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SCHEME OF TEACHING AND EXAMINATION
B. Tech. Seventh Semester- MECHANICAL ENGINEERING

Sl. No.	Board of Studies (BOS)	Courses (Subject)	Category	Course Code	Period per Week			Scheme of Examination Theory/Lab			Total Marks	Credit
					L	T	P	ESE	CT	TA		
1	Mechanical Engineering	I C Engines	PEC	**ME107701**	2	1	-	100	20	30	150	3
2	Mechanical Engineering	Computational Fluid Dynamics	OEC	**ME107702**	2	1	-	100	20	30	150	3
3	Mechanical Engineering	Production Planning and Control	OEC	**ME107703**	3	-	-	100	20	30	150	3
4	Mechanical Engineering	Professional Elective III *	HSMC	table IV	3	-	-	100	20	30	150	3
5	Mechanical Engineering	Open Elective II **	HSMC	table V	3	-	-	100	20	30	150	3
6	Mechanical Engineering	I C Engine and Automobile lab	PEC	**ME107791**	-	-	2	25	-	25	50	1
7	Mechanical Engineering	Computational Fluid Dynamics Lab	PCC	**ME107792**	-	-	2	25	-	25	50	1
8	Mechanical Engineering	Capstone Project Phase I	PSI	**ME107793**	-	-	4	50	-	50	100	2
9	Mechanical Engineering	Internship assessment/Industrial training (Report and Seminar)	PSI	**ME107794**	-	-	2	-	-	25	25	1
10	Mechanical Engineering	Universal Human Values and Professional Ethics	NC	**ME100795**	-	-	-	-	-	25	25	-
Total					**13**	**2**	**10**	**600**	**100**	**200**	**1000**	**20**

L : Lecture, T: Tutorial, P : Practical, ESE : End Semester Exam CT : Class test TA: Teacher's assessment

*** Table IV : Professional Elective - III**

S.No.	Board of Studies (BOS)	Courses (Subject)	Course Code
1	Mechanical Engineering	Robotic System and Automation	ME107721
2	Mechanical Engineering	Mechanical Vibrations	ME107722
3	Mechanical Engineering	Automobile Engineering	ME107723
4	Mechanical Engineering	Soft computing Techniques	ME107724
5	Mechanical Engineering	Quality Control	ME107725

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*** Table V: Open Elective - II**

S. No.	Board of Studies (BOS)	Courses (Subject)	Course Code
1	Mechanical Engineering	Supply Chain Management	ME100741
2	Mechanical Engineering	Fuel Cells	ME100742

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B.TECH. (MECHANICAL ENGINEERING)

SEVENTH SEMESTER

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Subject Code ME107701	IC ENGINE	L = 2	T = 1	P = 0	Credits = 3
Evaluation Scheme	ESE	CT	TA	Total	ESE Duration
	100	20	30	150	3 Hours

Course Objectives	Course Outcomes
The objective of the course to: 1. To make the students familiar with the engine fuel and air supply systems, electronic injection systems used in modern automotive engines. 2. To make the students understand about the combustion phenomenon of SI and CI engines, engine pollutants 3. To teach the students on production and utilization of alternative solid, liquid and gaseous fuels. 4. To teach modern trends in IC engines	**Students will be able to:** CO1: Recognize and differentiate various types of IC engines and will understand the basic thermodynamics of IC engine CO2: Compute the performance of IC engines. CO3: Apply knowledge in developing engine combustion models. CO4: To develop and modify fuel supply systems for SI and CI engines. CO5: Apply concepts of different alternate fuels used for SI and CI engines.

UNIT 1 **Introduction:** Internal and external combustion engine and their comparison, four stroke cycle S.I. and C.I. engine, two stroke engine, comparison of four stroke and two stroke engines, comparison of S.I. and C.I. engine, classification of I.C. Engine on various basis Valve timing diagram for S.I. and C.I. engines. Effect of valve timing and engine speed on volumetric efficiency. **Fuel-air cycles and actual cycle:** Reasons for deviation of actual cycle from air standard cycles, fuel air cycles and their analysis, actual cycles and their analysis. Reasons of ignition advance and injection advance	**CO1** **7 Hrs**
UNIT II **Testing and Performance:** Performance parameters, measurements of brake power, indicated power, measurement friction power Willan's line method, Morse test, motoring test, measurement fuel consumption, and measurements of air consumption, exhaust gas calorimeter. **Calculation of various performance parameter,** heat balance sheet and heat balance diagram. Performance curves of S.I. and C.I. Engine at full throttle variable speed operation and at constant speed variable load operation.	**CO 2** **8 Hrs**
UNIT III **Combustion in SI and CI engines**- Ignition - Stages of combustion-Normal and abnormal combustion- Factors affecting knock -Combustion chambers- Fuel spray behavior, spray structure, spray penetration-and evaporation, air motion-stages of combustion-Factors affecting combustion- Direct and indirect injection systems –Combustion chambers **Introduction to Turbo charging and supercharging**, Engine emissions Emission control methods in SI and CI engines, catalytic converters-EGR, Modern evaporative emission control system Lean Burn Engines, homogeneous charge compression	**CO 3**

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ignition engines	**8 Hrs**
UNIT IV **Fuel supply systems in IC Engine**-introduction-carburetion- mixture requirements-simple carburetor, compensation devices, high altitude fuel supply device-, Electronic injection system, CI engine- Injection systems- Mechanical and electronic-Combustion in CI engines	**CO 4** **6 Hrs**
UNIT V **Fuels:** Basic requirement of I.C. Engine fuels, requirement of an ideal gasoline, structure of petroleum, effect of fuel structure on combustion, volatility of liquid fuels, ASTM distillation curve, effect of volatility on engine performance, cold starting, hot starting, vapor lock, acceleration, carburetor icing, and crank case dilution. **Introduction to alternate fuels-bio fuels,** thermo-chemical and biochemical conversion, Vegetable oils and Biodiesel, Ethanol, LPG, Natural gas, Hydrogen-Production and Utilization perspective.	**CO5** **5 Hrs**

