forward control systems and their applications. System Response, modelling of dynamic systems, dynamic response of first order, second order systems to step, ramp and impulse inputs. Transfer functions, Bode plots, stability of systems. Control Actions: On – Off, proportional, proportional + integral, P + D. Proportional + integral + derivative control actions.
Control systems Components: Transmitters, controllers/ pressure/ flow/ level/ temperature/ limit/ proximimity/ magnetic switches and relays. Analog signal processing, introduction, principle, passive circuits, operational amplifiers -characteristics and specifications. Op–amp circuits for inverting, non-inverting, difference amplifiers, integrator, differentiator, comparator and sample and hold applications (no analytical treatment.) Digital Signal Processing: Timing diagrams, sequential logic, flip flops, D flip flop, JK flip flop, master slave flip flop. Applications of flip flop, decade counters, Schmitt trigger, 555 timers. A/D and D/A converters. Programming Logic Controllers: Relay logic, basic structure, input/output processing, timers, internal relays and counters, shift resisters, ladder diagram and programming, selection of PLCs, introduction to microcontroller.

Reference Books / Material:

1. Musa Jouaneh, "Fundamentals of Mechatronics", Cengage Learning, 1st edition.
2. G Bolton W., "Mechatronics – Electronics Control Systems in Mechanical and Electrical Engineering", Pearson – Education (Singapore) Pt. Ltd., 5 edition.
3. P.C. Pandey, and H.S. Shan, "Modern Machining Processes", Tata McGraw-Hill Publishing Co. Ltd, New Delhi, 1980.
4. K.P. Ramachandran, " Mechatronics - Integrated Mechanical Electronics System," John Wiley & Sons, 2008.

Course Outcomes:

At the end of course the students will have:

1. Ability to design and calculate mechanical designs
2. Ability to design and calculate electronic circuits
3. Ability to develop software for intelligent products
4. Ability to model and build mechatronic systems and implement these systems
5. Ability to apply technological knowledge and theories for the development of new products
6. Specialised knowledge within either of the profiles: Mechanical Engineering, Electronic Engineering or Embedded Engineering
7. Ability to carry out development projects independently and in teams.

Course Name: MEL504- Gas Dynamics

Pre-requisites: Nil

Offered in: I Semester (Odd Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Elective

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course Objectives:

Syllabus:

Reference Books/Material:

Course Outcomes:

Course Name: MEP435- Computational Fluid Dynamics Lab

Pre-requisites: Nil

Offered in: I Semester (Odd Semester)

Scheme and Credit: [(0-0-2); Credits: 1]

Type of Course: Elective

Course Assessment Method: Continuous assessment

Course Objectives :

1. To provide students with the necessary skills to use commercial CFD packages
2. To carry out research in the area of Computational Fluid Dynamics.
3. To solve a variety of flow situations and heat transfer tutorials.

Syllabus :

The set of tutorials designed to provide the student with the necessary tools for using sophisticated commercial Ansys fluent CFD software. A set of laboratory tasks will take the student through a series of increasingly complex flow and heat transfer simulations, requiring an understanding of the basic theory of computational fluid dynamics (CFD).

At the end of the course each student will have to complete a mini project.

Course Name: MEP422-Mechatronics Lab

Pre-requisites: Nil

Offered in: I Semester (Odd Semester)

Scheme and Credit: [(0-0-2); Credits: 1]

Type of Course: Elective

Course Assessment Method: Continuous assessment

Course Objectives :

1. To demonstrate students mechatronics hardware
2. To understand ; basic programming using microprocessor/microcontroller
3. To demonstrate machine condition monitoring.

