UNIVERSITY OF CALICUT
(Abstract)

Faculty of Engineering – Scheme and Syllabi of the five M.Tech courses in Water Resources nd Hydroinformatics – Communication Engineering and Signal processing - Power Electronics – Internal Combustion Engines and Turbo Machinery and Manufacturing Systems Management – Sanctioned – with effect from 2010-2011 admission – Orders issued.

GENERAL & ACADEMIC BRANCH-IV 'E' SECTION

No. GA IV/E1/7377/2010(ii) Dated, Calicut University PO, 10.11.2010

Read: 1. Letter No.C3/5468/2007 from the Principal, Govt.Engineering College, Thrissur dated 22.07.2010.
2. U.O.No.GAI/D4/7094/2010 dated 02.11.2010.
3. Item No.7 of the minutes of the meeting of the Board of Studies in Engineering (PG) held on 13.08.2010.
4. Orders of Registrar in charge of Vice-Chancellor in the file of even No. dated 08.09.2010.

O R D E R

As per paper read (1) above, Principal, Govt.Engineering College, Thrissur has informed that government has accorded sanction for starting five new M.Tech programmes in the college.

1. Water Resources and Hydroinformatics.
2. Communication Engineering and Signal Processing.
3. Power Electronics.
4. Internal Combustion Engines and Turbo Machinery.
5. Manufacturing Systems Management.

University has given affiliation for starting the above five new M.Tech courses in Govt.Engineering College, Thrissur during the academic year 2010-11 as per paper read 2 (above).

Preparatiion of the syllabi of these courses were co-ordinated by the Principal. Syllabi were prepared by expert Committees Comprising of experts from Govt.Engineering College and Industries and the details of these expert Committees for each branch along with the list of members has been forwarded.

As per the paper read (3) above, the Board of Studies in Engineering (UG) scrutinized the syllabi and observed that the syllabi were prepared by highly qualified and experienced members of expert Committee, strictly in accordance with the M.Tech regulations (2010), Board is of opinion that content of proposed syllabi are suitable for the said M.Tech programmes. Under these circumstances, the board unanimously recommended for the approval of the scheme and syllabi of the following M.Tech programmes.

Contd…………(2)

1. Water Resources and Hydroinformatics.
2. Communication Engineering and Signal Processing.
3. Power Electronics.
4. Internal Combustion Engines and Turbo Machinery.
5. Manufacturing Systems Management.

Considering the urgency of the matter, the Registrar incharge of Vice-Chancellor, approved the proposal of the Board of Studies in Engineering and ordered to implement the decision of Board of Studies, subject to ratification by Academic Council.

Sanction has therefore been accorded for implementing the syllabi of the above five new M.Tech programmes with effect from 2010-2011 admission.

Orders are issued accordingly. (Regulation, Scheme and Syllabus appended)

Sd/-
DEPUTY REGISTRAR(G&A IV)

*For **REGISTRAR***

To

The Principals of all affiliated Colleges

where M.Tech is offered.

Copy to:

PS to VC/PA to Registrar/DR M.Tech Sn-PB/

PA to CE/EX Sn/EG Sn/System Administrator

(with a request to upload in the University website)/SF/FC

Forwarded/By Order
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SECTION OFFICER

M.Tech. INTERNAL COBUSTION ENGINES AND TURBO MACHINERY (MECHANICAL ENGINEERING)

SCHEME OF EXAMINATIONS

Semester - I

Code	Subject	Hours per week			Marks		Total Marks	Sem-end exam duration - Hrs	Credits
		L	T	P/D	Intl.	Sem-end			
MIT10 101	Applied Mathematics	3	1	-	100	100	200	3	4
MIT10 102	Advanced Thermodynamics	3	1	-	100	100	200	3	4
MIT10 103	Advanced Fluid Mechanics	3	1	-	100	100	200	3	4
MIT 10 104	Advanced Heat and Mass transfer	3	1	-	100	100	200	3	4
MIT 10 105	Elective-1	3	1	-	100	100	200	3	4
MIT10 106(P)	*I C Engine Laboratory*	-	-	2	100	-	100	3	2
MIT10 107(P)	*Seminar*	-	-	2	100	-	100	-	2
	Departmental Assistance	-	-	6	-	-	-	-	-
TOTAL		15	5	10			1200		24

Electives -I

MIT 10 105(A) Energy Conservation in Thermal Systems
MIT 10 105 (B) Engine Pollution and Control
MIT 10 105(C) Direct Energy Conversion Systems

Semester - II

Code	Subject	Hours per week			Marks		Total Marks	Sem-end exam duration-Hrs	Credits
		L	T	P/D	Intl.	Sem-end			
MIT 10 201	Combustion and Emission in I C Engine	3	1	-	100	100	200	3	4
MIT 10 202	Computational Fluid Dynamics	3	1	-	100	100	200	3	4
MIT 10 203	Plant Maintenance and Safety	3	1	-	100	100	200	3	4
MIT 10 204	Elective-2	3	1	-	100	100	200	3	4
MIT 10 205	Elective-3	3	1	-	100	100	200	3	4
MIT10 206(P)	*Seminar*	-	-	2	100	-	100	-	2
MIT10 207(P)	*Mini Project*	-	-	2	100	-	100	-	2
	Departmental Assistance		-	6	-	-	-	-	-
TOTAL		15	5	10			1200		24

Electives –II

MIT 10 204 (A) Internal Combustion Engine Design
MIT 10 204(B) Management Information System (common for MIT 10 204(B),CEH10 204(B), PMS 10 204(B))
MIT 10 204(C) Thermal Turbo Machines

Electives –III

MIT 10 205(A) Alternative Fuels for I C Engines
MIT 10 205(B) Design and Analysis of Thermal Systems
MIT 10 205(C) Simulation of I C Engine processes

Semester - III

Code	Subject	Hours per week			Marks			Total Marks	Sem-end exam duration-Hrs	Credits
		L	T	P/D	Intl.		Sem-end			
MIT 10 301	Elective-4	3	1	-	100		100	200	3	4
MIT 10 302	Elective-5	3	1	-	100		100	200	3	4
MIT10 303(P)	*Industrial Training*	-	-	-	50		-	50	-	1
MIT10 304(P)	*Masters Research Project(Phase -I)*	-	-	22	Guide 150	EC* 150	-	300	-	6
TOTAL		6	2	22	500			750		15

NB: The student has to undertake the departmental work assigned by HOD
*EC – Evaluation Committee

Electives –IV

MIT 10 301(A) Advanced Finite Element Methods. (Common to MIT 10 301(A), MPE 10 301(A), CEH 10 301(B))
MIT 10 301(B) Automotive Engine systems.
MIT 10 301(C) Research Methodology. (commonto MIT 10 301(C),CEH 10 301(A), CEE 10 301(A),PMS 10 301(A), EPS 10 301(A), EPE 301(A))

Electives –V

MIT 10 302(A) Industrial Energy Management (common to MIT 10 301(C),MPE 10 301(C))

MIT 10 302(B) Soft Computing Techniques.(common to MIT 10 302(B), EPE 10 302(B), CEH 10 302(B),PMS 10 302(B))
MIT 10 302 (C) Optimization Techniques. (common to MIT 10 301(C),MPE 10 301(C))

Semester - IV

Code	Subject	Hours per week			Internal Marks		Sem-end exam.		Total Marks	Credits
		L	T	P/D	Guide	Evaluation committee	Extl. Guide	Viva-Voce		
MIT10 401(P)	*Masters Research Project (Phase -II)*	-	-	30	150	150	150	150	600	12
TOTAL				30	150	150	150	150	600	12

NB: The student has to undertake the departmental work assigned by HOD

MIT 10 101: APPLIED MATHEMATICS

Teaching scheme: 3 hours lecture and 1 hour tutorial per week **Credits:** 4

Objectives: *To enable the students to apply partial differential equations and transformations in Thermal problems.*

Module I (13 hours)

Vector spaces – Basis – Dimensions – Inner product spaces – Gram-Schmidt process– Linear Transformations – Range and Kernel – Isomorphism – Matrix of Transformations and change of Basis**.**

Module II (13 hours)

Power series solutions about ordinary point – Legendre Equation – Legendre Polynomials – Solution about singular points – The method of frobenius – Bessel equation - Bessel functions – Strum-Liouville problem – Generalized Fourier series .

Module III (13hours)

First order PDE's – Linear equations – Lagrange method – Cauchy method - charpits method – Jacobi method – second order PDE's – Classifications, formulations and method of solutions of wave equation – Heat equation – Laplace equation.

Module IV (13hours)

Line – Volume – Area integrals – Spaces of N dimensions – Coordinate Transformations– Covariant and mixed tensors – Fundamental operation with Tensors – The line element and metric tensor conjugate Tensor – Christoffel's symbols – Covariant derivative.

REFERENCES:

1. Lay D.C; Linear Algebra & its Applications
2. Florey F.G; Elementary Linear Algebra and its Applications, Prentice Hall, 1979.
3. Hoffman K &Kunze R; Linear Algebra, PHI, 1971
4. Sneddon. I; Elements of PDE, MGH, 1985.
5. Spain B; Tensor calculus, 3rd Ed. Oliver & Boyd, 19
6. Ross S.L; Differential equations, 3rd Ed. John Wiley.
7. Bell. W.W; Special Functions for Scientists & Engineers; Dover
8. C.R.Wylie and L.C.Barrett, Advanced Engineering Mathematics. 6th Ed. McGraw Hill.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

Semester end examination: 100 marks

Question pattern:

Answer *ANY* 5 questions by choosing at least *ONE* question from each module. All questions carry equal (20) marks.