Text Books:

S. No.	Title	Author(s)	Publisher
1	A course in internal Combustion Engines	M.L. Mathur and R.P.Sharma	Dhanapat Rai Publications, New Delhi.
2	Internal combustion Engines.	R.B.Mathur and R.P. Sharma	Dhanapat Rai Publications, New Delhi.
3	Internal Combustion Engine Fundamentals	J.B Heywood	McGraw Hill
4	Int. Combustion Engines	V. Ganesan	II Edition, TMH, 2002

Reference Books:

S. No.	Title	Author(s)	Publisher
1	Internal Combustion Engine Fundamentals	K.K. Ramalingam,	Scitech Publications,
2	Computer simulation of spark ignition process:	V. Ganesan	University process, Hyderabad 1993.
3	Auto fuel Systems,	D. Smith	The Good Heart Willox Company, Inc.

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B. Tech. Seventh Semester- MECHANICAL ENGINEERING

Subject Code ME107702	Computational Fluid Dynamics	L = 2	T = 1	P = 0	Credits = 3
Evaluation Scheme	ESE	CT	TA	Total	ESE Duration
	100	20	30	150	3 Hours

Course Objectives	Course Outcomes
The objective of the course to: 1. To study the basic governing equations and understand the basic properties of CFD. 2. To understand discretization techniques and solving methods for improving accuracy. 3. To inculcate the knowledge required to solve real time physical problems using simulation software. 4. To study the application of numerical methods to convection — diffusion system. 5. To study the incompressible fluid flow and application flow through pipe.	**Students will be able to:** CO1: Understand the classification of PDEs, governing equations CO2: Understand Solution algorithms and various discretization schemes. CO3: Understand the basic principles of computational methods CO4: Apply finite volume method to solve steady and unsteady diffusion, advection-diffusion problems. CO5: Solve engineering problems using CFD software

UNIT 1 **Introduction to CFD** CFD - a research and design tool, CFD as third dimension of engineering supplementing theory and experiment, Steps in CFD solution procedure, strengths and weakness of CFD, Flow modeling using control volume - finite and infinitesimal control volumes, Concept of substantial derivative, divergence of velocity, Basic governing equations in integral and differential forms - conservation of mass, momentum and energy (No derivations), Physical interpretation of governing equations, Navier- Stoke's model and Euler's model of equations.	**CO1** **07 Hrs.**
UNIT 2 **Basic Discretization Techniques** Introduction to grid generation (Types of grids such as structured, unstructured, hybrid, multi- block, Cartesian, body fitted and polyhedral etc.), Need to discretize the domain and governing equations, Finite difference approximation using Taylor series, for first order (Forward Difference Approximation, Backward Difference Approximation, Central difference Approximation) and second order (based on 3 node, 4 node and 5 node points), explicit and Implicit approaches applied to 1D transient conduction equation, Counter flow equation (using FTCS and Crank Nicholson's Method, Stability Criteria concept and physical interpretation, Thomas Tri-diagonal matrix solver.	**CO2** **07 Hrs.**
UNIT 3 **Two Dimensional Steady and Unsteady Heat Conduction** Solution of two dimensional steady and unsteady heat conduction equation with Dirichlet, Neumann, Robbins and mixed boundary condition — solution by Explicit and Alternating Direction Implicit Method (ADI Method), Approach for irregular boundary for 2D heat conduction problems.	**CO3** **07 Hrs.**

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UNIT 4 **Application of Numerical Methods to Convection — Diffusion System** Convection: First order wave equation solution with upwind, Lax-Wendroff, MacCormack scheme, Stability Criteria concept and physical interpretation. Convection-Diffusion: 1D and 2D steady Convection Diffusion system - Central difference approach, Peclet Number, stability criteria, upwind difference approach, 1D transient convection-diffusion system.	**CO4** **07 Hrs.**
UNIT 5 **Incompressible Fluid Flow** Solution of Navier-Stoke's equation for incompressible flow using SIMPLE algorithms and its variation (SIMPLER), Application to flow through pipe, Introduction to finite volume method.	**CO5** **06 Hrs.**

Text Books:

S. No.	Title	Author(s)	Publisher
1	Computational Methods for Fluid Dynamics	Ferziger, J. H. and Peric, M.	Third Edition, Springer Verlag, Berlin
2	Introduction to Computational Fluid Dynamics: The Finite Volume Method	Versteeg, H.K. and Malalasekara, W	Second Edition (Indian Reprint) Pearson Education
3	Computational Fluid Mechanics and Heat Transfer	Anderson, D.A., Tannehill, J.C. and Pletcher, R.H.	Taylor & Francis

Reference Books:

S. No.	Title	Author(s)	Publisher
1	Computational Fluid Dynamics	Rajiv Kaul	Nirala Prakashan
2	Numerical Heat Transfer and Fluid Flow	Patankar, S.V.	Hemisphere Publishing Corporation
3	Computational fluid dynamics	Anderson, J. D., & Wendt, J.	Vol. 206, New York, McGraw-Hill

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B. Tech. Seventh Semester- MECHANICAL ENGINEERING

Subject Code ME107703	Production Planning and Control	L = 3	T = 0	P = 0	Credits = 3
Evaluation Scheme	ESE	CT	TA	Total	ESE Duration
	100	20	30	150	3 Hours

Course Objectives	Course Outcomes
The objective of the course to: 1.To understand the various components and functions of production planning and control such as work study, product planning, process planning, production scheduling, Inventory Control. 2. To know the recent trends like manufacturing requirement Planning (MRP II) and Enterprise Resource Planning (ERP). 3. To learn work study, time study, work measurement. 4. To understand the problems and opportunities faced by the operations manager in manufacturing and service organizations.	**Student will be able to:** CO1: Recognize the objectives, functions, applications of PPC and forecasting techniques. CO2: Explain different Inventory control techniques. CO3: Solve routing and scheduling problems. CO4: Summarize various aggregate production planning Techniques. CO5: Describe way of integrating different departments to Execute PPC functions.