Syllabus :

Demonstration of mechatronics hardwares; servo- position and velocity control; process control; basic programming using microprocessor/microcontroller; ADC and DAC interfacing with microcontroller/microprocessor; machine condition monitoring; development of multiple sensor fusion; image based navigation and control of robot; control of non-linear systems; machine vision inspection and image surveillance; mini-projects on mechatronic system design

Course Name: MEP504- Gas Dynamics Lab

Pre-requisites: Nil

Offered in: I Semester (Odd Semester)

Scheme and Credit: [(0-0-2); Credits: 1]

Type of Course: Elective

Course Assessment Method: Continuous assessment

Course Objectives :

List of Experiments:

Course Name: MEL430- Advanced IC Engines

Pre-requisites: Nil

Offered in: II Semester (Odd Semester)

Scheme and Credit:[(3-0-0); Credits: 3]

Type of Course: Elective

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course objectives :

1. To get the knowledge of IC, CI engines and testing and characterization of engines.

Syllabus:

Introduction : Engines types and their operation, Introduction and Historical Perspective, Engine classifications, Engine operating cycles, Engine components, Engine friction, lubrication and cooling, lubrication systems. Frictional losses, blow by losses, pumping loss, Factors affecting mechanical friction

Fuels : Fluid, Solid, gaseous, liquid fuels, SI Engine fuels characteristics, C.I. Engine fuels, characteristics, Rating of engine fuels, I.C. engine fuels - petrol, diesel ENG, LPG, Alcohol, Vegetable oils, Combustion, Combustion stoichiometry - The first low of thermodynamics and combustion, Enthalpies of formation, Heating values combustion efficiency. The second law of thermodynamics applied to combustions. Maximum work, chemical equilibrium, theoretical flame temperature.

SI Engine : S. I. Engine fuel requirements, carburetors, factors attesting carburetion, moderns carburetors, metering systems, choke, altitude compensation, fuel injection systems, multipoint port injection, feedback systems, charge motion within the cylinder swirl, squish, combustion stages, flame propagation cyclic variations in combustion, ignition fundamentals, conventional ignition system, abnormal combustion, knock and surface ignition, knock fundamentals, turbo charging, supercharging and scavenging in engines.

C. I. Engines : Essential features of the process, combustion systems. Combustion in direct and indirect injection, fuel spray behavior. Fuel injection systems, fuel pumps, fuel injectors, atomization, combustion in C. I. Engines, ignition delay, certain number, auto ignition. Factors affecting delay. Effects of fuel properties. Abnormal combustion, supercharging and turbo charging in engines.

Pollutant formation & Control

Nature and extent of problem, Nitrogen oxides Kinetics of NO formation, formation of NO2 NO formation in S. I. Engines NOx formation in C. I. Engine Carbon monoxide and unearned hydrocarbon emissions in S.I. and C.I. engines, EGR Particulate emissions, measurement technique. Catalytic converters, particulate traps.

Engine Design and Operating Parameters : Important engine characteristics, Geometrical properties of Reciprocating engines, Brake, Torque & Power, Indicated work per cycle, Mechanical efficiency, Road load power, Mean effective pressure, Specific fuel consumption and efficiency, Air/Fuel and Fuel/Air ratios, Volumetric efficiency, Engine specific weight and specific volume, Correction factors for power and efficiency, Specific emission and emission index, Relationship between performance parameters

Measurement and Testing : Measurement of friction 'power indicated power, Brake power, Fuel consumption, Air consumption, Performance parameters and characteristics: Engine Power, Engine efficiencies, Engine performance characteristics, Variables affecting performance characteristics

Reference Books / Material:

1. Heywood J.B, “Internal Combustion Engine Fundamentals”, McGraw Hill, 1988.
2. Obert E.F, “Internal Combustion Engines and Air pollution”, Intext Educational Pub, 1974
3. Ganesan V, “Internal Combustion Engines”, Tata Mc Graw Hill Publishing Co. , 6th Ed
4. Mathur M.C., Sharma.R.D , "Internal Combustion Engines", Dhanpat Rai Pub, 8th Ed 2003

Course Outcomes: On completion of the course students shall be able to:

• Analyze engine cycles and the factors responsible for making the cycle different from the Ideal cycle

• Apply principles of thermodynamics, fluid mechanics, and heat transfer to influence the engine’s performance

• To Demonstrate the delay period and fuel injection system • Demonstrate an understanding of the

Course Name: MEP430-Advanced IC Engines Lab

Pre-requisites: Nil

Offered in: II Semester (Even Semester)

Scheme and Credit:[(0-0-2); Credits: 1]

Type of Course: Core

Course Assessment Method: Continuous evaluation

List of Experiments:

1. Study of Carburetors
2. Study of Fuel Injection Systems
3. Study of Engine Components
4. Performance Characteristics of C.I. Engine
5. Performance Characteristics of C.I. Engine
6. Experiment on Air Pollution