Module I	**Module II**	**Module III**	**Module IV**
Question 1: 20 marks Question 2: 20 marks	Question 3: 20 marks Question 4: 20 marks	Question 5: 20 marks Question 6: 20 marks	Question 7: 20 marks Question 8: 20 marks

MIT 10 102: ADVANCED THERMODYNAMICS AND COMBUSTION

Teaching scheme: 3 hours lecture and 1 hour tutorial per week **Credits:** 4

Objectives: *To impart knowledge on various thermodynamic systems, fuels, combustion systems and estimation of pollutant emission.*

Module I: (13 hours)

Introduction to thermodynamics – Equation of states – Properties of gases & gas mixtures – First law of TD – Enthalpy of formation – Heat of reaction – Law of mass action – Fugacity and activity – First law for reaction systems – Second law analysis for reaction systems– Chemical Energy– Stoichiometric & Equivalence ratio – Adiabatic flame temperature

Module II: (13 hours)

Second law of TD – Concept of chemical equilibrium – Gibbs free energy and equilibrium constant of a chemical reaction – Vant Hoff's equation - Calculation of equilibrium composition of a chemical reaction.Thermodynamic availability analysis-Thermodynamic efficiencies-Available energy.

Module III: (13 hours)

Fuels and combustion – Classification of fuels (Detailed) – Basic chemistry- Combustion equations-theoretical & Excess air – Stoichiometric Air – fuel – ratio (A/F) – Air fuel ratio from analysis of products – Analysis of exhaust & flue gases – Calorific value of fuels– Determination of calorific values of solids liquid & gaseous fuels – Actual combustion analysis.

Module IV: (13 hours)

Combustion systems – Modelling – Well stirred & plug flow model – Laminar- turbulent premixed flows – Determination of flow velocity & length– correlations- Flammability limits – uses in gas burner design – Burning of fuel jets – Liquid droplets and sprays– Combustion in fluidized beds – Estimation of pollutant Emission (CO, NO_x, unburned HC) – Emission indices and control measures.

REFERENCES:

1. Engineering Thermodynamics, P K Nag.
2. Engineering Thermodynamics, Dr. M. Achuthan
3. Fuels and Combustion, Sharma &Chandramohan.
4. Thermodynamics & Heat transfer, YunusCengel.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students at the beginning of the semester by the teacher.

Semester end examination: 100 marks

Question pattern:

Answer *ANY* 5 questions by choosing at least *ONE* question from each module.

Module I	**Module II**	**Module III**	**Module IV**
Question 1: 20 marks Question 2: 20 marks	Question 3: 20 marks Question 4: 20 marks	Question 5: 20 marks Question 6: 20 marks	Question 7: 20 marks Question 8: 20 marks

MT 10 103: ADVANCED MECHANICS OF FLUIDS

Teaching scheme: 3 hours lecture and 1 hour tutorial per week **Credits:** 4

Objectives: *To impart knowledge of various basic principles and equations of fluid flow, exact and approximate solutions of Navier-Stokes equations under various flow conditions and introducing concepts in compressible flow normal shock, oblique shock and Fanno flow and Reyleigh flow.*

Module I (13 hours)

Basic equations of fluid flow: Reynold's transport equation-integral and differential formulations-integral form of the equations of continuity-momentum and energy equations-use of integral equations-differential form of these equations-Stoke's postulates and constitutive equations-Navier-Stokes equations and energy equations for Newtonian fluids

ModuleII (13 hours)

Some exact solutions of the Navier-Stokes equations: Couette flows-plane Poiseuille flow-flow between rotating cylinders-Stokes problems-fully developed flow through circular and non circular pipes

Approximate solutions: Creeping flow past a sphere- theory of hydro dynamic lubrication-boundary layer on a flat plate-Blassius solution and use of momentum integral equation

Module III(14 hours)

Introduction to compressible flows:basic concepts-equations for one dimensional flow through stream tubes-speed of sound and Mach number-qualitative difference between incompressible,subsonic and super sonic flows-characteristic velocities-adiabatic flow ellipse

Isentropic flow through a duct: criterion for acceleration and deceleration-stagnation quantities-isentropic relations-use of gas tables-operation of nozzles at off-design conditions.

Normal shocks in one dimensional flow: Occurrence of shocks-analysis of normal shocks-Prandtl's equation-Rankine-Hugoniot equation and other normal shock relations-moving shocks

Module IV (14 hours)

Oblique shocks and expansion waves: oblique shock relations-θ-β-M relations-shock polar-supersonic flow over a wedge-expansion waves-Prandtl-Meyer function-intersection of shocks-detatched shocks-Mach deflection-shock expansion theory

Flow with friction:Fanno lines and Fanno flow relations-effect of friction on properties-choking –isothermal flows.

Flow with heat transfer-Rayleigh lines-effect of heat addition-thermal choking

REFERENCES

1. MuralidharK.&Biswas .G, Advanced Engineering Fluid Mechanics,Narosa Publishing House.
2. RathakrishnanE.,Gas Dynamics,Prentice Hall India
3. Gupta. V & Gupta .S, Fluid Mechanics and its Applications, Wiley Eastern Ltd.
4. White.F.M.,Viscous fluid flow,McGraw Hill
5. Zuckrow.M.J. &Hoffman.D.H.,Gas Dynamics, McGraw Hill

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students at the beginning of the semester by the teacher.

Semester end examination: 100 marks

Question pattern:

Answer *ANY* 5 questions by choosing at least *ONE* question from each module.

Module I	**Module II**	**Module III**	**Module IV**
Question 1: 20 marks Question 2: 20 marks	Question 3: 20 marks Question 4: 20 marks	Question 5: 20 marks Question 6: 20 marks	Question 7: 20 marks Question 8: 20 marks

MIT10 104:ADVANCED HEAT AND MASS TRANSFER

Teaching scheme: 3 hours lecture and 1 hour tutorial per week **Credits:** 4

Objectives: *To enable the students to grasp the principles of Heat and Mass transfer and to apply them to design, analysis and further development of various heat and mass transfer systems/applications.*

Module I (13 hours)

General heat conduction equation in Cartesian, cylindrical and spherical co-ordinates –Composite geometries – Variable thermal conductivity – Uniform heat generation- Extended surfaces - Two and three dimensional heat conduction –Numerical and analytical methods.

Unsteady heat conduction – Lumped heat systems – Infinite and semi- infinite bodies – Numerical and analytical methods – Periodic variation of surface temperature – Moving boundaries.

Module II (13 hours)

Convective heat transfer – Boundary layers – Continuity, momentum and energy equations - Boundary layers equations – Dimensional analysis - Exact and approximate solutions to forced convection in laminar and turbulent, internal and external flow – Reynolds and Colburn analogies – forced convection correlations – Solution to free convection problems - Heat transfer at high velocity and incompressible fluid - Liquid metal heat transfer.

Module III (13 hours)

Radiation heat transfer – Basic laws of radiations – Emissive power – Stefan – Boltzmann, Lambert's, Wien's and Kirchhoff's laws – Emissivity – Radiation intensity -

Radiative exchange between black isothermal surfaces, diffuse grey surfaces - Reflecting surfaces – Radiation shape factor - Shape factor algebra – Radiation shields – Combined convective and radiation – Electrical net work analogy solution – Radiosity – Solar radiation – Radiation from gases and vapours.

Module IV (13 hours)

Heat transfer with phase change – Boiling and Condensation – Flow boiling – Correlations.

Mass Transfer – Concentration, velocities, Mass fluxes Fick's law – Species – Conservation equation – Steady state molecular diffusion, Equimolar counter diffusion, diffusion through a stagnant gas film – Chemical reaction.

Convective mass transfer – Concentration boundary layer – Momentum, mass and heat transfer analogy – Convective mass transfer numbers – Flow over flat plates, flow through tubes – Correlations – Evaporation of water into air – Heat and mass transfer in separated flows.

REFERENCES:

1. Arpaci, V.S., "Conduction Heat Transfer", Addison Wesley, 1966.

2. E.R.G. Eckert and R.M. Drake, “Analysis of Heat Transfer”, McGraw Hill, 1972.
3. E.M. Sparrow, R.D. Cess, “Radiative Heat Transfer”, McGraw Hill, 1972.
4. Holman. J.P, “Heat Transfer”, McGraw Hill.
5. R.C. Sachdeva, “Fundamental of Engineering. Heat and Mass Transfer”, New age International, 2003.
6. Bird R.B and J.R. Howell, “Transport Phenomena” Wiley International, 1960.
7. PatricoOostiuson, “Convective heat and mass Transfer” McGraw Hill
8. Frank P Incropera and David P Dewitt, “ Fundamentals of HMT ” 6^{th} Edition
9. AdsianBejan, “Convective Heat Transfer” Wiley and Sons

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students’ right at the beginning of the semester by the teacher.

Semester end examination: 100 marks

Question pattern:

Answer *ANY* 5 questions by choosing at least *ONE* question from each module. All questions carry equal (20) marks

Module I	**Module II**	**Module III**	**Module IV**
Question 1: 20 marks Question 2: 20 marks	Question 3: 20 marks Question 4: 20 marks	Question 5: 20 marks Question 6: 20 marks	Question 7: 20 marks Question 8: 20 marks

MIT 10 105(A) ENERGY CONSERVATION IN THERMAL SYSTEMS

Teaching scheme: 3 hours lecture and 1 hour tutorial per week **Credits:** 4

Objectives: *To provide knowledge about the following aspects of energy conservation in thermal systems i)details of steam generation and distribution and management ii)thermodynamics and economics of thermal systems iii)thermodynamics analysis of common unit operations iv)principles of waste heat recovery and utilization*

MODULE – I (13 hours)

Definition of energy management-Energy conservation schemes-Optimizing steam usage-Waste heat management-Insulation-Optimum selection of pipe size-Energy conservation in space conditioning-Energy and cost indices-Energy diagrams-Energy auditing-Thermodynamic availability analysis-Thermodynamic efficiencies-Available energy and fuel.

