CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 36001	Dynamics of Machines	4	1	2	4	1	5	70	30	40	60	200

Pre-requisites: MA 2604, ME2606, PE2609, MA 2655, ME 2660, ME 2661 and ME2662

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
3. **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.
4. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes:

CO 1	Learning of thrust and radial load bearings, power screw
CO 2	Learning friction devices
CO 3	Dynamics of governors
CO 4	Dynamic analysis of mechanisms
CO 5	Learning balancing of rotating and reciprocating machines

COURSE CONTENTS

Unit 1

Friction and Lubrication: Screw Friction, Sliding and Rolling Friction, the Law of Solid Friction. Fluid Friction, Angle of Friction, Friction Circle, Journal Bearings, Thrust Bearings, Mitchell Thrust Bearing, Pivot and Collar Bearing, Ball and Roller Bearing, Belt, Rope and Chain Drives.

Unit 2

Clutches, Brakes and Dynamometer: Plate Clutch, Cone Clutch, band brake, the band and block brake, absorption dynamometer, prony, rope and band brake, hydraulic absorption dynamometer propulsion and braking vehicles.

Unit 3

Governors: Principles of Power Control, Types of Governors, Watt, Porter and Spring Loaded Governor, Governor Characteristics, Effect of Friction.

Unit 4

Transmission of Power by Mechanism: Inertia Forces of Reciprocating parts, Piston Efforts and Crank Effort Diagrams, Fluctuation of energy and speed. The Flywheel.

Unit 5

Balancing : Static Balancing, Balancing of revolving masses, Primary balancing of reciprocating masses, locomotive balancing, hammer blow, pitching and swaying couple, secondary balancing of reciprocating masses. Condition of balance in V-Engine, radial engine and multi cylinder inline engine.
Industrial practices of rotor balancing, Field balancing of rotors

Text Books:

1. Ambekar A. G., Mechanism & Machine Theory, Prentice-hall of India, 2007
2. Ghosh, A. & Malik, A.K., Theory of Mechanisms and Machines, East-West Press, 1988

Reference Books:

1. Bevan Thomas, Theory of Machine, CBS Pub. India, 2005
2. Green W. G., Theory of Machines, Blackie, London, 1962
3. Martin G. H., Kinematics & Dynamics of Machine, Overseas Press (India), 2008

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 36003	Measurement and Automatic Control	4	-	2	3	1	4	70	30	40	60	200

Pre-requisites: ME2601, MA2604, ME2608, PE2609, MA2655, ME2660, ME2661, ME2662, ME2664 and EC2663

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
3. **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.
4. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes:

CO 1	Learning of engineering skills required for understanding measurement & control systems
CO 2	Enhancement of analytical skills for modeling & analyses of measurement& control system
CO 3	Learning problem solving in domain of measurement & control
CO 4	Exposure to application oriented problem solving and building capabilities to formulate and solve such problems

COURSE CONTENTS

Unit 1

Basic Concepts of Measurement: General measurement system, Noise and interference, Calibration, Static Performance Characteristics of measuring instrument and measurement system, Sequential and random tests. Measurement errors; error sources: calibration, data acquisition, data reduction; Design stage uncertainty analysis; combining elemental errors; Bias & Precision errors; Error propagation, Higher order uncertainty analysis.

Unit 2

Temperature Measurements: Temperature standards, Temperature scales; Thermometry based on thermal expansion: Liquid in glass thermometers, Bimetallic Thermometers; Electrical resistance thermometry: Resistance Temperature Detectors, Thermistors; Thermoelectric Temperature Measurement: Temperature measurement with thermocouples, thermocouple standards.

Pressure and Velocity Measurements: Relative pressure scales, pressure reference instruments, barometer, manometer, deadweight tester, pressure gauges and transducers, total and static pressure measurement in moving fluids

Flow measurements: Pressure differential meters: Orifice meter, Venturi meter; rota-meter.

Unit 3

Strain Measurements: Stress and strain, resistance strain gauges, gauge factor, strain gauge electrical circuits, multiple gauge bridge, bridge constant, apparent strain and temperature compensation, bending compensation

Motion, Force and Torque Measurements: Displacement measurement: Potentiometers, Linear variable differential transformers, rotary variable differential transformer; Velocity measurement: moving coil transducers; angular velocity measurement: electromagnetic techniques, stroboscopic measurement; Force measurement: load cells, piezoelectric load cells; Torque measurement: measurement of torque on rotating shafts, Power estimation from rotational speed and torque.

