Bansilal Ramnath Agarwal Charitable Trust's

Vishwakarma Institute of Technology

(An Autonomous Institute affiliated to Savitribai Phule Pune University formerly University of Pune)

Structure & Syllabus of

B.Tech. (Mechanical Engineering)

Pattern 'F-11 '

Effective from Academic Year 2016-17

(Final Year B.Tech.)

Prepared by: - Board of Studies in Mechanical Engineering

Approved by: - Academic Board, Vishwakarma Institute of Technology, Pune

Signed by

Chairman – BOS **Chairman – Academic Board**

Final Year B.Tech -Mechanical Engineering Structure with effect from Academic Year 2016-17 MODULE 7

Code	Subject	Type	Teaching Scheme			Assessment Scheme						Credits
			L	P	Tut.	ISA					ESA	
						Test 1	Test 2	HA	Tut.	CA	ESE	
	Elective *	Theory - Core	3	-	1	10	20	5	5	-	60	4
	Elective **	Theory – Core	3	-	1	10	20	5	5	-	60	4
ME 40101	Design of Mechanical Systems	Theory – Core	3	-	-	15	20	5	-	-	60	3
ME40103	CAD/CAM/CAE	Theory – Core	3	-	-	15	20	5	-	-	60	3
ME 40301	Design of Mechanical Systems	Lab – Core	-	2	-	-	-	-		70	30	1
ME40303	CAD/CAM/CAE	Lab – Core	-	2	-	-	-	-		70	30	1
		TOTAL	**12**	**4**	**2**							**16**

Elective*		***Elective*** **	
Tribology	ME42103	Power Plant Engineering	ME42118
Dynamics-Kinematics	ME42123	Turbo Machines	ME42111
Heat exchange Devices	ME42109	Industrial Fluid power	ME42117

Final Year B.Tech -Mechanical Engineering Structure with effect from Academic Year 2016-17 MODULE 8

Code	Subject	Type	Teaching Scheme			Assessment Scheme						Credits
			L	P	Tut.	ISA					ESA	
						Test 1	Test 2	HA	Tut.	CA	ESE	
	Elective[$]	Theory - Core	3	-	1	10	20	5	5	-	60	4
	Elective[$$]	Theory – Core	3	-	1	10	20	5	5	-	60	4
ME 40106	Vibration Analysis	Theory – Core	3	-	-	15	20	5	-	-	60	3
ME 40108	Refrigeration and Air Conditioning	Theory – Core	3	-	-	15	20	5	-	-	60	3
ME 40306	Vibration Analysis	Lab – Core	-	2	-	-	-	-		70	30	1
ME 40308	Refrigeration and Air Conditioning	Lab – Core	-	2	-	-	-	-		70	30	1
		TOTAL	**12**	**4**	**2**							**16**

Elective[$]		***Elective[$$]***	
Finite Element Method	ME 42102	Nonconventional Energy Sources	ME42119
Optimization Techniques and Operations Research	ME42122	Automobile Engineering	ME42120
Robotics	ME42110	Hybrid-Electric vehicles- Performance & Environment Impact	ME42124

Final Year B.Tech --Mechanical Engineering Structure with effect from Academic Year 2016-17

Semester I – Irrespective of Module

Code	Subject	Type	Teaching Scheme			Assessment Scheme						Credits
			L	P	Tut.	ISA					ESA	
						Test 1	Test 2	HA	Tut.	CA	ESE	
ME47303	Major Project – Stage II	Project	-	8	-	-	-	-	-	70	30	4
TOTAL			**-**	**8**	**-**							**4**

Final Year B.Tech --Mechanical Engineering Structure with effect from Academic Year 2016-17

Semester II – Irrespective of Module

Code	Subject	Type	Teaching Scheme			Assessment Scheme						Credits
			L	P	Tut.	ISA					ESA	
						Test 1	Test 2	HA	Tut.	CA	ESE	
ME47304	Major Project- Stage III	Project	-	12	-	-	-	-	-	70	30	6
TOTAL			**-**	**12**	**-**							**6**

MODULE VIII

ME42102-FINITE ELEMENT METHOD

Credits: 03 **Teaching Scheme: 3 Hours /Week**

Unit I **(7 Hrs)**

Fundamental Concepts

A. Stresses and equilibrium, boundary conditions, strain displacement relation, temperature effect, potential energy and equilibrium, Galerkin's method, Integral formulation for Numerical Solution-Variational method, Collocation method, Galerkin's method.