MODULE II (13 hours)

Thermodynamics and economics-Systematic approach to steam pricing-pricing other utilities-Investment optimization-Limits of current technology-Process improvements-Characterizing energy use-Optimum performance of existing facilities-Steam trap principles-Effective management of energy use-Overall site interactions- Total site cogeneration potential-Linear programming approach.

MODULE III (13 hours)

Thermodynamic analysis of common unit operations-Heat exchange-Expansion-Pressure let down-Mixing-Distillation-Combustion air preheating-Systematic design methods-Process synthesis-Application to cogeneration system-Thermo economics-Systematic optimization-Improving process operations-Chemical reactions-Separation-Heat transfer-Process machinery-System interaction and economics.

MODULE IV (13 hours)

Potential for waste heat recovery- Direct utilization of waste heat boilers- Use of heat pumps-Improving boiler efficiency—Industrial boiler inventory.-Use of fluidized beds-Potential for energy conservation-Power economics-General economic problems-Load curves-Selection of plants-Specific economic energy problems-Energy rates.

REFERENCES

1. W.F.Kenney: Energy Conservation in the Process Industries, Academic Press,1984
2. A.P.E.Thummann:Fundamentals of Energy Engiineering ,Prentice Hall,1984
3. M.H.Chiogioji:Industrial Energy Conservation,Marcel Dekker,1979
4. A.P.E.Thummann,Plant Engineers and Managers Guide to Energy conservation,Van Nostrand,1977
5. W.R.Murphy and G.Mc.Kay:Energy Management,Butterworth-Heinemann,2001
6. F.B.Dubin: Energy conservation Standards. McGraw Hill,1978.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students at the beginning of the semester by the teacher.

Semester end examination: 100 marks

Question pattern:

Answer *ANY* 5 questions by choosing at least *ONE* question from each module.

Module I	**Module II**	**Module III**	**Module IV**
Question 1: 20 marks Question 2: 20 marks	Question 3: 20 marks Question 4: 20 marks	Question 5: 20 marks Question 6: 20 marks	Question 7: 20 marks Question 8: 20 marks

MIT 10 105 (B) ENGINE POLLUTION AND CONTROL

Teaching scheme: 3 hours lecture and 1 hour tutorial per week **Credits:** 4

Objectives :

(i) *To create an awareness on the various environmental pollution aspects and issues.*
(ii) *To give a comprehensive insight into the pollution in engine and gas turbines.*
(iii) *To impart knowledge on pollutant formation and control.*
(iv) *To impart knowledge on various emission instruments and techniques.*

Module – I (13 hours)

Pollution in engine and turbines-atmospheric pollution from Automotive and Stationary engines and gas turbines, Global warming – Green house effect and effects of I.C. Engine pollution on environment.

Module III (14 hours)

Pollution formation and emission measurement-Formation of oxides of nitrogen, carbon monoxide, hydrocarbon, aldehydes and Smoke, Particulate emission. Effects of Engine Design - operating variables on Emission formation – Noise pollution. Non dispersive infrared gas analyzer, gas chromatography, chemiluminescentanalyzer and flame ionization detector, smoke meters – Noise measurement and control

Module III (14hours)

Emission control-Engine Design modifications, fuel modification, evaporative emission control, EGR, air injection, thermal reactors, Water Injection, catalytic converters, application of microprocessor in emission control. Common rail injection system, Particulate traps, NOx converters, SCR systems. GDI and HCCI concepts.

Module IV (13hours)

Driving cycle and emission standards-Transient dynamometer, Test cells, Driving cycles for emission measurement, chassis dynamometer, CVS system, National and International emission standards.

REFERENCES :

1. Crouse William, Automotive Emission Control, Gregg Division /McGraw-Hill,1980
2. Ernest,S., Starkman, Combustion Generated Air Pollutions, Plenum Press, 1980.
3. George Springer and Donald J.Patterson, Engine emissions, Pollutant Formation and Measurement, Plenum press, 1972.
4. Obert, E.F., Internal Combustion Engines and Air Pollution, Intext Educational

Publishers, 1980.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students at the beginning of the semester by the teacher.

Semester end examination: 100 marks

Question pattern:

Answer *ANY* 5 questions by choosing at least *ONE* question from each module.

Module I	**Module II**	**Module III**	**Module IV**
Question 1: 20 marks Question 2: 20 marks	Question 3: 20 marks Question 4: 20 marks	Question 5: 20 marks Question 6: 20 marks	Question 7: 20 marks Question 8: 20 marks

MIT 10 105(C) DIRECT ENERGY CONVERSION SYSTEMS

Teaching scheme: 3 hours lecture and 1 hour tutorial per week **Credits:** 4

Objective: *To impart detailed knowledge about various types of energy conservation systems and their principles of operation.*

Module 1(13hours)

Basic science of energy conversion – Orderly and disorderly energy - Reversible and irreversible engines – Analysis of basically reversible engines – Duality of matter – Thermoelectric vs photoelectric phenomena – Basic thermoelectric engine – Thermoelectric materials – Applications.

ModuleII (13hours)

Physics of solar photovoltaic cells – Production of solar cells – Design concept of PV cell systems – Solar cells connected in series and parallel – Voltage regulation and energy storage – Centralized and decentralized PV systems – Maintenance of PV systems – Current developments.

Module III (14hours)

Thermionic emission – Richardson's equation – Analysis of high vacuum thermionic converter – Gaseous converters – Introduction to MHD generators – Seeding and ionisation in MHD generators – Analysis of MHD engines and MHD equations – Conversion efficiency and electrical losses in MHD power generation systems.

Module IV(14hours)

Definition ,general description , types, design and construction of fuel cells – Thermodynamics of ideal fuel cells – Practical considerations - Present status – Future energy technologies – Hydrogen energy - Nuclear fusion.

REFERENCES

1. S.S.L Chang: Energy Conversion, Prentice Hall, 1963
2. G. W. Sutton: Direct Energy Conversion, McGraw Hill, 1966
3. S.L. Soo: Direct Energy Conversion, Prentice Hall ,1968
4. S.W.Angrist: Direct Energy Conversion,4e,Allwyn & Bycon,1982
5. D.Merick and R.Marshall: Energy,Present and future options,VolI&II,John Wiley,1981
6. B.Sorenson: Renewable Energy, Academic Press,1989
7. N.B.Breiter: Electro chemical Processes in fuel cells ,Spring-Verlag,1969.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students at the beginning of the semester by the teacher.

Semester end examination: 100 marks

Question pattern:

Answer *ANY* 5 questions by choosing at least *ONE* question from each module.

Module I	**Module II**	**Module III**	**Module IV**
Question 1: 20 marks Question 2: 20 marks	Question 3: 20 marks Question 4: 20 marks	Question 5: 20 marks Question 6: 20 marks	Question 7: 20 marks Question 8: 20 marks

MIT10 106(P): INTERNAL COMBUSTION ENGINE LABORATORY

Teaching scheme: 2 hours practical per week **Credits:** 2

Objective: *To build knowledge about the parameters affecting the performance of I C engines and turbo machineries. To get experience in the analysis of exhaust gas emission and it's controlling.*

LIST OF EXPERIMENTS

1. Assembly of Engine and its Components
2. Performance, Combustion and Emission Studies on S.I. Engine fuelled with alternative fuels
3. Performance, combustion and Emission Studies on C.I. Engines fuelledwith alternative fuels.
4. Study on the effect of varying fuel injection pressure and fuel injection Timing on the engine Performance, Combustion and Emission
6. Study on the effect of preheating air and fuel on the Performance, Combustion and Emission characteristics
7. Study of construction and principle of operation of Emission/Smoke analyzers
8. Performance studies on Turbo machines.

LABORATORY EQUIPMENTS

1. S.I Engine Components
2. C.I Engine Components
3. Single/ Multicylinder S.I. Engine
4. Single/ Multicylinder C.I. Engine
5. HC/CO Analyser
6. NOx Analyser
7. Smoke Meter
8. Pressure Transducer
9. Charge Amplifier

MIT10 107(P): SEMINAR

Teaching scheme: 2 hours per week **Credits:** 2

Objective: *To assess the debating capability of the student to present a technical topic. Also to impart training to a student to face audience and present his ideas and thus creating in him self esteem and courage that are essential for an engineer.*

- Individual students are required to choose a topic of their interest from IC Engines and Turbo Machinery related topics preferably from outside the M.Tech syllabus and give a seminar on that topic about 30 minutes. A committee consisting of at least three faculty members (preferably specialized in Production engineering) shall assess the presentation of the seminar and award marks to the students. Each student shall submit two copies of a write up of his / her seminar topic. One copy shall be returned to the student after duly certifying it by the Chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.

- **Internal continuous assessment: 100 marks**

  Evaluation shall be based on the following pattern:

Report	=	50 marks
Concept/knowledge in the topic	=	20 marks
Presentation	=	30 marks
Total marks	=	100 marks

MIT 10 201: COMBUSTION AND EMISSION OF I C ENGINES

Teaching scheme: 3 hours lecture and 1 hour tutorial per week **Credits:** 4 .