Unit 4

Introduction to control systems: Examples of control systems. Open loop and closed loop control.

Mathematical modeling of dynamic systems: Transfer function, impulse response function, block diagram of closed loop system, block diagram reduction, modeling of mechanical systems, modeling of electrical systems, signal flow graphs, modeling of fluid systems, liquid level systems, hydraulic systems, modeling of thermal systems.

Unit 5

Transient and steady state response analyses: First order systems, unit step and unit impulse response of first order systems, second order systems, unit step and unit impulse response of second order systems, transient response specifications. Routh Hurwitz stability criteria, Introduction to Bode plot and root locus method. System modelling using MATLAB.

Text Books:

1. Nakra B.C., Chaudhary K.K., Instrumentation, Measurement and Analysis, Tata McGraw Hill, New Delhi, 2004
2. Nakra B.C., Chaudhary K.K., Control Systems, Tata McGraw Hill, New Delhi, 1985
3. Modern Control Engineering, 4e, Katsuhiko Ogata, Pearson Education, New Delhi, 2004

Reference Books:

1. Richard S. Figiola & Donal E. Beasley, Theory and Design for Mechanical Measurements, 5e, John Wiley, 2005
2. Gopal M., Control Systems Principles and Design, 2e, Tata McGraw Hill, New Delhi, 2006
3. Beckwith and Buck, Mechanical Measurements, Addison-Wesley Pub. Co., 1982

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 36006	Heat & Mass Transfer	4	-	2	3	1	4	70	30	40	60	200

PRE-REQUISITES: MA 2604, ME 2601, ME 2608, MA 2655, ME 2661, ME 2664 and EC 2663.

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
3. **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.
4. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

COURSE OUTCOMES:

CO1	Explain basic modes of heat transfer. Application of Fourier's law in different applications like plane and composite wall, cylinder and sphere.
CO2	Analyze finned surfaces and assess how fins can enhance heat transfer, and unsteady state heat conduction.
CO3	Describe various convection modes and their application to solve heat transfer problems for tubes, flat plates and for turbulent flow.
CO4	Design heat exchangers using LMTD and NTU methods and explain heat transfer with change of phase.
CO5	Apply the principles of radiation heat transfer and basics of mass transfer to real world problems.

COURSE CONTENTS

Unit 1

Introduction: Various modes of Heat Transfer. Fourier's low, Thermal conductivity, Newton's law, film coefficient, combined conduction and convection: overall heat transfer coefficient, Stephan Boltzman's law.

Conduction: General heat condition equation in Cartesian coordinate, one dimensional study state, conduction through plane wall, cylinder and spheres. Composite wall cylinders and spheres. Critical thickness of insulation. Effects of variable thermal conductivity on temperature distribution and heat flux.

Unit 2

Fins: Heat transfer from fins of uniform cross section for different boundary condition. Fins effectiveness and fins efficiency.

Brief introduction to Unsteady State Heat Conduction: Lumped parameters, Heisler chart.

Unit 3

Boundary Layer: Fundamentals, Equations of energy in the boundary layer. Thermal boundary layer. The Nusselt number.

Convection Heat Transfer: Mechanism of convection, free and forced Dimensionless numbers used in convections. Empirical relations for convective heat transfer through tubes and flat plate, Heat transfer in turbulent flow. Reynold's Analogy.

Unit 4

Heat exchangers: Basic types of heat exchangers. The overall heat transfer coefficient and fouling factor. Log – Mean temperature difference. Effectiveness – NTU approach.

Recent Development in the heat transfer: Elementary idea about heat pipe, transpiration and ablation cooling, heat transfer in high speed flow etc.

Heat transfer with change of phase: Fundamentals of boiling heat transfer. Boiling curve and various boiling regions. Condensation heat transfer phenomena.

Unit 5

Radiation: Thermal Radiation. Monochromatic and total emissive power, absorptivity, reflectivity and transmissivity, Kirchoff's law, Black and Gray bodies, Plank's distribution law, Stefan Boltzman's law, Heat transfer by radiation between Black surfaces. Electrical analogy for solving Radiation problems.

Mass Transfer: Fick's Law, Analogy between heat and mass transfer through molecular diffusion, mass transfer by convection, Evaluation of mass transfer coefficient.