Course Outcomes:

Upon successful completion students will be able to:
(i) Understand the current available engines, their operating principles and their characteristics
(ii) Be able to test the performance of engines

Course Name: MEL508- Energy Management

Pre-requisites: Nil

Offered in: II Semester (Even Semester)

Scheme and Credit:[(3-0-0); Credits: 3]

Type of Course: Core

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course Objectives :

On completing the course, you should have a good knowledge of how economic analysis can help understand problems related to energy; be able to analyse alternative energy policy options in terms of benefits and costs; have a good understanding of world energy markets; and be able to analyse the risks associated with energy options. You will have acquired the skills needed to structure, analyse and evaluate energy-related problems.

Syllabus:

Introduction: Importance of energy management, Energy auditing, methodology, analysis of past trends (plant data), closing the energy balance, laws of thermodynamics, measurements, portable and online instruments. Energy Economics: discount rate, payback period, internal rate of return, life cycle costing

Thermal & Mechanical systems: Boiler efficiency testing, excess air control, steam distribution and use of steam traps, condensate recovery, flash steam utilization, thermal insulation. Energy conservation in pumps, fan (flow control), Compressed air systems, Refrigeration and air conditioning systems.

Electrical Systems: demand control, power factor correction, load scheduling / shifting, motor drives-motor efficiency testing, energy efficient motors, and motor speed control.

Lighting: Lighting levels, efficient options, fixtures day lighting, timers, and energy efficient windows.

Waste heat recovery: Recuperators, heat wheels, heat pipes, heat pumps. Cogeneration concept, options (steam / gas turbines / diesel engine based). Demand side management.

Energy Auditing: Introduction, importance of energy audit, uses of energy audit basic terms of energy audit, types of energy audit, procedure for carrying energy audit, instruments used for energy audit

Reference Books / Material:

1. Turker W. C., “Energy Management Handbook”, The Fairmont Press Lilburn, 1993
2. Witte, Schmidt, Brown , “Industrial Energy Management & Utilization”, Hemisphere Publications
3. Dryden, “The efficient use of Energy”, Butter worth, London, 1982

Course Outcome:

After completion of this course, the student will have

1. Understanding of energy conservation and identification of energy conservation opportunities in various industrial processes
2. Knowledge of various tools and components energy auditing
3. Ability to evaluate the performance of industrial boilers, furnaces etc. by direct and indirect methods
4. Understanding of cogeneration in industry and waste heat recovery techniques and Devices

Course Name: MEL444-Solar Energy Utilization

Pre-requisites: Nil

Offered in: II Semester (Even Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Core

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course Objectives:

Introduce to the students

1) fundamentals of solar radiation
2) Estimation of solar energy available.
3) Design and fabrication of solar thermal systems
4) Analyze the solar thermal system
5) Design a solar PV system.

Syllabus:

Solar Thermal systems : Liquid Flat – Plate collector, air heater and concentrating collector, Solar pond, Solar distillation, Solar drying. Thermal storage.

Analysis : Modeling of above systems, Steady state and transient analysis, simulation in process design.

Design: Design of active systems by f-chart and utilizability methods. Passive heating and cooling of Buildings.

Reference Books / Material:

1. Sukhatme S.P , “Solar energy,” Tata McGraw Hill, 2nd Ed 2003
2. Duffie, Beckman, “Solar energy”, John Wiley & Sons, 1974
3. Parulekar B.B., Rao S, “Energy technology”, Khanna Publishers, 3rd Ed 1995

Course Outcomes: After completion of this course, student will be able to

1) Implement fundamentals of solar radiation to real time systems
2) Do estimation of solar energy available.
3) Design and fabrication of solar thermal systems
4) Analyze the solar thermal system
5) Design a solar PV system.