OBJECTIVE :

(i) Understand combustion in spark ignition and diesel engines.

(ii) To identify the nature and extent of the problem of pollutant formation and Control in internal combustion engines government legislation.

Module 1 (13 hours.)

COMBUSTION PRINCIPLES : Combustion – Combustion equations, heat of combustion - Theoretical flame temperature - chemical equilibrium and dissociation - Theories of Combustion - Pre-flame reactions - Reaction rates - Laminar and Turbulent Flame Propagation in Engines.

Module II (13 hours.)

COMBUSTION IN S.I. ENGINE: Initiation of combustion, stages of combustion, normal and abnormal combustion, knocking combustion, pre-ignition, knock and engine variables, features and design consideration of combustion chambers. Flame structure and speed, Cycle by cycle variations, Lean burn combustion, stratified charge combustion systems. After treatment devices for SI engines.

Module III (13 hours.)

COMBUSTION IN C.I. ENGINE : Stages of combustion, vaporization of fuel droplets and spray formation, air motion, swirl measurement, knock and engine variables, features and design considerations of combustion chambers, delay period correlations, heat release correlations, Influence of the injection system on combustion. Direct and indirect injection systems. After treatment devices for diesel engines.

Module IV (13 hours.)

EMISSIONS : Main pollutants in engines, Kinetics of NO formation, NOx formation in SI and CI engines. Unburned hydrocarbons, sources, formation in SI and CI engines, Soot formation and oxidation, Particulates in diesel engines, Emission control measures for SI and CI engines, Effect of emissions on Environment and human beings.

<u>REFERENCES:</u>

1. Ramalingam, K.K., Internal Combustion Engines, Scitech Publications (India) Pvt. Ltd., 2004.
2. Ganesan, V, Internal Combustion Engines, Tata McGraw Hill Book Co., 2003.
3. John B.Heywood, Internal Combustion Engine Fundamentals,McGraw Hill Book, 1998
4 Mathur,M.L., and Sharma,R.P., A Course in Internal Combustion Engines, DhanpatRai Publications Pvt. New Delhi-2, 1993.
5 Obert,E.F., Internal Combustion Engine and Air Pollution, International Text Book Publishers, 1983.
6 Cohen,H, Rogers,G,E.C, and Saravanamuttoo, H.I.H., Gas Turbine Theory, Longman Group Ltd., 1980.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students at the beginning of the semester by the teacher.

Semester end examination: 100 marks

Question pattern:

Answer *ANY* 5 questions by choosing at least *ONE* question from each module.

Module I	**Module II**	**Module III**	**Module IV**
Question 1: 20 marks Question 2: 20 marks	Question 3: 20 marks Question 4: 20 marks	Question 5: 20 marks Question 6: 20 marks	Question 7: 20 marks Question 8: 20 marks

MIT 10 202: COMPUTATIONAL FLUID DYNAMICS

Teaching scheme: 3 hours lecture and 1 hour tutorial per week **Credits:** 4

Objective: *To impart knowledge on Computational Fluid Dynamics and Finite Volume Method for Unsteady flow**.***

Module I(13 hours)

Philosophy of Computational Fluid Dynamics, Forms of Governing equations particularly suitable for CFD , Mathematical behavior of Partial Differential Equations – Hyperbolic equations – Parabolic equations – Elliptical equations.

Module II(13 hours)

Discretization – Introduction to finite differences- Difference equations – Explicit and Implicit approaches-stability – Simple CFD Techniques- Lax-Wendroff – Mac Cormack's – Viscous flow-Conservation form – Space marching- The Relaxation Technique – Pressure correction – Stream function, Vorticity method of solution.

Module III(13 hours)

Finite Volume Method – One Dimensional steady state diffusion – Two and Three Dimensional diffusion problems – One Dimensional steady convection & diffusion – Central differencing scheme – Upwind differencing scheme – QUICK scheme – SIMPLE, SIMPLER, SIMPLEC, PISO

Module IV(14 hours)

Finite Volume Method for Unsteady flow – One Dimensional Steady heat conduction – Explicit scheme – Crank-Nicholson scheme – Fully implicit scheme – Turbulence models- K- εmodel –Reynolds stress equation model.

REFERENCES

1. John D Anderson Jr - "Computational Fluid Dynamics"– McGraw Hill
2. H.K Versteeg& W Malalasekera - "An Introduction to Computational Fluid Dynamics"–
3. S.V. Patankar Hemisphere - "Numerical Fluid Flow & Heat transfer"
4. HoftmanKlaw Vol-1 & 2 " Computational Fluid Dynamics"
5. T. Sundernajan- Narosa "Computational Fluid Flow and Heat Transfer"

6. Anderson, Tunne Hill and Pletcher "Computational Fluid Flow and Heat Transfer"

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students at the beginning of the semester by the teacher.

Semester end examination: 100 marks

Question pattern:

Answer *ANY* 5 questions by choosing at least *ONE* question from each module.

Module I	**Module II**	**Module III**	**Module IV**
Question 1: 20 marks Question 2: 20 marks	Question 3: 20 marks Question 4: 20 marks	Question 5: 20 marks Question 6: 20 marks	Question 7: 20 marks Question 8: 20 marks

MIT 10 203: PLANT MAINTENANCE & SAFETY

(Common to MIT 10 203, MPE 10 203)

Teaching scheme: 3 hours lecture and 1 hour tutorial per week **Credits:** 4

Objectives: *To understand types of maintenance, concepts of various corrosions, failure data analysis and the concept of safety and measurement of safety performance.*

Module I (16 hours)

Types of Maintenance – Break down, Routine, Planned, Preventive, Diagnostic Maintenance. Condition Monitoring – Principles and methods . Contaminant monitoring, Spectral Oil Analysis Procedure, Ferrography. Vibration Monitoring and Analysis – Transducer selection, Frequency analysis. Condition Monitoring of Rolling Element Bearing.

Module II (12 hours)

Basic concepts of Corrosion, Forms of Corrosion, Corrosion Testing, Corrosion Monitoring Techniques, Corrosion Prevention. Industrial Lubrication, Selection of Lubricant, Lubrication Systems.

Module III (12 hours)

Reliability, Availability, Maintainability. Failure Data Analysis. MTTF, MTTR, Fault Tree Analysis, FMEA, FMECA. Reliability estimation.

Module IV (12 hours)

Introduction to the concept of safety-Need-safety provisions in the factory Act-Laws related to the industrial safety-Measurement of safety performance, Safety Audit, Work permit system, injury and accidents-Hazards, types of industrial hazards-nature, causes and control measures, Threshold limit values, Logics of consequence analysis-Estimation-Toxic release and Fire hazard, Emergency planning and preparedness.

<u>REFERNCES:</u>

1 R.A.Collacot – *Mechanical Fault Diagnosis and Condition Monitoring*. Chapman & Hall, London.
2. Mars G. Fontana – *Corrosion Engineering*. McGraw-Hill
3. L.S.Srinath – *Reliability Engineering*. Affiliated East West Press
4. Thomas J. Anton, *Occupational Safety and Health Management,* McGraw Hill.
5. Ian T.Cameron& Raghu Raman, *Process Systems Risk Management*, ELSEVIER Academic press.
6. Lees F.P, *Loss Prevention in Process Industries*, Butterworths, New Delhi.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students at the beginning of the semester by the teacher.

Semester end examination: 100 marks

Question pattern:

Answer *ANY* 5 questions by choosing at least *ONE* question from each module.

Module I	**Module II**	**Module III**	**Module IV**
Question 1: 20 marks Question 2: 20 marks	Question 3: 20 marks Question 4: 20 marks	Question 5: 20 marks Question 6: 20 marks	Question 7: 20 marks Question 8: 20 marks

MIT 10 204 (A) INTERNAL COMBUSTION ENGINE DESIGN

Teaching scheme: 3 hours lecture and 1 hour tutorial per week **Credits:** 4

OBJECTIVE :*To gain knowledge on the principles and procedure for the design of engine components.*

Module I (13 hours)
General Consideration in engine design, Choice of material, stress and fatigue considerations, design for manufacture, Noise, Vibration and Harshness.**Pi**ston system, Power cylinder system, connecting rod assembly, crankshaft system, valve gearing, stress analyses.

Module II (13 hours)
Design of engine components, Inlet and exhaust manifolds, cylinder block, cylinder-head, crankcase, engine foundations and mountings, gaskets, bearings, flywheel, turbocharger, supercharger, computer controlled fuel injection system, Basics of ignition, lubrication and cooling system design.

Module III (13 hours)
Design of two stroke engines, arrangement and sizing of ports, piston assembly, intake and exhaust system, scavenging, application to automotive gasoline and marine diesel engines.

Module IV (13 hours)
Design of pollution control equipment, introduction to design of catalytic converters, particulate traps and EGR systemsPreparation of working drawings of designed components using CAD system.

REFERENCES :

1. Gordon P.Blair, Basic Design of Two-stroke Engines, S.A.E., 1992.
2. Gordon P.Blair, Advanced Concepts of Two-stroke Engines, S.A.E., 1990.
3. Pounder, C.C., Marine Diesel Engines, Butterworths, 1981.
4. A.Kolchin and V.Demidov, Internal Combustion Engine Design, MIR Publishers, Moscow, 1984.
5. Gordon P.Blair, Design and Simulation of Four-Stroke Engines, Society of Automotive Engineers, Inc., USA, 1999.
6. D.E.Winterbone and R.J.Pearson, Design Techniques for Engine Manifolds, Wave action methods for I.C.Engines, Professional Engineering Publishing Ltd., UK, 2000.
7. John Fenton (Editor), Gasoline Engine Analysis for Computer Aided Design, Mechanical Engineering Publishing Ltd., UK, 1986.
8. RodicaBaranescu and Bernard Challen (Editors), Diesel Engine Reference Book, Second Edition, Society of Automotive Engineers, Inc., USA, 1999.
9. SAE Special Publication SP-700, Adiabatic Engines and Systems, Society of

   Automotive Engineers, Inc., USA, 1987.