Text Books Recommended:

1. Holman J. P., Heat Transfer, Tata McGraw Hill, 1968
2. Kumar, D.S., Heat &Mass transfer, S K Kataria & Sons, 2009
3. Cengel Y. A., Heat Transfer, Tata McGraw Hill, 2005

Reference Books:

1. Eckert & Drake, Heat &Mass Transfer, Tata McGraw Hill, 1979
2. Ozisic, Basic Heat Transfer, Tata McGraw Hill, 1975
3. Incropera & DeWitt, Fundamentals of Heat and Mass Transfer, Wiley, 1996

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 36xxx	Power Plant & Energy Management	4	-	-	3	-	3	70	30	-	-	100

Pre-requisites: ME 3606, ME3608, ME3603, IM3621, ME3659, ME3656 and IM3661

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes:

CO1	Enhancement of fundamental knowledge of power plant & energy management
CO2	Learning problem solving in domain of power plant.
CO3	Exposure to application oriented problem solving and building capabilities to formulate and solve such problems.
CO4	Inculcation of sense of social responsibility
CO5	Understanding the importance of sustainable development and evolving approaches for it.

COURSE CONTENTS

Unit 1

(a) Introduction to Various Energy Conversion System: Conventional and commercial power plants, e.g. principles of energy conversion in thermal, hydro, nuclear and Internal Combustion Engine Plants. Principle of Direct Energy Conversion Systems including Materials Processes, and applications, of Thermoelectric Converter, Thermion convertors, Photovoltaic Cells, Magneto-Hydro Dynamic Generators and Fuel Cells, properties of semiconductor material and plasma. Introduction to Renewable Energy Conversion Systems like solar energy, wind energy, geothermal energy tidal energy etc.

(b) Selection: Economic and other considerations in the selection of site for thermal, hydro, nuclear and other types of power plant.

(c) Thermodynamic Cycles of Steam Power Plant. Analysis and calculation of reheat. Regenerative & Binary Cycles.

Unit 2

(a) Thermal Power Plant: Description of the principle and the working of the units of Fossil, Fuel Fire Thermal Power Plant e.g. Boilers, Coal Firing Systems, Turbines, Condensers, Draft Pump Water Treatment Plant, Coal And Ash Handling System, cooling towers, Dust Collection etc. Introduction to Super Critical Pressure Plants.

(b) Design of Components of Thermal Power Plants: To calculate capacity and major dimensions of boiler, fuel firing system, water treatment plants, economics of super-heaters feed water heaters, reheaters, condensers, pumps, cooling towers etc.

Unit 3

(a) Hydro Power Plants: Estimation of power available from hydrological data, selection of water turbines, layout of different types of plants. Introduction to pumped storage plants. Principles of economic consideration of hydro and steam power plant.

(b) Internal Combustion Engine Power Plant: Introduction to various systems and components of Diesel Engine Power Plant e.g. Engine, Air, Intake and Exhaust gas systems, Fuel and lube oil systems, cooling water system etc. calculations of capacity of engine, fuel and lube oil requirements, efficiencies, cooling water quantities etc.

Unit 4

(a) Principles of working of gas turbines cycles. Efficiencies and output of gas turbines, Reheating regenerative and multistage compression.

(b) Introduction to Stationary Gas Turbine Power Plant and their components, combined cycles and cogeneration plants.

Unit 5

(a) Nuclear Power Plants: nuclear reactions used for power generation elements of a slow and a fast reactor, Different types of power reactors, calculations of fuel feed rate, cooling water rate, quantity of steam supplied etc.

(b) Power Station Economics: Definitions and application of load curves, load factor, plant capacity factor, plant utilization factor, diversity factor and demand factor. Introduction to energy audit. Elements of fixed and operating costs, power and various tariff.

Text Book:

1. Yadav, R., Steam & Gas Turbine, Standard Publishers, 2007
2. Cohen, Rogers, & Saravanamuttoo, Gas Turbine Theory, Prentice Hall, 2001
3. Domkundwar & Arora, A Course in Power Plant Engineering, Dhanpat Rai and Sons, 2005
4. Rajput R.K., A textbook of Power Plant Engineering, Laxmi Publications, 2005
5. Nag P.K., Power Plant Engineering, Tata McGraw-Hill Education, 2002

Reference Books:

1. Noeb Hussain, Steam turbine theory and Design, Tata McGraw-Hill, 1984
2. Yahaya S.M., Turbine Compressors & Fans, Tata McGraw Hill, 2005
3. Khajuria & Dubey, Gras Turbine & Propulsive System, Dhanpat Rai and Sons, 1984
4. Black & Veatch,Power Plant Engineering, Springer, 1996
5. Angrist, S.W., Direct Energy Conversion, Allyn and Bacon, 1976
6. Skrotzki and Vopat, Power stations engineering and economy, Tata McGraw-Hill Education, 1960