UNIT 1 **Introduction** Types and characteristics of production systems Objective and functions of Production, Planning & Control, Place of production, Planning in Engineering, manufactures organization. Preplanning: Forecasting & Market Analysis. Factory Location & Layout, Equipment policy and replacement. Capacity planning.	**CO1** **07 Hrs.**
UNIT 2 **Work Study** Method study, basic procedure-Selection-Recording of process, Critical analysis, Development, Implementation, Micro motion and memo motion study ,work measurement Techniques of work measurement ,Time study ,Work sampling, Synthesis from standard data.	**CO2** **07 Hrs.**
UNIT 3 **Production Planning** Aggregate Planning, MPS, Material Resource Planning, Selection of material methods, machines & manpower. Routing, Scheduling and Dispatching and its sheets & charts, Production Line Balancing.	**CO3** **07 Hrs.**
UNIT 4 **Production and Inventory Control** Progress control through records and charts. Types of inventories, Inventory Classification. Inventory Control under constraints Economic lot (batch) size. JIT production, ERP, CAPPC.	**CO4** **07 Hrs.**
UNIT 5 **Productivity**	**CO5**

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Importance, Productivity patterns, productivity measurements & ratios, improvement maintenance Process. Human Factors & Ergonomics: Human abilities, Training & motivation safety programs.	**06 Hrs.**

Text Books:

S. No.	Title	Author(s)	Publisher
1	Elements of Production Planning & Control	S. Eilon	Universal Publication
2	Production Planning & Control	Jain and Agarwal	Khanna Publisher

Reference Books:

S. No.	Title	Author(s)	Publisher
1	Project Management	S.C. Sharma	Khanna Publishing House
2	Industrial Engineering and Production Management	Martand Telsang	S. Chand and Company, 2000
3	Theory and Problems in Production & Operations Management:	Chary. S.N	Tata McGraw Hill, 1995

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Subject Code ME107721	Robotic System and Automation	L = 3	T = 0	P = 0	Credits = 3
Evaluation Scheme	ESE	CT	TA	Total	ESE Duration
	100	20	30	150	3 Hours

Course Objectives	Course Outcomes
The objectives of this course are Identify robots and its peripherals for satisfactory operation and control of robots for industrial and non-industrial applications.	On completion of the course the student will be able to: CO 1 List and explain the basic elements of industrial robots CO 2 Analyze robot kinematics and its control methods. CO 3 Classify the various sensors used in robots for better performance. CO 4 Summarize various industrial and non-industrial applications of robots.

UNIT 1 Robot-Basic concepts, Need, Law, History, Anatomy, specifications. Robot configurations-Cartesian, cylinder, polar and articulate. Robot wrist mechanism, Precision and accuracy of robot. **Robot elements:** End effectors-Classification, Types of Mechanical actuation, Gripper design, Robot drive system Types, Position and velocity feedback devices-Robot joints and links-Types, Motion interpolation.	**CO1** **07 Hrs.**
UNIT 2 **Robot Kinematics and Control** Robot kinematics, Basics of direct and inverse kinematics, Robot trajectories, 2D and 3D Transformation-Scaling, Rotation, Translation Homogeneous transformation.	**CO2** **07 Hrs.**
UNIT 3 Control & Trajectory Planning Drives, Control of Trajectory: Hydraulic system stepper motor, Direct current servomotors, A-C servomotors, adaptive control, interpolators, trajectory planning, resolved motion rate control method. Control of robot manipulators, Point to point, Continuous Path Control, Robot programming.	**CO3** **07 Hrs.**
UNIT 4 **Robot Sensors** Sensors in robot, Touch Sensors-Tactile sensor, Proximity and range sensors. Force sensor-Light sensors, Pressure sensors, Introduction to Machine Vision and Artificial Intelligence.	**CO4** **07 Hrs.**
UNIT 5 Industrial applications of robots, Medical, Household, Entertainment, Space, Underwater, Defense, Disaster management. Applications, Micro and Nanorobots, Future Applications. Applications of Robot Handling, loading, unloading, welding, painting, assembly, Machining, Manufacturing, Work-cell, Installation of Robots.	**CO5** **06 Hrs.**

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S. No.	Title	Author(s)	Publisher
1	Robotics and Control	R K Mittal and I J Nagrath,	Tata McGraw Hill, New Delhi,2003.
2	Introduction to Robotics	S K Saha	Mc Graw Hill Education

Reference Books:

S. No.	Title	Author(s)	Publisher
1	Industrial Robotics Technology, Programming and Application	Mikell P. Groover, Mitchell Weiss, Roger N Nagel,	Tata –McGraw Hill Pub. Co., 2008.
2	Robotics Technology and Flexible Automation	Deb. S.R and Sankha Deb,	Tata McGraw Hill Publishing Company Limited, 2010
3	Robot Engineering: An Integrated Approach	Klafter.R.D Chmielewski.T.A, and Noggin's.,	Prentice Hall of India Pvt. Ltd., 1994.
4	Robotics control, sensing, vision and intelligence	Fu.K.S, Gonzalez.R.C&Lee.C.S.G,	Tata- McGraw Hill Pub. Co., 2008
5	Industrial Robotics	Yu.	MIR Publishers Moscow, 1985.