.**Internal continuous assessment: 100 marks**

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students at the beginning of the semester by the teacher.

Semester end examination: 100 marks

Question pattern:

Answer *ANY* 5 questions by choosing at least *ONE* question from each module.

Module I	**Module II**	**Module III**	**Module IV**
Question 1: 20 marks Question 2: 20 marks	Question 3: 20 marks Question 4: 20 marks	Question 5: 20 marks Question 6: 20 marks	Question 7: 20 marks Question 8: 20 marks

MIT 10 204 (B): MANAGEMENT INFORMATION SYSTEM
(Common to MIT 10 204 (B),MPE 10 204(B), CEH 10 204(B), PMS 10 204(B))

Teaching scheme: 3 hours lecture and 1 hour tutorial per week **Credits:** 4

Objectives:-*To provide knowledge on different types of Information systems and their applications in industry.*

Module – 1 (13 Hrs.)

The Concept of MIS - Role of MIS - Characteristic of MIS - Functional Subsystems - Activities Subsystems Pre-requisites of MIS-Contemporarily Approaches to MIS-Technical Approach, Behavioral Approach,-Socio-technical Approach, Technical Approach-Information as Strategic Resource-Use of Information for Complete Advantage.

Module – 2 (14 Hrs.)

Evolution of Computers-Computer Hardware-Generation of Computers-Complete Categories - Software - System Software, Application Software-Data Communication - Data Processing-Transaction Processing-Data Processing Modes-Data Transmission-Functions of Telecommunication- Communication-Transmission Channel- Characteristic of Communication Channel- Network - Topologies, Types of Networks, OSI, TCP/IP-Internet -Internal, External, ISDN - Multimedia-IT Enabled Services - SPO, Call Centers, MT, GIS-Information.

Module – 3 (14 Hrs.)

Management-Decision Making - Decision Types, Decision Making Process,-Decision Making Tools, Principle of Rationality, Principle of Logic & Interaction-Decision Making Models - Classical Model, Administrative-Model, Herbert, Simon Model-Information - Sources of Information, Types of Information, Information requirements, Techniques for Assessing-Information Requirements - Systems Analysis and Design-System-Types, Characteristics-Control- Control Process, Requirements of Good Control-System, Control System-Law of Requisite Variety-Systems Development-System Analysis, System Design, System Implementation, System Development Process-System Development Life Cycle-Rapid System Development Tools - Prototyping, CASE Tools, Object Oriented Systems 4 Decision Support System-The Decision Support System - Components, Characteristics, Structure -Group Decision Support System-Configuration, Features-Executive Information System / Executive Support System-Definition, Characteristic, Capabilities, Benefits-Expert System-Artificial intelligence Database Management System-DBMS Components-Database Model.

Module – 4 (13 Hrs.)

Data Warehousing & Data Mining-Data Warehousing Definition, Structure / Architecture-Data Mining - Information Security and Control-Information System Security Threats-External & Internal Threats Information System and Quality-Quality Assurance-Software Quality Assurance-Management Role in Software Quality Assurance -Quality Assurance Methods - Quality Profile Model, Construction Quality Model, Tick IT, Initiative-Functional applications of MIS -Stores & Purchase Management-Accounts Payable System-Inventory Management-Production Management System -Marketing Service System-Applications in Service Sector-MIS Application in Service Industry-Airlines, Hospital, Banking.

REFERENCES:

1) Jerome Kanter – Managing with Information
2) Gordon B. Davis and Alson – Management Information Systems
3) Robert C Murdick Joel E Ross and James R Clagget – Information Systems for Modern management
4) Henry c Lucas Jr. – The Analysis Design and Implementation of Management Information Systems.
5) Kickson and Wheterbe – Management Information Systems.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students at the beginning of the semester by the teacher.

Semester end examination: 100 marks

Question pattern:

Answer *ANY* 5 questions by choosing at least *ONE* question from each module.

Module I	**Module II**	**Module III**	**Module IV**
Question 1: 20 marks Question 2: 20 marks	Question 3: 20 marks Question 4: 20 marks	Question 5: 20 marks Question 6: 20 marks	Question 7: 20 marks Question 8: 20 marks

MIT 10 204 (C) THERMAL TURBOMACHINES

Teaching scheme: 3 hours lecture and 1 hour tutorial per week **Credits:** 4

Objective: *To familiarize the students to the principles and operations of Turbo-machines so as to enable them to take up the Design, analysis and development of such systems.*

Module I(13 hours)

Equation of motion in Cartesian and cylindrical co-ordinates – Absolute potential flow – Potential and stream functions – Vorticity, circulation, rotational and irrotational flows – Two and three dimensional flows in turbo-machines.

Flow through cascade of blades, Annular, radial and compressor and turbine cascades – Cascade tunnel – Cascade performance, variables and losses – Blade forces – Performance parameters of compressible machines.

Module II (13 hours)

Incompressible fluid machines – Theory of centrifugal pumps – Ideal torque equation – pressure rise – Circulatory flow – Effect of blade angle, number of blade, speed and diameter – Losses – Cavitation, NPSH, Surging. Design of radial stage impeller – Simple curvature blades – Design of volutes and diffusers – Francis type impeller – Blade twist.

Axial flow pumps – Experimental design factors – Aerofoil theory of design.

Module III(13 hours)

Centrifugal fans and blowers – Compressibility – Stage parameters – Volutes and diffusers – Losses – Design parameters – Design calculations for impeller, volute and diffusers.

Centrifugal compressors – stage velocity triangles – Blade shapes – Enthalpy –entropy diagrams – Analysis of flow in impeller and diffuser – slip factor – stage losses – Degree of reaction – Performance characteristics – Surging and choking – Multistage compressors.

Module IV (13 hours)

Axial flow compressors – velocity triangles - Enthalpy –entropy diagrams – Blade loading, stage losses and efficiencies – Degree of reaction – Varying reaction stage – Flow through rotor and stator blade rows – Work done factor – Radial equilibrium – supersonic and transonic stages – Performance characteristics of design operation – Surging and stalling.

Axial and radial flow turbines – Stage velocity triangles – Velocity and pressure compounding – reaction stages – Losses and efficiencies – Performance characteristics – Manufacture of blades – Blade fixing – High temperature cooled turbines – Blade cooling.

REFERENCES

1. D.G. Sheperd, "Principles of turbomachinery", The Macmillan Company, New York.

2. A. H. Church and JagadishLal, "Centrifugal Pumps and Blowers", Metropolitan Book Co. 1973
3. A.J. Stepanoff, "Centrifugal and Axial Flow Pumps", Wiley & sons, 1966.
4. J.H. Horlock, "Axial Flow Compressors", Butter worths Scientific Publications, 1958.
5. S.M. Yahya, "Turbine, Compressors and Fans", Tata McGraw Hill Co. New Delhi, 1998.
6. V. Ganesan, "Gas Turbines", Tata McGraw Hill Co. New Delhi, 2001.
7. M.H.Vavra, "Aerothermodynamics and Flow in Turbomachines"

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to student's right at the beginning of the semester by the teacher.

Semester end examination: 100 marks

Question pattern:

Answer *ANY* 5 questions by choosing at least *ONE* question from each module. All questions carry equal (20) marks.

Module I	**Module II**	**Module III**	**Module IV**
Question 1: 20 marks Question 2: 20 marks	Question 3: 20 marks Question 4: 20 marks	Question 5: 20 marks Question 6: 20 marks	Question 7: 20 marks Question 8: 20 marks

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students at the beginning of the semester by the teacher.

Semester end examination: 100 marks

Question pattern:

Answer *ANY* 5 questions by choosing at least *ONE* question from each module.

Module I	**Module II**	**Module III**	**Module IV**
Question 1: 20 marks Question 2: 20 marks	Question 3: 20 marks Question 4: 20 marks	Question 5: 20 marks Question 6: 20 marks	Question 7: 20 marks Question 8: 20 marks

MIT 10 205(A) ALTERNATIVE FUELS FOR I C ENGINES

Teaching scheme: 3 hours lecture and 1 hour tutorial per week **Credits:** 4

OBJECTIVE:

(i) *Gain a working understanding of the engineering issues and perspectives affecting fuel and engine development.*
(ii) *Examine future trends and development, including hydrogen as an internal combustion engine fuel.*
(iii) *Explore further fuel specification and performance requirements for advanced combustion systems.*

Module I (13 hours)
Availability and Suitability and properties of Potential Alternative Fuels – Ethanol, Methanol, DEE, DME, Hydrogen, LPG, Natural Gas, Producer Gas, Bio gas and Bio-diesel, Properties, Merits and Demerits.

Module I (13 hours)
Requirements of fuels for SI engines-Different Techniques of utilizing alternative liquid fuels– Blends, Neat form, Reformed Fuels - Manufacturing, Storage and Safety-Performance and Emission Characteristics of alternative liquid fuels.

Module I (13 hours)

Requirements of fuels for CI engines- Different Techniques for their utilization- Blends, Fuel modifications to suit CI engines, Neat fuels, Reformed fuels, Emulsions, Dual fuelling, Ignition accelerators and other additives– Performance and emission characteristics.