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 36501	Refrigeration & Air Conditioning	4	-	2	3	1	4	70	30	40	60	200

Pre-requisites: ME 3606, ME3608, ME3603, IM3621, ME3607, ME3607, ME3656, PE3662, and IM3661

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
3. **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.
4. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes:

CO1	Illustrate the basic concepts of refrigeration system explain various types of refrigerants and their properties
CO2	Explain and analyze vapour compression systems
CO3	Analyse vapour absorption systems. Discuss low temperature and unconventional refrigeration systems
CO4	Analyze air-conditioning processes using the principles of psychometry
CO5	Discuss the theory of air-conditioning systems and their applications in real world scenario.

COURSE CONTENTS

Unit 1

Principles of refrigeration : Review of revised Carnot cycle. Coefficient of Performance, Ton of Refrigeration, Various types of Refrigeration systems.

Air Refrigeration System : Bell Coleman Cycle, air cycle systems for aircraft. Boot Strap Type and simple evaporative system.

Refrigerants : Classification, Nomenclature, Desirable properties, important refrigerants, secondary refrigerants

Unit 2

Vapour Compression Systems : The Simple cycle. The Analysis of the simple cycle, effects of suction superheat and under cooling representation of cycle on T-S and P-H diagrams.

Unit 3

Vapour Absorption System: The simple Absorption cycle, use of heat exchanger, analysis and rectifier, the electrolux system Lithium – Bromide Water Absorption system.

Low Temperature Refrigeration: Limitations of vapour compression systems for production of low temperature. Cascade System of Refrigeration. Multistage systems. Use of Flash Intercooler Dry ice, its manufacture and uses. Joule-Thomson Effect and liquification of gases. Application of low temperatures.

Unconventional Refrigeration System: Steam jet and thermo-electric refrigeration systems, their principle of working and application.

Unit 4

Psychrometric Process: Different psychrometric chart. By-pass factor.

Comfort Air Conditioning: Factors affecting human comfort. Flienyer's Equation. Effective temperature, comfort chart and comfort zone.

Air conditioning load calculation: Sensible and latent loads, principles for calculation of building heat transmission, solar heat gain, infiltration and occupancy loads, load due to electric motors and electric driven machineries, other sources of heat gain.

Unit 5

Air conditioning Systems: Unitary and central air conditioning systems, evaporative cooling system, heat pump.

Air conditioning equipment: Direct expansion and chilled water coils, air washers, apparatus dew point temperature, cooling towers, simple heat factor. Requirement of air for heating and cooling system. Fans and Blowers for air conditioning, their classification and characteristics, grills and registers.

Ducts and Piping: Principles of layout and design of duct system, refrigerants and water pipings pressure losses through ducts and pipings.

Application of Refrigeration and Air conditioning: Food preservation, industrial air conditioning, survey of applications, manufacturing of ice.

Text Books:

1. Arora C. P., Refrigeration and Air Conditioning,, Tata McGraw-Hill Education, 2000
2. Ananthanarayanan, Basic Refrigeration and Air Conditioning, Tata McGraw-Hill Education, 2005
3. Prasad Manohar, Refrigeration and Air Conditioning, New Age International, 2003

Reference Books:

1. Dossat, R.J., Principles of Refrigeration, Pearson Education India, 1996
2. Whitman, Johnson & Tomczyk, Refrigeration and Air Conditioning Technology. Cengage Learning, 2009
3. Hundy, & Trott,Welch Refrigeration and Air Conditioning, Butterworth-Heinemann, 2008
4. Althouse, Willcox Publisher, 1982-Refrigeration and Air Conditioning. Goodheart Turnquist & Bracciano, Modern

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 36xxx	Machine Design – II	4	-	4	3	2	5	70	30	40	60	200

Pre-requisites: ME 26002, ME26008, ME26551, ME36001

Course Assessment: The following methods are adopted for the assessment of this course;

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
3. **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.
4. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes:

CO1	Understand and apply the theory of dynamics loading, fatigue, endurance limits, creep and stress concentration to solve engineering problems.
CO2	Design analysis of different types of gears.
CO3	Design of different types of springs, axle and shaft, power screw
CO4	Design analysis and selection of different types of journal bearings, selection of belts and chains
CO5	Design analysis of various I.C. engine components

COURSE CONTENTS

Unit 1

Dynamic loading, fatigue and endurance limits, creep: Effect of abrupt changes in the geometries in stresses, stress concentration, stress concentration factors and methods of reduction, notch sensitivity.