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B. Tech. Seventh Semester- MECHANICAL ENGINEERING

Subject Code ME107722	Mechanical Vibrations	L = 3	T = 0	P = 0	Credits = 3
Evaluation Scheme	ESE	CT	TA	Total	ESE Duration
	100	20	30	150	3 Hours

Course Objectives	Course Outcomes
The objective of the course to: **1.** To introduce students to Fundamentals of Vibrations. **2.** To introduce students to damped and forced vibrations. **3.** To introduce students to Two Degree of Freedom System. **4.** To introduce students to Multi-Degree of Freedom System. **5.** To introduce students about Analysis and Measurement of Sound.	**Students will be able to:** CO1: Students will understand Fundamentals of vibrations. CO2: Students will understand damped and forced vibrations. CO3: Students will understand Two Degree of Freedom System. CO4: Students will understand Multi-Degree of Freedom System. CO5: Students will understand about Analysis and Measurement of Sound.

UNIT 1 **Fundamentals of Vibrations:** Simple harmonic motion, combination of two simple harmonic motions, beats, Fourier analysis Single degree of freedom system: Free un-damped vibrations: Equivalent systems linear and torsional, natural frequency estimation, energy methods.	**CO1** **06 Hrs.**
UNIT 2 **Damped Vibrations:** Damping models, structural, coulomb, and viscous damping, critically, under and over-damped system, logarithmic decrement. **Forced Vibrations:** Harmonic excitation, support motion, vibration isolation, critical speeds of shafts in Bending	**CO2** **06 Hrs.**
UNIT 3 **Two Degree of Freedom System:** Free vibrations of spring coupled system, general solution, torsional vibrations, two degree of freedom mass coupled system, bending vibrations in two degree of freedom system, forced vibrations of an undamped two degree of freedom system, dynamic vibration absorber, forced damped Vibrations.	**CO3** **06 Hrs.**
UNIT 4 **Multi-Degree of Freedom System:** Free un-damped analysis. **Numerical Methods:** Dunkerley's, Rayleigh, Holzer methods.	**CO4** **04 Hrs.**
UNIT 5 **Analysis and Measurement of Sound:** One dimensional wave in a gas, sound perception and the decibel scale, the ear, combining sound levels in decibels, octave bands, loudness, weightings, directionality of acoustic sources and receivers, directivity index	**CO5** **04 Hrs.**

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Text Books:

S. No.	Title	Author(s)	Publisher
1	Mechanical Vibrations	Thomson W T	Prentice Hill of India
2	Theory & Practice of Mechanical Vibrations	J.S. Rao, Gupta	New Age International

Reference Books:

S. No.	Title	Author(s)	Publisher
1	Mechanical Vibrations and Noise Engineering	A G Ambekar	PHI, Delhi
2	Acoustics and Noise Control	Smith, Peters & Owen	Addison-Wesley-Longman
3	Industrial Noise Control: Fundamentals and Applications	Bell and Bell	Marcel-Dekker
4	Vibration And Noise For Engineers	Kewal Pujara	Dhanpat Rai, Delh

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SYLLABUS

B. Tech. Seventh Semester- MECHANICAL ENGINEERING

Subject Code ME107723	Automobile Engineering	L = 3	T = 0	P = 0	Credits = 3
Evaluation Scheme	ESE	CT	TA	Total	ESE Duration
	100	20	30	150	3 Hours

Course Objectives	Course Outcomes
The objective of the course to: 1. To understand the basic structure of an automobile and its suspension system. 2. To understand the operation of various clutches and their torque transmitting capacity. 3. To understand the function of axles, tyres and braking systems. 4. To understand the steering mechanisms and electrical system. 5. To understand the concept of electric and hybrid vehicles.	**Students will be able to:** CO1: Describe the basic structure of an automobile with applied engineering principle in its design. CO2: Describe clutches and fluid flywheel, construction and working principle of gear box and torque conveter and solve related problems. CO3: Describe construction and working of propeller shaft, differential, axle assembly, tyres and braking system of an automobile. CO4: Describe construction and working of steering and electrical systems with applied engineering principle in its design. CO5: Describe about working principle of electric and hybrid vehicles.

UNIT 1 **Vehicle Structure:** Type of automotive vehicles, general layout, vehicle construction-chassis, frame and body, types of frames, frameless and unitary construction, position of power unit. **Suspension system:** Objects & principles of suspension, system, types, rigid axle suspension & Independent suspension for front & rear ends, simple & double arm parallel & perpendicular type of suspension system. Gas filled suspension system. **Springs:** Purpose, types viz. leaf, coiled, rubber, air, suspension system, torsion bar, stabilizer, telescopic damper.	**CO1** **07 Hrs.**
UNIT 2 **Clutches:** Characteristics, functions, principles of operation of clutch, friction clutch, single-plate, multi-plate, centrifugal clutch, positive clutch, friction plate clutch lining materials. Torque transmitted and related problems. **Fluid flywheel:** Construction, working principles & characteristics. **Gear Box:** Object of Gear Box, air, rolling & gradient resistance, tractive effort variation with speed, performance curve. **Types of Gear Boxes:** Sliding mesh, constant mesh, synchromesh device, automatic transmission, Overdrive, lubrication of gear box. **Torque Converter:** Principles of working, characteristics, Torque converter with direct drive.	**CO2** **07 Hrs.**
UNIT 3 **Universal Joint:** Types, propeller shaft, slip joint. **Differential:** Functions, single & double reduction differential, limited slip differential. **Front Axle:** Live & dead axle, stub axle. **Back Axle:** Hotchkiss drive, torque tube drive.	**CO3**