Module I (13 hours)
Use of Hydrogen, CNG, LPG, Natural Gas, Producer gas and Bio gas in SI engines– Safety Precautions – Engine performance and emissions. Use of Hydrogen, Producer Gas, Biogas, LPG, Natural gas, CNG in CI engines. Dual fuelling, Performance and emission characteristics.

REFERENCES :

1. Osamu Hirao and Richard K.Pefley, Present and Future Automotive Fuels, John Wiley and Sons, 1988.

2. Keith Owen and Trevor Eoley, Automotive Fuels Handbook, SAE Publications,1990.

3. Richard L.Bechtold, Automotive Fuels Guide Book, SAE Publications, 1997.

4.Automotive Lubricants Reference Book, Second Edition, Roger F. Haycock and John E. Hillier, SAE International Publications, 2004.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students at the beginning of the semester by the teacher.

Semester end examination: 100 marks

Question pattern:

Answer *ANY* 5 questions by choosing at least *ONE* question from each module.

Module I	**Module II**	**Module III**	**Module IV**
Question 1: 20 marks Question 2: 20 marks	Question 3: 20 marks Question 4: 20 marks	Question 5: 20 marks Question 6: 20 marks	Question 7: 20 marks Question 8: 20 marks

MIT 10 205(B) DESIGN AND ANALYSIS OF THERMAL SYSTEMS

Teaching scheme: 3 hours lecture and 1 hour tutorial per week **Credits:** 4

Objective:*To impart knowledge about*

(i) The fundamentals of thermal systems design.
(ii) Design of various types of heat exchanger system, pumping system and their analysis.
(iii) Modelling and simulation of various types of thermal systems.

Module – I (9 hours)

Engineering design fundamentals – Design of a workable systems – curve fitting – design optimization – knowledge based system design - economic analysis

Module II (8 hours)

Heat exchanger design – evaporators and condensers. Temperature, concentration and pressure characteristics of binary solutions. Rectifiers. Cooling towers – pressure drop and pumping power

Module III (12 hours)

Modeling and simulation principle – Hardy-Cross method – multi-variable Newton-Raphson simulation method. Simulation of gas turbine system. Simulation using differential equations. Mathematical modeling of thermodynamic properties. Steady state simulation of large systems. Dyanamicbehavior of large thermal systems

Module IV (10 hours)

Pump characteristics – manufacturer's specifications – relationship among performance characteristics. Pump system operation – cavitation prevention – other system considerations. Fans and nozzles

REFERENCES

1. Y. Jaluria, Design and Optimization of Thermal Systems, McGraw Hill, 1998
2. R.F. Boehm, Design and analysis of Thermal Systems, John Wiley, 1987
3. A. Bejan, Thermal Design and Optimization, John Wiley, 1995
4. W.F. Stoeker, Design of Thermal Systems, 3rd Edition, McGraw Hill, 1989
5. W.J. Gajda, and W.E. Biles, Engineering Modeling and Computation, Houghton Miffin, 1980

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students at the beginning of the semester by the teacher.

Semester end examination: 100 marks

Question pattern:

Answer *ANY* 5 questions by choosing at least *ONE* question from each module.

Module I	**Module II**	**Module III**	**Module IV**
Question 1: 20 marks Question 2: 20 marks	Question 3: 20 marks Question 4: 20 marks	Question 5: 20 marks Question 6: 20 marks	Question 7: 20 marks Question 8: 20 marks

MIT 10 205 (C): SIMULATION OF I C ENGINE PROCESESS

Teaching scheme: 3 hours lecture and 1 hour tutorial per week **Credits:** 4

OBJECTIVE : *To learn the simulation of engine combustion based on first and second law of thermodynamics.*

Module I (13 hours)

Simulation principles-First and second laws of thermodynamics – Estimation of properties of gas mixtures - Structure of engine models – Open and closed cycle models - Cycle studies,Chemical Reactions, First law application to combustion, Heat of combustion – Adiabatic flame temperature, Chemical Equilibrium and calculation of equilibrium composition - – Heat transfer in engines – Heat transfer models for engines.

Module II(13 hours

Simulation in S I engine -Combustion in SI engines, Flame propagation and velocity, Single zone models – Multi zone models – Mass burning rate, Turbulence models – One dimensional models – Chemical kinetics modeling – Multidimensional models.

Module III (13 hours)

Simulation in C I engine Combustion in CI engines Single zone models – Premixed-Diffusive models – Wiebe' model – Whitehouse way model, Two zone models - Multizone models- Meguerdichian and Watson's model, Hiroyasu's model, Lyn's model – Introduction to Multidimensional and spray modeling

Module IV (13 hours)

Thermodynamics of the gas exchange process - Flows in engine manifolds – One dimensional and multidimensional models, Flow around valves and through ports Models for scavenging in two stroke engines – Isothermal and non-isothermal models.

REFERENCES :

1. Ashley S. Campbell, Thermodynamic Analysis of Combustion Engines, John Wiley and Sons, 1980.
2. V.Ganesan, Computer Simulation of Spark Ignition Engine Processes, Universities Press, 1995.
3. V.Ganesan, Computer Simulation of Compression Ignition Engine Processes, Universities Press, 2002..
4. Gordon P. Blair, The Basic Design of two-Stroke engines, SAE Publications, 1990.
5. Horlock and Winterbone, The Thermodynamics and Gas Dynamics of Internal Combustion Engines, Vol. I & II, Clarendon Press, 1986.
6. J.I.Ramos, Internal Combustion Engine Modeling, Hemisphere Publishing Corporation, 1989.
7. J.N.Mattavi and C.A.Amann, Combustion Modeling in Reciprocating Engines, Plenum Press, 1980.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students at the beginning of the semester by the teacher.

Semester end examination: 100 marks

Question pattern:

Answer *ANY* 5 questions by choosing at least *ONE* question from each module.

Module I	**Module II**	**Module III**	**Module IV**
Question 1: 20 marks	Question 3: 20 marks	Question 5: 20 marks	Question 7: 20 marks
Question 2: 20 marks	Question 4: 20 marks	Question 6: 20 marks	Question 8: 20 marks

MIT 10 206 (P): SEMINAR

Teaching scheme: 2 hours per week **Credits:** 2

Objectives: *To assess the debating capability of the student to present a technical topic. Also to impart training to a student to face audience and present his ideas and thus creating in him / herself esteem and courage that are essential for an engineer.*

- Individual students are required to choose a topic of their interest from IC Engines and Turbo Machinery related topics preferably from outside the M.Tech syllabus and give a seminar on that topic about 30 minutes. A committee consisting of at least three faculty members (preferably specialized in Production engineering) shall assess the presentation of the seminar and award marks to the students. Each student shall submit two copies of a write up of his / her seminar topic. One copy shall be returned to the student after duly certifying it by the Chairman of the assessing committee and the other will be kept in the departmental library. Internal continuous assessment marks are awarded based on the relevance of the topic, presentation skill, quality of the report and participation.
- **Internal continuous assessment: 100 marks**

Evaluation shall be based on the following pattern:

Report	=	50 marks
Concept/knowledge in the topic	=	20 marks
Presentation	=	30 marks
Total marks	=	100 marks

MIT 10 207 (P): MINI PROJECT

Teaching scheme: 2 hours per week **Credits:** 2

Objectives:

- *To practice the steps involved for the selection, execution, and reporting of the project.*
- *To train the students for group activities to accomplish an engineering task.*

Individual students are required to choose a topic of their interest. The subject content of the mini project shall be from emerging /thrust areas, topics of current relevance having research aspects or shall be based on industrial visits. At the end of the semester, the students should submit a report duly authenticated by the respective guide, to the head of the department.

Mini Project will have internal marks 50 and Semester-end examination marks 50. **Internal marks** will be awarded by respective guides as per the stipulations given below.

- Attendence, regularity of student (20 marks)
- Individual evaluation through viva voce / test (30 marks)

Total (50 marks)

Semester End examination will be conducted by a committee consisting of three faculty members. The students are required to bring the report completed in all respects duly authenticated by the respective guide and head of the department, before the committee. Students individually will present their work before the committee. The committee will evaluate the students individually and marks shall be awarded as follows.

- Report = 25 marks
- Concept/knowledge in the topic = 15 marks
- Presentation = 10 marks
- Total marks = 50 marks

MIT 10 301(A):ADVANCED FINITE ELEMENT METHODS
(Common to MIT 10 301(A), MPE 10 301(A), CEH 10 301(B))

Teaching scheme: 3 hours lecture and 1 hour tutorial per week **Credits:** 4

Objectives

- *To master linear finite element procedures and programming techniques.*
- *To understand the basic mathematics of finite element analysis and equip the students to formulate finite element procedures for engineering problems.*
- *To train the students in structural, thermal and flow analysis problems using finite element software.*
- *To introduce finite element procedures and programming techniques for non-linear and transient problems.*

Pre-requisites

- *A basic knowledge of Partial differential equations, Structural Mechanics, Heat transfer, Fluid Mechanics and Elementary Finite Element Method.*

Module I (14 hours)

Introduction – review ofcomputational procedures with 1D elements – interpolation and shape functions – 2D elements – simple solid elements – element matrices for structural mechanics, heat transfer and fluid flow problems – choice of interpolation functions - convergence and completeness conditions – modelling considerations – symmetry - applications.