Course Name: MEL513-Advanced Heat Transfer

Pre-requisites: Nil

Offered in: II Semester (Even Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Elective

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course Objectives:
1. Analyse multi dimensional transient & steady state heat transfer through solids
2. Predict heat transfer coefficient on different surfaces/ tube banks and design of heat exchanging equipments
3. Estimate radiative heat transfer in enclosures with/ without participating media
4. Analyse one dimensional steady state mass transfer rate for different situations

Syllabus:
Conduction:
Multi dimensional heat flow; steady state and unsteady state, with and without heat generation. Longitudinal and circumferential fins/ spines with rectangular and non rectangular profiles. Analytical methods and numerical techniques.
Convection
Basic concepts, hydrodynamic and thermal boundary layers, momentum and energy integral equations, Natural, forced and two phase convection heat transfer characteristics for different geometries, Empirical correlations. Nusselt theory for film wise condensation on vertical plates, condensation on horizontal tube banks. Design of single/ multiple pass heat exchangers.
Radiation
Basic concepts and laws governing radiation, coloured body, radiosity and irradiation, Shape factors for non standard geometries, Radiation in enclosures, multilayer insulation, radiation with participating media, gaseous emissions and absorption.
Mass Transfer
Fick's law of diffusion, Diffusion coefficient, steady state diffusion of gases and liquids through solids, isothermal evaporation, mass transfer coefficient, analogy between heat and mass transfer

Reference Books/Material:
1. Incropera F P, Dewitt D P, "Introduction to heat transfer",4th Ed, 1996, John Wiley & Sons
2. Holman J.P., "Heat transfer", 9th Ed 2004, McGraw Hill
3. Nag P K, "Heat and Mass Transfer", 3rd Ed, 2011, McGraw Hill

Course Outcomes: On successful completion of this course, the students will be able to
1. Analyse multi dimensional transient & steady state heat transfer through solids
2. Predict heat transfer coefficient on different surfaces/ tube banks and design of heat exchanging equipments
3. Estimate radiative heat transfer in enclosures with/ without participating media
4. Analyse one dimensional steady state mass transfer rate for different situations

Course Name: MEP513- Heat and Mass Transfer Lab

Pre-requisites: Nil

Offered in: II Semester (Even Semester)

Scheme and Credit: [(0-0-2); Credits: 1]

Type of Course: Elective

Course Assessment Method: Continuous Assessment

Course Objectives:

To impart practical knowledge to the students on how to;
1. Determine temperature dependence of thermal conductivity of materials
2. Establish heat transfer characteristics for different geometries, fluid flows & during phase change
3. Estimate various radiative properties such as emissivity, Stephan Boltzmann constant, etc
4. Analyze heat exchanging gadgets like boilers, heat exchangers, solar heaters, etc.
5. Estimate diffusion coefficient and mass transfer coefficient

List of Experiments:

Following is the list of experiments (minimum 8 but covering all the COs)
1.CO1 : To study the temperature dependence of thermal conductivity of a material.
2.CO1 : Determination of efficiency of a pin fin with different profiles.
3.CO2 : Comparison of exact and lumped capacitance method of transient conduction.
4.CO2 : Determination of two phase heat transfer coefficient inside a pipe
5.CO2 : Determination of buoyancy induced flow inside a pipe
6.CO2 : Determination of forced convection heat transfer characteristics for flow through pipes
7.CO2 : Determination of natural convection heat transfer characteristics for inclined plates.
8.CO3 : Determination of effective emissivity of a surface in presence of participating medium
9.CO3 : To study the effect of shield(s) on radiation heat transfer
10.CO4: Determination of overall heat transfer coefficient for shell & tube type heat exchangers
11.CO4: Parametric studies on the performance of a solar collector
12.CO5 : Determination of diffusion coefficient of liquid in air
13.CO5 : Determination of mass transfer coefficient

Course Name: MEL449- Advanced Turbo Machinery

Pre-requisites: Nil

Offered in: II Semester (Even Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Elective

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course Objectives:

The course aims at giving an overview of different types of turbomachinery used for energy transformation, such as pumps, fans, compressors, as well as hydraulic, steam and gas-urbines. It will focus on applications in power generation, transport, refrigeration and the built environment.

Syllabus:

Machinery, dimensionless parameters, specific speed, applications, stage velocity triangles, work and efficiency.

Centrifugal fans and blowers: Types, stage and design parameters, flow analysis in impeller blades-volute and diffusers, losses, characteristic curves and selection, fan drives and fan noise.

Centrifugal Compressor: Construction details, impeller flow losses, slip factor, diffuser analysis, losses and performance curves.