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Tyres: Types specification, causes of tyre wear & rim. **Brakes & Braking system:** Purpose, principles, layout of braking system. Classification, mechanical, hydraulic, master cylinder, Tandem master cylinder, wheel cylinder, self-energizing & self-adjusting brakes, disc brakes, antiskid brakes, power operated brakes.	**07 Hrs.**
UNIT 4 **Steering system** Gear & links, types of steering gears, reversibility of steering, center point steering, steering geometry viz. castor, camber, king pin inclination toe in, toe out, cornering power, under-over steer; power steering, effect of shimmy, condition of true rolling, calculation of turning radius. Correct steering equation and related problems. **Electrical System** Battery: construction, maintenance, testing and charging. Cut-out, lighting circuit, horn, signals etc.	**CO4** **07 Hrs.**
UNIT 5 **Introduction to Electric Vehicles** Electric Vehicle, Need, Types, Cost and Emissions, End of life. Electric Vehicle Technology, layouts, cables, components, Controls. Batteries, overview and its types. Battery plug-in and life. Ultra-capacitor, Charging, Methods and Standards. Alternate charging sources, Wireless & Solar. **Hybrid Vehicles** Hybrid Electric vehicles, Classification, Micro, Mild, Full, Plug-in, EV. Layout and Architecture, Series, Parallel and Series-Parallel Hybrid, Propulsion systems and components. Regenerative Braking, Economy, Vibration and Noise reduction. Hybrid Electric Vehicles System, Analysis and its Types, Controls.	**CO5** **06 Hrs.**

Text Books:

S. No.	Title	Author(s)	Publisher
1	Automobile Engineering	Kripal Singh	Standard Publications, New Delhi
2	Automobile Mechanics	N. K. Giri	Khanna Publishers, New Delhi
3	Hybrid, Electric and Fuel Cell Vehicles	Jack Erjavec and Jeff Arias	Cengage Learning

Reference Books:

S. No.	Title	Author(s)	Publisher
1	Automobile Engineering	G.B.S. Narang	Khanna Publishers, New Delhi
2	Automotive Mechanics: Principles and Practices	W.H.Crouse, and D.L. Anglin	TMH, New Delhi
3	Automobile Engineering	K. R. Govindan	Anuradha Agencies
4	The Automobile	Harbans Singh Reyat	S.Chand , New Delhi

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5	Automotive Mechanics	Joseph Heitner	CBS Pub., New Delhi
6	Motor Vehicle	Newton & Steeds	Life & Sons Limited
7	Hybrid Electric Vehicle System Modeling and Control	Wei Liu	General Motors, USA, John Wiley & Sons, Inc.,

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Subject Code ME107724	Soft Computing Techniques	L = 3	T = 0	P = 0	Credits = 3
Evaluation Scheme	ESE	CT	TA	Total	ESE Duration
	100	20	30	150	3 Hours

Course Objectives	Course Outcomes
The objective of the course to: 1. To learn the basic concepts of Soft Computing. 2. To become familiar with various techniques like neural networks, genetic algorithms and fuzzy systems. 3. To apply soft computing techniques to solve problems.	**Students will be able to:** Apply suitable soft computing techniques for various applications. Integrate various soft computing techniques for complex problems.

UNIT 1 **Introduction to Soft Computing** Introduction-Artificial Intelligence-Artificial Neural Networks-Fuzzy Systems-Genetic Algorithm and Evolutionary Programming-Swarm Intelligent Systems-Classification of ANNs-McCulloch and Pitts Neuron Model-Learning Rules: Hebbian and Delta-Perceptron Network-Adaline Network-Madaline Network.	**CO1** **07 Hrs.**
UNIT 2 **Artificial Neural Networks** Back propagation Neural Networks - Kohonen Neural Network -Learning Vector Quantization -Hamming Neural Network - Hopfield Neural Network- Bi-directional Associative Memory -Adaptive Resonance Theory Neural Networks- Support Vector Machines - Spike Neuron Models.	**CO2** **07 Hrs.**
UNIT 3 **Fuzzy Systems** Introduction to Fuzzy Logic, Classical Sets and Fuzzy Sets - Classical Relations and Fuzzy Relations -Membership Functions -Defuzzification - Fuzzy Arithmetic and Fuzzy Measures - Fuzzy Rule Base and Approximate Reasoning - Introduction to Fuzzy Decision Making.	**CO3** **07 Hrs.**
UNIT 4 **Genetic Algorithms** Basic Concepts- Working Principles -Encoding- Fitness Function - Reproduction - Inheritance Operators - Cross Over - Inversion and Deletion -Mutation Operator - Bit-wise Operators -Convergence of Genetic Algorithm.	**CO4** **07 Hrs.**
UNIT 5 **Hybrid Systems** Hybrid Systems -Neural Networks, Fuzzy Logic and Genetic -GA Based Weight Determination - LR-Type Fuzzy Numbers - Fuzzy Neuron - Fuzzy BP Architecture - Learning in Fuzzy BP- Inference by Fuzzy BP - Fuzzy ArtMap: A Brief Introduction - Soft Computing Tools - GA in Fuzzy Logic Controller Design - Fuzzy Logic Controller	**CO5** **06 Hrs.**

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Text Books:

S. No.	Title	Author(s)	Publisher
1	S.P.Simon, "Soft Computing with MATLAB Programming"	N.P.Padhy	Oxford University Press, 2015
2	"Principles of Soft Computing"	S.N.Sivanandam	Wiley India Pvt.Ltd., 2nd Edition, 2011.
3	S.Rajasekaran, G.A.Vijayalakshmi Pai, "Neural Networks, Fuzzy Logic and Genetic Algorithm, Synthesis and Applications "	S.N.Deepa	PHI Learning Pvt.Ltd., 2017

Reference Books:

S. No.	Title	Author(s)	Publisher
1	Neuro-Fuzzy and Soft Computing	Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani	Prentice-Hall of India, 2002
2	First course on Fuzzy Theory and Applications	Kwang H.Lee	Springer, 2005
3	Fuzzy Sets and Fuzzy Logic-Theory and Application	George J. Klir and Bo Yuan	Prentice Hall, 1996
4	Neural Networks Algorithms, Applications, and Programming Techniques	James A. Freeman and David M. Skapura	Addison Wesley, 2003

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SYLLABUS

B. Tech. Seventh Semester- MECHANICAL ENGINEERING

Subject Code ME107725	Quality Control	L = 3	T = 0	P = 0	Credits = 3
Evaluation Scheme	ESE	CT	TA	Total	ESE Duration
	100	20	30	150	3 Hours

Course Objectives	Course Outcomes
The objective of the course to: 1. The objectives of the course are: to define and understand various terms associated with quality control. 2. The students enhance the understanding of the complexity of statistical analysis and interpretation, provide an introduction to the fundamental concept of SPC, total quality management, six sigma, quality function deployment. 3. The applications of these concepts, understanding the philosophies of TQM in order to better evaluate the TQM implementation proposals and access exactly where an organization stands on quality management with respect to ISO 9000 quality management.	**Students will be able to:** CO1: Explain the basic concept of quality &statistical Concept of variation. CO2: Demonstrate the understanding of basic concepts of quality assurance & use of the control charts. CO3: Apply the principles of acceptance sampling to solve practical problems. CO4: Demonstrate an understanding on quality management philosophies and frameworks. CO5: Demonstrate an in-depth understanding of Quality System.

UNIT 1 **Basic Concept of Quality:** Quality and quality control, concept of quality, quality characteristics, Quality of design and quality of conformance, History of quality control, Quality policy and objectives, Economics of quality. **Quality Assurance:** Concept, advantages, field complaints, quality rating, quality audit, inspection planning, quality mindness, quality budget, vendor quality rating (VQR), vendor rating (VR), manufacturing planning for quality, Quality function deployment (QFD).	**CO1** **04 Hrs.**
UNIT 2 **Statistical Concept of Variation:** Concept of variation frequency distribution, continuous and discrete, probability distributions viz. Normal, Exponential and Weibull distribution, pattern of variation, significance tests, Analysis of variance, statistical aids in limits and tolerances. **Acceptance Sampling:** Fundamental concept in acceptance sampling, operating characteristics curve. Acceptance plans, single, double and introduction of multiple plans.	**CO2** **05 Hrs.**
UNIT 3 **Statistical Quality Control:** Objectives, Growth and applications of S.Q.C., S.O.C, Techniques in manufacturing planning. Process capability analysis, Control charts for variables and attributes and their analysis, six sigma concepts.	**CO3** **06 Hrs.**
UNIT 4 **Total Quality Management:** Total Quality Control (TQC), Concept of Total Quality Management (TQM), TQM philosophies, Deming approach to TQM, Taguchi Philosophy, Crosby fourteen steps, TQM models, Tools and techniques of TQM.	**CO4** **04 Hrs.**
UNIT 5	**CO5**

		July 2023	1.00	Applicable for AY 2023-24 Onwards
Chairman (AC)	Chairman (BoS)	Date of release	Version	

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Quality system: Quality system, need for quality system, ISO 9000 Quality Management Standards, ISO 9000:2000 requirement, Quality Auditing, ISO 14000, Benefits of ISO 14000. **Benchmarking:** Definition of Benchmarking, Reasons for Benchmarking, Types of Benchmarking, Advantages of Benchmarking, and Limitations of Benchmarking.	**06 Hrs.**

Text Books:

S. No.	Title	Author(s)	Publisher
1	Quality Planning and Analysis	Juran & Gryana	McGraw Hill, New York
2	Statistical Quality Control	R.C. Gupta	Khanna Publishers, Delhi

Reference Books:

S. No.	Title	Author(s)	Publisher
1	Statistical quality control	Grant and Leavenworth	McGraw Hill, New York
2	Statistical Quality Control	M. Mahajan	Dhanpat Rai, New Delhi
3	Total Quality Management	K.C. Arora - S.K. Kataria	New Delhi
4	Total Quality Management	Suganthi & Samuel	PHI, Delhi

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SYLLABUS

B. Tech. Seventh Semester- MECHANICAL ENGINEERING

Subject Code ME100741	Supply Chain Management	L = 3	T = 0	P = 0	Credits = 3
Evaluation Scheme	ESE	CT	TA	Total	ESE Duration
	100	20	30	150	3 Hours

Course Objectives	Course Outcomes
The objective of the course to: 1. Understand the basics of Supply Chain Management 2. Learn about Supply Chain Network Design and Demand Management 3. Understand Supply Chain Planning, implementation and order processing with Information Technology 4. Learn application of Supply Chain Planning and Strategies. 5. Understand Location and Transportation Strategy in Supply Chain	**Students will be able to:** **CO1:** Describe the basics of Supply Chain Management **CO2:** Discuss and apply the Supply Chain Network Design and Demand Management **CO3:** Demonstrate Supply Chain Planning, implementation and order processing with Information Technology **CO4:** Apply the Supply Chain Planning and Strategies **CO5:** Demonstrate Location and Transportation Strategy in Supply Chain