Module II (14 hours)

Isoparametric formulation – 1D and 2D elements – numerical integration – choice in numerical integration – patch test. Coordinate transformation – transformation of characteristic matrix – transformation of restraint directions. Imposition of constraints – Lagrange multiplier and penalty function methods. Error – sources of error – ill conditioning – convergence – error estimates.

Module III (13 hours)

Boundary value problems – weak and strong forms – functionals – Euler-Lagrange equations – Rayleigh-Ritz method – finite element formulation from a functional.Weighted-residual methods – Gelerkin, least-square and collocation methods – Gelerkin finite element formulation – applications to structural, thermal and fluid flow problems.

Module IV (13 hours)

Finite element formulation for non-linear problems – solution methods - Newton-Raphson method – modified Newton-Raphson method – convergence criteria – applications.Transient finite element procedures – FE equations and matrices - integration techniques –applications. Introduction to coupled analyses (fluid-structure interaction, thermo-mechanical problems) and contact problems.

<u>REFERENCES:</u>

1. R. D. Cook, D. S. Malkus, M. E. Plesha, R. J. Witt, *Concepts & Applications of Finite Element Analysis*, John Wiley & Sons
2. D. V. Hutton, *Fundamentals ofFinite Element Analysis*, TataMcGraw Hill
3. S. S. Rao, *The Finite Element Method in Engineering*, Butterworth Heinemann

4. J. N. Reddy, *An Introduction to the Finite Element Method,* McGraw Hill International Edition
5. K. J. Bathe, *Finite Element Procedures in Engineering Analysis,* Prentice Hall of India
6. O. C. Zienkiewics, R. L. Taylor, *The Finite Element Method,* Vol I & II, McGraw Hill
7. H. C. Huang, A. S. Usmani, *Finite Analysis for heat transfer*, Springler-Verlag, London.
8. D. R. J. Owen, Earnest Hinton, *Finite Elements in Plasticity, Theory & Practice*, Pineridge Press
9. G. W. Rowe, C. E. N. Sturgess, P. Hartley, I.Pillinger, *Finite Element Plasticity and Metal Forming Analysis*, Cambridge University Press, UK
10. Ted Belytschko, Wing Kam Liu, Brain Moran, *Non-linear Finite Elements for Continua and Structures*, John Wiley & Sons Ltd.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students at the beginning of the semester by the teacher.

Semester end examination: 100 marks

Question pattern:

Answer *ANY* 5 questions by choosing at least *ONE* question from each module.

Module I	**Module II**	**Module III**	**Module IV**
Question 1: 20 marks Question 2: 20 marks	Question 3: 20 marks Question 4: 20 marks	Question 5: 20 marks Question 6: 20 marks	Question 7: 20 marks Question 8: 20 marks

MIT 10 301 (B): AUTOMOTIVE ENGINE SYSTEM

Teaching scheme: 3 hours lecture and 1 hour tutorial per week **Credits:** 4

OBJECTIVE:

(i) To impart knowledge on various automotive engine types and its performance characteristics.
(ii) To impart knowledge on fuel and fuel systems.
(iii) To impart knowledge on current trends in engine technology.

Module I (13 hours)

Automotive Engine Types – On-highway, Off-highway, Gasoline, Diesel and Alternate Fueled. Characteristics of Automotive Engines – Power, Torque, Fuel Consumption, Pollutant Emissions, Thermal Efficiency, Life Cycle Cost.

Module II(13 hours)

Fuel systems-Carburetion, fixed venturi and variable venturi and constant vacuum types,Gasoline Injection – TBI, MPFI, GDI and Air-assisted Injection, Engine Management System, Catalytic Conversion of Engine Pollutants, Electrical Catalyst Heaters, Common rail injection, Diesel Particulate Trapping and Trap Regeneration, Gaseous Fuel Injection, Lean NOx catalysts, SCR systems, Dual and Bifueling and Controls.

Module III(13 hours)

Combustion chambers and Emissions-Fuel – Quality standards for Automotive Engines – Lead free gasoline, low and ultra – low sulphur diesels, LPG, CNG, Alcohols, Biodiesels, FT diesels, hydrogen.Ignition, Combustion and knock in SI and CI engines, Control of combustion in SI and CI engines, Importance of control of parameters. Combustion chambers. Emission formation in SI and CI engines. Lean burn, GDI and HCCI systems

Module IV(13 hours)

Development trends-Current trends in engine technology - Multi-valving, Tuned manifolding, camless valve gearing, variable valve timing, Turbo and supercharging. EGR, Part-load charge stratification in GDI systems, Current materials and production processes for engine components, TS 16949 Certification, performance testing of automotive engines, parasitic losses, standard codes of testing automotive engine components and assemblies, Hybrid electric vehicular piston engines and their characteristics.

REFERENCES :

1. Robert Bosch, GmbH, Automotive Hand Book, Germany, 2000.
2. Tom Denton, Automobile Electrical and Electronic Systems, SAE International USA, 2000.
3. Eric Chowanietz, Automobile Electronics, SAE International, 1995.
4. SAE Inc., Advanced Power Plant Concepts, SP – 1325, 1998.
5. Michael Plintand Anthony Martyr, Engine testing Theory and Practice (Second Edition) SAE International, 1999.
6. SAE Inc, Advancements in Electric and Hybrid Electric Vehicle Technology, SP – 1023, 994.

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Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students at the beginning of the semester by the teacher.

Semester end examination: 100 marks

Question pattern:

Answer *ANY* 5 questions by choosing at least *ONE* question from each module.

Module I	**Module II**	**Module III**	**Module IV**
Question 1: 20 marks Question 2: 20 marks	Question 3: 20 marks Question 4: 20 marks	Question 5: 20 marks Question 6: 20 marks	Question 7: 20 marks Question 8: 20 marks

MIT 10 301 (C): RESEARCH METHODOLOGY

(Common toMIT 10 301(C), CEE 10 301(A), CEH 10301(A), EPE 10 301(A), EPS 10 301(A), PMS 10301(A))

Teaching scheme: 3 hours lecture and 1 hour tutorial per week **Credits:** 4

Objective:To impart knowledge about various methodologies followed in engineering research, formulation of research problems and to apply the same in project work. To make students aware of the problems faced by Indian researchers.

MODULE 1(13HOURS)

Research Concepts – concepts – meaning – objectives – motivation. Types of research – descriptive research – conceptual research – theoretical research – applied research – experimental research. Research process – Criteria for good research – Problems encountered by Indian researchers.

MODULE II (13HOURS)

Formulation of Research Task – Literature Review – Importance & Methods – Sources – Quantification of Cause Effect Relations – Discussions – Field Study – Critical Analysis of Generated Facts – Hypothetical proposals for future development and testing, selection of Research task

MODULE III (14HOURS)

Mathematical modelling and simulation – Concepts of modelling – Classification of mathematical models – Modelling with – Ordinary differential equations – Difference equations – Partial differential equations – Graphs – Simulation – Process of formulation of model based on simulation.

MODULE IV(14HOURS)

Interpretation and report writing – Techniques of interpretation – Precautions in interpretation – Significance of report writing – Different steps in report writing – Layout of research report – Mechanics of writing research report – Layout and format – Style of writing – Typing – References – Tables – Figures – Conclusion – Appendices.

<u>REFERENCES</u>

1. J.W Bames, Statistical Analysis for Engineers and Scientists, McGraw Hill, N.York

2. Schank Fr., Theories of Engineering Experiments, Tata McGraw Hill Publication.

3. C. R. Kothari, Research Methodology, New Age Publishers.

4. Willktnsion K. L, Bhandarkar P. L, Formulation of Hypothesis, Himalaya Publication.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be a minimum of two tests per subject. The assessment details are to be announced to students' right at the beginning of the semester by the teacher.

End semester Examination:100 marks

Question pattern

Answer any 5 questions by choosing at least one question from each module.

Module I	**Module II**	**Module III**	**Module IV**
Question 1: 20 marks Question 2: 20 marks	Question 3: 20 marks Question 4: 20 marks	Question 5: 20 marks Question 6: 20 marks	Question 7: 20 marks Question 8: 20 marks

MIT10 302 (A): INDUSTRIAL ENERGY MANAGEMENT

(Common to MIT 10 302(A), MPE 10 302(A))

Teaching scheme: 3 hours lecture and 1 hour tutorial per week **Credits:** 4

Objectives: *To understand the concept of energy engineering, electrical system optimization, energy conservation, energy economics and environmental aspects of energy utilization.*

Module 1(14 hrs)

Energy Engineering- World energy outlook. Application of Non Conventional and Renewable Energy Systems - Use of Energy Efficient Technologies -Solar energy –solar energy collectors and energy storage-applications of solar energy. Wind energy-basic components of a wind energy conversion system-performance of wind machines-applications of wind energy. Energy from biomass – biomass conversion technologies-types of biogas plants-Energy conservation schemes-case studies.

Module 2 (14 hrs)

Electrical system optimization-Importance of power factor-Power factor correction-Energy efficient motors – lighting basics-energy efficient light sources-domestic, commercial or industrial lighting. Energy conservation in lighting schemes-case studies.
Energy conservation in HVAC system, energy conservation by cogeneration scheme-boiler efficiency improvement-waste heat recovery –case studies

Module 3 (13 hrs)

Energy economics-payback analysis-energy auditing and accounting-types-energy use profiles-the energy survey-Sankey diagram for energy audit- Energy Audit Instruments- Thermal Energy Efficiency & Audits - Electrical Energy Efficiency - Audits -case studies

Energy management- Maintenance management-Preventive maintenance schedule-Energy management organization.