Axial flow compressor: Stage velocity diagrams, enthalpy-entropy diagrams, stage losses and efficiency, work done, stage design problems and performance characteristics.

Axial and radial flow turbines: Stage velocity diagrams, reaction stages, losses and coefficients, blade design principles, testing and performance characteristics.

CFD for Turbo machinery, General Aspects.

Reference Books/Material:

1. Yahya, S.H., “Turbines Compressors and Fans”, Tata McGraw-Hill Publishing Company, 1996
2. Earl Logan, Jr., “Hand book of Turbomachinery”, Marcel Dekker Inc, 1992
3. Dixon, S.I., “Fluid Mechanics and Thermodynamics of Turbomachinery”, Pergamon Press, 1990
4. Shepherd, D.G, “ Principles of Turbomachinery”, Macmillan, 1969.

Course Outcomes:

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

1. Use dimensional Analysis to compare homologous Machines
2. Classify and explain the function of dimensionless number
3. Design Prototype from Model
4. Select Fluid Machines for Appropriate Operations
5. Applications of Thermodynamics Laws.
6. Design both positive Displacement and Rotodymanic Fluid Machines

Course Name: MEL443- Air Pollution and Control

Pre-requisites: Nil

Offered in: II Semester (Even Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Elective

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course objectives

1. The course objectives has three components i.e., sources of air pollution, pathways (air pollutants transformation and transport) and receptors.
2. Students would get an insight into the dispersion of air pollution in the atmosphere
3. This life cycle of air pollution will enable the student to first identify the pollutants and their sources and then the transport mechanisms of the pollutants followed by the affected population and there control mechanisms.

Syllabus:

Introduction

Conventional energy conversion methods using fossil fuels. Their environmental aspects, Pollution from the thermal power plants, thermal and particulate pollution and its control.

IC Engines

Combustion in petrol and diesel engines. Emissions from I.C. Engines and its control. Primary and Secondary Pollutants. Use of various alternative fuels, additives and their effect on pollution. Conventional and microprocessor based control of Air/Fuel ratio, ignition and injection timing, speed and emissions from I.C.Engines.

Noise pollution

Noise pollution and noise control. Standardization for environmental control pollution

Reference Books/Material:

1. Rao, “Air Pollution”, Tata Mc Graw Hill, 7th Edition, 2001
2. Obert E.F., “IC Engines and Air Pollution” , Harper & Row Pub, 1979
3. Reston, “Automotive Pollution Control”, Reston Pub Co1984
4. Prabhakar V.K , “Air Pollution Monitoring and Control”, Anmol Prakashan, 1st Edition, 2001

Course Outcomes: Upon completion of this course, student will have

1. After attending the course the students shall have acquired knowledge and understanding to evaluate air quality management and analyze the causes and effects of air pollution.
2. Students would be able to understand the type and nature of air pollutants, the behavior of plumes and relevant meteorological determinants influencing the dispersion of air pollutants.

Course Name: MEL520- Bio Energy Conversion

Pre-requisites: Nil

Offered in: III Semester (Odd Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Elective

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course Objectives:

Syllabus:

Reference Books/Material:

Course Outcomes:

Course Name: MEL509-Design & Optimization of Thermal Energy Systems

Pre-requisites: Nil

Offered in: III Semester (Odd Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Elective

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course Objectives:

Syllabus:

Reference Books/Material:

Course Outcomes:

Course Name: MEL509- Advanced CFD

Pre-requisites: Nil

Offered in: III Semester (Odd Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Elective

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course Objectives:

This is the advanced course; it covers finite volume methods for the solution of incompressible fluid flow and heat transfer phenomena. With the help of theoretical and numerical aspect, student will able to understand the basics of CFD, its problem solving methodology, solution algorithm, and turbulent modelling. With the help of theoretical tutorial, code development aspects and project, student get detail knowledge of actual CFD methodology and able to apply to the industrial problems. This knowledge in the field of CFD and allow them to use it in their academic growth.