Types of dynamic loading, S - N curves, fatigue life, fatigue strength, Bauschinger effects, low-high cycle fatigue, effect of various factors, Different criteria for design of parts subjected to fatigue.

Tribological consideration in design of machine components such as clutches and brakes

Unit 2

Gears: Material selection for different types of gears, reviews of kinematic considerations, design of spur, bevel, worm, helical gears, different case studies of failures.

Unit 3

Springs: Design of different types of springs subjected to axial, torsion, bending, and different combinations of loads and stresses. Different applications and case studies of design, Helical, leaf, spiral etc. types of springs.

Power screw: Parts of power screw, thread profiles of power screws, stress distribution, analysis and design of power screws for various applications.

Unit 4

Design of journal bearings: Specifying bearing modulus, minimum oil film thickness, flow of oil and bearing dimensions.

Belts, Rope and chain Drive: Types of belts and their selection criteria, types of ropes and chains and design criteria for their selections for various applications, matched sets of belts, calculations of different tensions, lengths, sections, materials, etc.

Unit 5

Design of engine components: such as– cylinder, piston, connecting rod, crank and crank shaft, etc.

Text Book:

1 Bhandari V.B., Introduction to Machine Design, Tata McGraw Publication, 2001
2 Sharma and Agrawal, Machine Design, S.K. Kataria and Sons, 2012

Reference Books:

1 Shigley and Mischke, Mechanical Engineering Design, Tata McGraw Publication, 2001
2 Robert C. Juvinall and Kurt M. Marshek, Fundamentals of Machine Component Design, John Wiley, 2006
3 Black V, Machine Design, Tata McGraw Publication, 1988

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 36506	Fluid Machinery	4	-	2	3	1	4	70	30	40	60	200

Pre-requisites: ME 2601, MA2604, PE2609, MA2655, ME2660, ME2662 and ME2664.

Course Assessment: The following methods are adopted for the assessment of this course

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
3. **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.
4. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes: At the end of this course the student is expected to-

CO1	Understand fundamentals of working of hydraulic turbines, reciprocating pumps, centrifugal pumps.
CO2	Have knowledge of steady and unsteady flow characteristics in hydraulic machinery and conduit systems connected to the machinery
CO3	Develop an ability to apply knowledge of mathematics, science and engineering, to understand effect of hydrodynamic force on various types of vanes
CO4	Be able to design a system, component or process to meet desired needs with in realistic constraints
CO5	Learning problem solving in particular domain such as hydraulic turbines, reciprocating pumps & centrifugal pumps

COURSE CONTENTS

Unit 1

Theory of Fluid Machinery: Impact of jet, velocity triangles, Euler's Equation for work done, efficiencies. Impulse flow turbines and their constructional details, characteristics of turbines, unit quantities, specific speed, governing of turbines, Phenomenon of water hammer, type of surge tank

Unit 2

Reaction Turbines: Francis, Propeller, Kaplan, Bulb Turbine, their constructional details, characteristics of turbines, unit quantities, specific speed, governing of turbines. , types of cavitation, cavitation effects, Thoma cavitation factor, apparatus for cavitation tests, effects of cavitation in pumps and turbine, prevention of cavitation..

Unit 3

Rotodynamics Pump: Classifications of Rotodynamics pumps and their constructional details, Vector diagram, Work done by impellor, Efficiencies, Specific speed, Performance characteristics, NPSH, Cavitation Specific Speed, Multi-staging.

Unit 4

Positive Displacement and other Pumps: Reciprocating pump theory, Slip, Indicator diagram, Effect of acceleration, air vessels and separation, Comparison of centrifugal and reciprocating pumps, Performance characteristics. Hydraulic ram, Jet pumps, Air lift pumps.

Unit 5

Dimensional Analysis: Dimensional homogeneity, Buckingham Theorem and its Applications, parameters, similitudes modelling criteria and distorted models.

Text Books:

1. Yahya, S.M., Turbines, Compressor & Fans, Tata McGraw Hill.
2. JagdishLal, Hydraulic Machine, Metropolitan book co.
3. Kumar, D.S., Fluid mechanics and Hydraulic Machines, S K Kataria& Sons Publication.