UNIT 1 **Introduction to SCM** Meaning, Importance, Overview, Objective, Process Overview, Process tools, Supply chain dynamics, A model of SCM, Focus areas in SCM, Change Drivers, Evolution of SCM, Types of Cargoes. Cross docking warehousing, Agile SCM, Green SCM, Maritime SCMs. Case studies on SCM.	**CO1** **04 Hrs.**
UNIT 2 **Supply Chain Network Design and Demand Management** Logistics and SCM Network design, Integrated SCM Planning, Strategic Importance of Logistics/SCM network planning, Factors influencing network design decisions, Major Locational determinants, Framework - Design, and Functions. Demand Management, Relationship between customer service and demand management, Performance measures for customer service. Demand management process, The Role of forecasting and production, Nature of forecasting, Basic approach to demand forecasting, collaborative planning.	**CO2** **05 Hrs.**
UNIT 3 **Supply Chain Planning, implementation and order processing with IT** Aggregate planning in a supply chain, Aggregate planning strategies, Planning supply and demand in a supply chain, Planning and managing inventories in a supply chain, Planning for optimal level of product availability, Sourcing/source management, Strategic sourcing management / Transportation management.	**CO3**

		July 2023	1.00	Applicable for AY 2023-24 Onwards
Chairman (AC)	Chairman (BoS)	Date of release	Version	

The customer order cycle, Order management system, Order and replenishment cycles, Order processing categories, The logistics information system, The order management system, The warehouse management system, The transportation management system.	**06 Hrs.**
UNIT 4 **Supply Chain Planning and Strategies** Supply chain strategies, Strategy classification, Corporate strategy, Logistics strategies, Strategic fit, Achieving strategic fit, Supply chain strategies, Supply chain strategy framework, Supply chain relationships, Customer relationship management, Supply chain integration, Push, Pull and Push Pull systems, Demand-driven strategies, Distribution strategies, Centralised control strategy versus decentralized control strategy.	**CO4** **04 Hrs.**
UNIT 5 **Location and Transportation Strategy in Supply Chain** The need for long range planning, Major locational determinants, Historical perspectives on location problems, Single facility versus multi facility location, Methods of evaluating location alternatives. The role of transportation in a supply chain, Traffic and transportation strategy, Carrier selection decision, Intermodel transportation, Transport documentation, Transportation economics and pricing costing of transportation services, Rate and rating, Transportation management strategy, Transportation Management System (TMS).	**CO5** **06 Hrs.**

Text Books:

S. No.	Title	Author(s)	Publisher
1	Supply Chain Management	K. Shridhara Bhat	Himalaya Publishing House
2	Supply Chain Management, Strategy, Planning and Operation	Sunil Chopra, Peter Meindl, Dharam Vir Kalra	Pearson

Reference Books:

S. No.	Title	Author(s)	Publisher
1	Supply Chain Management, Creating Linkages for Faster Business Turnaround	Sarika Kulkarni, Ashok Sharma	Tata McGraw-Hill Publishing Company Ltd
2	Supply Chain Project Management, A Structured Collaborative and Measurable Approach	James B. Ayers	CRC Press

SYLLABUS
B. Tech. Seventh Semester- MECHANICAL ENGINEERING

Subject Code ME100742	Fuel Cells	L = 3	T = 0	P = 0	Credits = 3
Evaluation Scheme	ESE	CT	TA	Total	ESE Duration
	100	20	30	150	3 Hours

Course Objectives	Course Outcomes
The objective of the course to: 1. To present a problem oriented in depth knowledge of fuel cell technology. 2. To address the underlying concepts, methods and application of fuel cell technology.	**Students will be able to:** **CO1:** Identify different areas of fuel cell technology. **CO2:** Find the applications of all the areas in day-to-day life.

UNIT 1 **Introduction to Fuel Cell** Introduction, working and types of fuel cell, low, medium and high temperature fuel cell, liquid and methanol types, proton exchange membrane fuel cell solid oxide, hydrogen fuel cells, thermodynamics and electrochemical kinetics of fuel cells.	**CO1** **04 Hrs.**
UNIT 2 **Fuel Cells for Automotive Applications** Fuel cells for automotive applications, technology advances in fuel cell vehicle systems, onboard hydrogen storage, liquid hydrogen and compressed hydrogen, metal hydrides, fuel cell control system, alkaline fuel cell, road map to market.	**CO2** **05 Hrs.**
UNIT 3 **Fuel Cell Components and their impact on Performance** Fuel cell performance characteristics, current/voltage, voltage efficiency and power density, ohmic resistance, kinetic performance, mass transfer effects, membrane electrode assembly components, fuel cell stack, bi-polar plate, humidifiers and cooling plates.	**CO3** **06 Hrs.**
UNIT 4 **Fueling** Hydrogen storage technology, pressure cylinders, liquid hydrogen, metal hydrides, carbon fibers, reformer technology, steam reforming, partial oxidation, auto thermal reforming, CO removal, fuel cell technology based on removal like bio-mass.	**CO4** **04 Hrs.**
UNIT 5 **Fuel Cycle Analysis** Introduction to fuel cycle analysis, application to fuel cell and other competing technologies like battery powered vehicles, SI engine fueled by natural gas and hydrogen and hybrid electric vehicle.	**CO5** **06 Hrs.**

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Text Books:

S. No.	Title	Author(s)	Publisher
1	Fuel Cells for automotive applications	R.H. Thring	Professional engineering publishing UK.
2	Fuel Cell Technology Handbook	Gregor Hoogers	CRC Press

SYLLABUS
B. Tech. Seventh Semester- MECHANICAL ENGINEERING

Subject Code ME107791	I C Engine and Automobile lab	L = 0	T = 0	P = 2	Credits = 1
Evaluation Scheme	ESE	CT	TA	Total	ESE Duration
	25	-	25	50	3 Hours

Course Objectives	Course Outcomes
The objective of the course to: 1. To make the students familiar with the engine fuel and air supply systems, electronic injection systems used in modern automotive engines. 2. To make the students understand about the combustion phenomenon of SI and CI engines, engine pollutants 3. To teach the students on production and utilization of alternative solid, liquid and gaseous fuels. 4. To teach modern trends in IC engines.	**Students will be able to:** CO1: Recognize and differentiate various types of IC engines and will understand the basic thermodynamics of IC engine CO2: Compute the performance of IC engines. CO3: Apply knowledge in developing engine combustion models. CO4: To develop and modify fuel supply systems for SI and CI engines. CO5: Apply concepts of different alternate fuels used for SI and CI engines.

LIST OF EXPERIMENTS (Minimum Six experiments and four studies are to be performed by each student)

1. Study of IC Engine. (Engine components, material used and engine nomenclature)
2. Study of working of four stroke petrol engine and four stroke diesel engines with the help of cut section models
3. Study of working of two stroke petrol and two stroke diesel engines with the help of cut section models.
4. Study of fuel supply system of a petrol engine (fuel pump and simple carburetor)
5. Study of complete carburetor
6. Study of Petrol Injection System.
7. Study of fuel supply system of a Diesel engine (fuel pump and fuel injector)
8. Study of Ignition systems of an IC Engine (Battery and Magneto ignition system and electronic ignition system).
9. Study of Lubrication system of an IC Engine (Mist, Splash and Pressure lubrication)
10. Study of cooling systems of an IC Engine (Air cooling and water cooling)
11. To conduct a performance test on diesel engine to draw heat balance sheet for given load and speed.
12. To determine friction power of diesel engine by Willan's line or fuel rate extrapolation method.
13. To conduct a performance test on the variable compression ratio engine and to draw the heat balance sheet forgiven compression ratio, speed and load and plot the performance curves.
14. To conduct a performance test on a four-cylinder four stroke petrol engine and to draw the heat

balance sheet and performance curves

15. To calculate the indicated power, friction power and mechanical efficiency of four stroke four-cylinder petrol engine at full load and rated speed by Morse test.
16. To draw the valve timing diagram of a four-stroke S.I. or C.I. Engine using experimental setup.
17. Analysis of engine exhaust gases using Orsat apparatus / gas analyzer.

LIST OF EQUIPMENTS/MACHINES REQUIRED

1. Model of Two & Four Stroke Petrol Engine
2. Model of Two & Four Stroke Diesel Engine
3. Single Cylinder Actual S.I. Engine in Cut Section
4. Single Cylinder Actual C.I. Engine in Cut Section
5. Four Stroke, Four-Cylinder Petrol Engine in Cut Section
6. Carburetors in Cut Section / Without Cut Section.
7. Model of Petrol Injection System
8. Bosch Fuel Pump in Cut Section
9. Nozzles in Cut Section 10. Diesel Injectors in Cut Section
10. Four Stroke Single-Cylinder Diesel Engine Test Rig
11. Variable Compression Ratio Engine Test Rig
12. Four Stroke Multi-Cylinder Petrol Engine Test Rig
13. Experimental Setup for Drawing Valve Timing Diagram of Four Stroke S.I. or C.I. Engines.
14. Orsat Apparatus / Gas Analyzer for Engine Exhaust Gas Analysis

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SYLLABUS

B. Tech. Seventh Semester- MECHANICAL ENGINEERING

Subject Code ME107792	Computational Fluid Dynamics Lab	L = 0	T = 0	P = 2	Credits = 1
Evaluation Scheme	ESE	CT	TA	Total	ESE Duration
	25	-	25	50	3 Hours

Course Objectives	Course Outcomes
The objective of the course to: **1.** To study the basic governing equations and understand the basic properties of CFD. **2.** To understand discretization techniques and solving methods for improving accuracy. **3.** To inculcate the knowledge required to solve real time physical problems using simulation software. **4.** To impart skills required for the creation of 2D and 3D geometries for flow modeling. **5.** To enable students to apply the concepts of CFD and perform simulations using flow solvers and visualize the results.	**Students will be able to:** CO1: Perform geometry modeling for simple fluid flow problems. CO2: Develop different types of mesh suited for the accurate capturing of flow field. CO3: Perform 2D analysis to understand the flow characteristics and forces involved in different internal and external flows. CO4: Develop user defined functions to perform customized simulations. CO5: Demonstrate simulation-results using different post processing tools.

EXPERIMENTS

1. 2D/3D geometry creation using Design Modeler and/or Space Claim.
2. Unstructured mesh generation for a y-section/ Bifurcating Artery domain.
3. Structured mesh generation for the study of external flow over a NACA aerofoil.
4. Laminar and turbulent flow over an aerofoil at different angles of attack.
5. Simulation of incident shock wave and boundary layer interaction.
6. Investigation of flow patterns in oil-water flows using VOF model.
7. Prediction of wake formation behind tandem cylinders subjected to constant heat flux.
8. Simulation of blood flow through bifurcating artery.
9. Numerical study of tube-in-tube heat exchanger with the incorporation of user defined inlet velocity profiles
10. Transient study of phase change characteristics of an ice block.