Syllabus:

Governing Equations Derivation of Navier-Stokes and energy equations. Physical interpretation of each terms

Discretization Methods Discretization procedure in Finite-volume. Stability analysis, convergence, various discretization schemes. Compact Schemes, high order discretization

Solution Algorithms Pressure-velocity coupling. Explicit methods: MAC, SMAC. Implicit Methods: SIMPLE, SIMPLER, PISO Matrix inversion methods: direct methods, smooth solver, conjugate gradient method, strongly implicit procedure, Advanced methods: AMG, BiCG, BiCGSTAB Solution methods for various grids

Grid-Generation: Algebraic, Transfinite, Poisson equation methods. Finite-difference Navier-Stokes solution on non-orthogonal grids, transformation. Collocated grids. Finite-volume methods on non-orthogonal grids.

Turbulent flows Boundary layer theory, Introduction to turbulent flows and Reynolds average Navier-Stokes equations (RANS). Turbulent modeling: k-epsilon, k-omega, k-omega SST models based on RANS, LES and DES calculation for internal and external flows.

Introduction to advanced applications Fluid structure interaction, Flow through porous media, moving frame of reference for turbomachines

Reference Books/Material:

1.Versteeg, H. K. and Malalasekera, W. , “An Introduction to Computational Fluid Dynamics”
2. Hirsh, “Numerical Computation of Internal and External Flows,” Vol. 2, Wiley, 1988.
3. Tannehill, and Pletcher , “Computational Fluid Mechanics and Heat Transfer,” Second Edition, Taylor & Francis, 1997.
4.Pope, S. B., “ Turbulent flows,” Cambridge University Press, New York, 2000.
5.Wilcox, D. C. , “Turbulence Modeling for CFD”, DCW Industries, La Caada CA, 2000.
6.Tennekes, H. A and Lumley, J. L. , “First Course in Turbulence”, MIT Press, Cambridge, MA, 1972.

Course Outcomes:

1. Knowledge required for performing a complete CFD analysis.

2. In particular to identify and choose approximations and models, choose boundary conditions, design and dimension the computational grid, identify and quantify sources of error, and take into account quality and reliability of the computational results.

Course Name: MEL516- Fuel Cell Technology

Pre-requisites: Nil

Offered in: III Semester (Odd Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Elective

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course Objectives:

Syllabus:

Reference Books/Material:

Course Outcomes:

Course Name: MEP516- Fuel Cell Technology

Pre-requisites: Nil

Offered in: III Semester (Odd Semester)

Scheme and Credit: [(0-0-2); Credits: 1]

Type of Course: Elective

Course Assessment Method: Continuous Evaluation

List of Experiments:

Course Name: MEL519- Cryogenics

Pre-requisites: Nil

Offered in: III Semester (Odd Semester)

Scheme and Credit: [(3-0-0); Credits: 3]

Type of Course: Elective

Course Assessment Method: Sessional I (15%), Sessional II (15%), Internal assessment through assignments/seminar/quizzes (10%), End Semester exam (60%).

Course Objectives:

Syllabus:

Reference Books/Material:

Course Name: MEP519- Cryogenics

Pre-requisites: Nil

Offered in: III Semester (Odd Semester)

Scheme and Credit: [(0-0-2); Credits: 1]

Type of Course: Elective

Course Assessment Method: Continuous evaluation

List of Experiments:

Course Name: MED401- Project Phase I

Pre-requisites: Semester I and Semester II credits must be complete

Offered in: III Semester (Odd Semester)

Scheme and Credit:[(3-0-0); Credits: 3]

Type of Course: Core

Course Assessment Method: Sessional I (25%), Sessional II (25%), End Semester exam (50%).

Course Objectives:

1. To define the aim, objective, scope of the project topic from the thorough literature review
2. To design the methodology to be followed for the project
3. To finalize the design of experiments or fabrication of required setup or questionnaire

Course Name: MED503- Project Phase II

Pre-requisites: MED401

Offered in: IV Semester (Even Semester)

Scheme and Credit:[(9-0-0); Credits: 9]

Type of Course: Core

Course Assessment Method: Sessional I (25%), Sessional II (25%), External Examination (50%).

Course Objectives:

1. To perform simulations or experiments or study as designed in MED401
2. To obtain results and analysis of the results
3. To draw conclusions and decide future scope of the work
4. To write and submit thesis based on project work

Course Outcome:

1. On successful completion of this course, student will be eligible for award of master's degree