Reference Books:

1. Govindarao, N.S., Fluid Flow Machines, Tata McGraw Hill.

CODE	SUBJECT NAME	L	T	P	Credits			Maximum Marks				
					T	P	Total	Th.	CW	SW	Pr.	Total
ME 36509	Internal Combustion Engines	4	-	2	3	1	4	70	30	40	60	200

Pre-requisites: ME2601, MA2604, MA2655, ME2661, ME2662, ME2664 and EC2663.

Course Assessment: The following methods are adopted for the assessment of this course-

1. **Class Work** (30 marks) on the basis of regular evaluation of assignments, two mid semester tests and class attendance.
2. **Sessional Work** (40 marks) on the basis of internal viva and continuous laboratory journal assessment and laboratory attendance.
3. **Practical Examination** (60 Marks) on the basis of evaluating practical knowledge, quiz and viva-voce.
4. **Theory Examination** (70 Marks) on the basis of end term theory paper examination.

Course Outcomes:

CO1	Analyze various air standard and actual cycles. Classify internal combustion engines based on different parameters.
CO2	List various qualities of engine fuels. Discuss carburetor fundamentals, design and its function for automobiles.
CO3	Analyze the phenomenon of combustion and describe the functioning of fuel injection system in SI engine and analyze the combustion phenomenon in CI engine.
CO4	Discuss pollutant formation and their control. Explain modern trends in IC engines
CO5	Illustrate various mechanisms of lubrication and cooling systems in IC engines. List types of lubricants and additives and Evaluate the performance of engines by understanding its operating characteristics.

COURSE CONTENTS

UNIT I

Air-Standard cycle and their analysis, Comparison of cycles. Classification of engine and their application, Engine Design and operating parameters. Fuel-air cycles and their analysis. Thermochemistry of fuel air mixture. Properties of working fluids and thermodynamics charts. Actual cycles and their analysis of SI and CI Engine cycles.

UNIT II

Fuel and Carburetion: Important qualities of engine fuels and their chemical compositions. Energy enthalpy and heating values. Entropy and maximum work from Internal combustion and engine efficiency (Chemical equilibrium and Reaction rate) Carburetor fundamental and its type, Modern carburetor design and function and characteristics for automobiles. Fuel Injection system in SI engine and flow in intake manifold. Mean velocity and turbulence characteristics and swirl.

Combustion in S.I. Engine: Combustion SI engine, Analysis of mixture of combustion flame structure and speed, factors influencing combustion and rate of pressure rise. Abnormal combustion, knock and surface ignition and fuel factor and mixture. Combustion chambers for SI Engine combustion models.

Injection system of SI Engine: Requirement and classification, Components Ignition system in SI engine its requirement. Modern Ignition system i.e. Electronic spark advance system and firing order in multi-cylinder engine.

UNIT III

Combustion in CI engine: Type of combustion system, Fuel spray behavior, ignition delay and factors effecting it. Phenomenon of knock in CI engine and its compression with SI engine. Combustion chambers for CI engine. Combustion models.

UNIT IV

Pollutant formation and its control, Nature and extent of problem. Formation and control of Nitrogen oxides, Carbon mono oxides, Unburnt hydrocarbons and particulate of emission. Various emission control Standards, its measure and its prevention.

Modern trend in IC engine, Wankle rotary engine. Free piston engine and their application.

UNIT V

Engine friction and lubrication and cooling Mechanical friction and factor controlling it. Blow by losses, pumping losses. Lubrication of engine components. Lubrications systems, Properties of lubricants and additives used. Heat transfer and its parameters. Characteristics of efficient cooling and types of cooling system and their comparisons.

Performance and Testing: Engine operating characteristic and its parameters variable effecting SI and CI Improvements performance map.

Two Stroke Engine: Types of scavenging process and various terminology. Actual scavenging process. Advantage disadvantages of SI and CI engines and compression, Supercharging.

Text Books:

1. John B. Heywood, I. C. Engines Fundamental, McGraw Hill Publication, 1988
2. Mathur & Sharma, I. C. Engine, Dhanpatrai Publication,2010
3. Ganeshan, I. C. Engine, Tata McGraw Publication, 2012

References Books:

1. Ashely S. and Campbel, Thermodynamics & Analysis of Combustion Engines, Wiley, 1979
2. Taylor, The Internal Combustion in Engine in Theory and Practice, MIT Press, 1985
3. Benson, The I. C. Engine, Claredon Press Oxford, 1982