Module 4 (13 hrs)

Energy and Environment. Environmental aspects of energy utilization-public health issues related to environmental pollution. Methods to measure pollution in industries-air pollution & water pollution. Compliance with standards-International Environmental Policy. Energy recovery by solid waste management. Environmental auditing-case studies.

REFERENCES:

1. A.P.E.Thumann, *Fundamentals of Energy*, Engineering,Prentice Hall,1984.
2. A.P.E.Thumann, *Plant Engineers and Managers Guide to Energy Conservation*, 7e,UNR,1977.
3. W.F.Kenney, *Energy Conservation in the Process Industries*, Academic press,1984
4. M.H.Chiyogioji, *Industrial Energy Conservation*, Marcel Dekker,1979
5. C.B. Smith, *Energy Management Principles*, Pergamon Press, New York, 1981.
6. AmitTyagi, *Handbook on Energy Audit and Management*, TERI, New Delhi, 2000
7. *Environmental Considerations in Energy Development*, Asian Development Bank (ADB) publication,Manila, 1991

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students at the beginning of the semester by the teacher.

Semester end examination: 100 marks

Question pattern:

Answer *ANY* 5 questions by choosing at least *ONE* question from each module.

Module I	**Module II**	**Module III**	**Module IV**
Question 1: 20 marks Question 2: 20 marks	Question 3: 20 marks Question 4: 20 marks	Question 5: 20 marks Question 6: 20 marks	Question 7: 20 marks Question 8: 20 marks

MIT10 302 (B): SOFTCOMPUTING TECHNIQUES
(Common to MIT 10 302 (B), EPE 10 302(B), CEH 10 302(B), PMS 10 302(B))

Teaching scheme: 3 hours lecture and 1 hour tutorial per week **Credits:** 4

Objective: *To acquaint the students with soft computing methodologies such as neural networks, fuzzy logic, genetic algorithms and hybrid algorithms and enable the students to implement real time intelligent and adaptive systems.*

MODULE 1(13hours)

Introduction to Fuzzy logic: Fuzzy sets- Fuzzy set operations- Fuzzy relations-Cardinality of Fuzzy relations-Operations on Fuzzy relations-Properties of Fuzzy relations-Membership Functions-Features of Membership functions- Fuzzification-Methods of Membership value Assignments- Fuzzy Rule Base-Defuzzification-Deffuzzification methods- Fuzzy logic controller(Block Diagram)

MODULE II(14 hours)

Artificial Neural Networks: Basic concepts-Neural network Architectures-Single layer feed forward network-Multilayer feed forward network-Recurrent Networks-Characteristics of Neural Networks-Learning methods. Perceptron networks-Back Propagation networks-Radial base function network-Hopfield network- Kohonen Self organizing maps-ART

MODULE III(13hours)

Fundamentals of genetic algorithms: Basic concepts- working principle – encoding – different methods – fitness function – reproduction-different methods. Genetic modelling-inheritance- Crossover mutation-convergence of genetic algorithm.

MODULE IV(14hours)

Hybrid systems: Neural network, fuzzy logic and genetic algorithm hybrids – Neuro fuzzy hybrids- neuro genetic hybrids-Fuzzy genetic hybrids-Genetic algorithm based back propogation network- Fuzzy back propagation networks -fuzzy logic controlled genetic algorithms.

Note:Specific Power System applications are to be covered along with the respective modules.

REFERENCES

1. S.Rajasekharan, G.A.VijayalakshmiPai, Neural Network, Fuzzy Logic and Genetic Algorithms Synthesis and Applications, Prentice Hall India.
2. S.N.Sivanandam, S.N.Deepa, Principles of Soft Computing, Wiley India.
3. Timothy J Ross, Fuzzy logic with Engineering Applications, McGrawHill ,New York.
4. S.Haykins, Neural Networks a Comprehensive foundation,Pearson Education.
5. D.E.Goldberg, Genetic Algorithms in Search Optimisation and Machine Learning, Pearson Education.
6. Recent Literature.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students at the beginning of the semester by the teacher.

Semester end examination: 100 marks

Question pattern:

Answer *ANY* 5 questions by choosing at least *ONE* question from each module.

Module I	**Module II**	**Module III**	**Module IV**
Question 1: 20 marks Question 2: 20 marks	Question 3: 20 marks Question 4: 20 marks	Question 5: 20 marks Question 6: 20 marks	Question 7: 20 marks Question 8: 20 marks

MIT10 302 (C): OPTIMIZATION TECHNIQUES

(Common to MIT 10 302(C),MPE 10 302 (C))

Teaching scheme: 3 hours lecture and 1 hour tutorial per week **Credits:** 4

Objectives: *To understand the theory of simplex method, non-linear programming, algorithms for unconstrained optimization and sequential decision making*

Module (14 hours)

Theory of Simplex Method, Duality Theory, Duality theorems, Dual simplex method, Revised simplex method, Bounded variables algorithm, Sensitivity analysis, Parametric programming. Integer Programming: Cutting plane method, Branch and bound method.
Network Models and Solutions: Shortest Route problems, Minimal spanning tree problems, Maximal flow problems.

Module 2 (14 hours)

Non-linear Programming Problems: General non-linear programming problems; convex, quasi-convex, concave and unimodal functions, Theory of unconstrained optimization-Necessary and sufficient conditions for extrema, Theory of constrained optimization-Lagrange multipliers and Lagrangian optimization, Inequality constraints, Kuhn-Tucker conditions.

Module 3 (13 hours)

Algorithms for Unconstrained Optimization: Fibonacci search method, Golden section search method , Cauchy's (Steepest descent) method Algorithms for Constrained Optimization: Quadratic programming, Separable convex programming .
Multi-objective Decision Models: Introduction to multi-objective decision making, Concept of pareto-optimality, Goal programming formulation, The weighting method of solution, Analytic hierarchy process.

Module 4 (13 hours)

Sequential Decision Making (Stochastic Case): Stochastic processes, Markov processes, Markov chains, Markov decision problems, Algorithms for solving Markov decision problems, finite-stage models, infinite stage models.
Metaheuristics: Nature of metaheuristics, Tabu search, Simulated Annealing, Genetic Algorithm. Complexity of algorithms: Complexity of algorithms for combinatorial optimization problems.

References

1. Hillier, F.S. and Liberman, G.J., *Introduction to Operations Research,* McGraw-Hill International edition, Eighth Edition 2009.
2 Rao, S.S, *Optimization: Theory and Applications*, Second edition, Wiley eastern, 1994.
3 Ravindran, A., Philips, D.T., and Solberg, J.J., *Operations Research: Principles and Practice,* Second Edition, John Wiley & Sons, 1987.
4 Taha, H.A., *Operations Research: An Introduction*, Sixth Edition, Prentice-Hall of India, New Delhi, 1999.
5 Deb, K., *Optimization in Engineering Design*, Prentice-Hall of India, New Delhi, 1994.
6 Papadimitriou, C.H., and Steghtz, K., *Combinatorial Optimization: Algorithms and Complexity*, Prentice-Hall, New Jersey, 1982.
7 Simmons, D.M., Ravindran, A., *Non-linear Programming for Operations Research*, Prentice-Hall, New Jersey, 1975.

8 Reklatis, G.V., Ravindran, A., and Ragsdell, K.M., *Engineering Optimization: Methods and applications,* Wiley Interscience, New York, 1983.
9 Budnick F.S., McLeavey and R. Mojena, *Principles of Operations Research for Management,* 2/e, Richard D. Irwin Inc., Homewood, Illinois, 1991.

Internal continuous assessment: 100 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of all whichever suits best. There will be minimum of two tests per subject. The assessment details are to be announced to students at the beginning of the semester by the teacher.

Semester end examination: 100 marks

Question pattern:

Answer *ANY* 5 questions by choosing at least *ONE* question from each module.

Module I	**Module II**	**Module III**	**Module IV**
Question 1: 20 marks Question 2: 20 marks	Question 3: 20 marks Question 4: 20 marks	Question 5: 20 marks Question 6: 20 marks	Question 7: 20 marks Question 8: 20 marks

MIT10 303 (P): INDUSTRIAL TRAINING

Teaching scheme: 1 hour per week **Credits:** 1

The students have to undergo an industrial training of minimum two weeks in an industry preferably dealing with IC Engines and Turbo machinery during the semester break after second semester and complete within 15 calendar days from the start of third semester. The students have to submit a report of the training undergone and present the contents of the report before the evaluation committee constituted by the department. An internal evaluation will be conducted for examining the quality and authenticity of contents of the report and award the marks at the end of the semester.

Internal continuous assessment: Marks 50

MIT10 401(P): MASTERS RESEARCH PROJECT (PHASE-II)

Teaching scheme: 30 hours per week **Credits:** 12

Objectives:

To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.

Masters Research project phase-II is a continuation of project phase-I started in the third semester. Before the end of the fourth semester, there will be two reviews, one at middle of the fourth semester and other towards the end. In the first review, progress of the project work done is to be assessed. In the second review, the complete assessment (quality, quantum and authenticity) of the thesis is to be evaluated. Both the reviews should be conducted by guide and Evaluation committee. This would be a pre qualifying exercise for the students for getting approval for the submission of the thesis. At least one technical paper is to be prepared for possible publication in journal or conferences. The technical paper is to be submitted along with the thesis. The final evaluation of the project will be external evaluation.

Internal Continues assessment:

First review:

Guide	50 marks
Evaluation committee	50 marks

Second review:

Guide	100 marks
Evaluation committee	100 marks

Semester end Examination:

Project evaluation by external examiner: 150 marks

Viva-voce by internal and external examiner: 150 marks (75 marks each)