B. Saint Venant's principle, Von Mises stress, Gaussian Elimination, Stress and strain relations, plane stress and plain strain, Potential energy method.

Unit II **(10 Hrs)**

One Dimensional Problems

A. Linear element, Solution by Galerkin's method, solution for nodal residual equation, Obtaining elemental stiffness and load matrices form the above equation. Assembly of the above matrices for obtaining Global stiffness and Load matrix. Application of the above equation for Problems like, axially loaded bar, temperature distribution analysis, Voltage distribution analysis, etc.

B. Quadratic shape functions, one dimensional acoustical vibrations

Unit III **(5 Hrs)**

Two Dimensional Finite Elements

A. Linear triangular and Bilinear Rectangular elements, Shape function for the same. Local co-ordinate system, significance of natural co-ordinate system, Natural co-ordinate systems for linear element, Linear Triangular element.

B. Local co-ordinate system for Bilinear Rectangular elements.

Unit IV **(8 Hrs)**

Two Dimensional FEA Modeling

A. FEA modeling, Const. strain triangles-Isoperimetric representation, potential energy method, stiffness and force terms, stress calculations, temperature effect. Problem modeling and boundary conditions.

B. Application of the above equation to Torsion of Non Circular cross section, Electromagnetic static FEA for finding magnetic flux density in air gap.

Unit V **(10 Hrs)**

Two Dimensional FEA Applications

A. Differential equation for Axisymmetric field problems, solution by Galerkin's method, obtaining elemental stiffness and load matrices. Problems by using triangular elements. Problems on Plane Trusses, analysis of Beam for transverse loads.

B. One case study on Axisymmetric FEA

Text Books

1. "Applied Finite Element Analysis", Segerlind L. J., John Wiley and Sons New York.

2. "Concepts and Applications of Finite Element Analysis", Cook R D., Malkus D. S. and Plesha M. E., New York. John Wiley and Sons.

3. "Textbook Of Finite Element Analysis", Seshu P., New Delhi. Prentice Hall of India.

Reference Books

1. "Theory and Problems of Finite Element Analysis", Buchanan G. R., Mcgraw Hill Inc. New York, 1994.

2. "Finite Element Method-Linear Static and Dynamic Finite Element Analysis", Hughes Thomas J., New York. Dover Pub., 2007

3. "Finite Element Analysis-thermo mechanics of solids", Nicholson David W: New York. CRC Press, 2003.

4. "Finite Element Analysis in Engineering Design", Rajasekaran S., Wheeler Publication, Allahabad.

5. "Schaum's Otlines Finite Element analysis", Buchanan George R., New Delhi. Tata Mc Graw Hill Publication Co.

6. "Fundamentals of Finite Element Analysis", Hutton David V., New Delhi. Tata Mcgraw-Hill Publishing Company Ltd.

Course Outcomes:

1. Recognise the significance and importance of finite element methods to the professional design engineer.
2. Demonstrate a basic understanding of the concepts, mathematical formulation and numerical implementation
3. Formulate and solve mechanical system involving 1D elements.
4. Formulate and solve mechanical system involving 2D elements.
5. Demonstrate the ability to invoke appropriate assumptions, select proper elements and develop FEA models and interpret the numerical results in design
6. Able to identify and solve engineering problems using commercial FEA code such as ANSYS, NASTRAN

ME42202-FINITE ELEMENT METHOD (Tutorial)

Credits: 01 **Teaching Scheme: 1Hours / Week**

List of Tutorials

1. Integral formulation for numerical solution by variational method
2. Analysis of simply supported beam by weighted residual method
3. Calculation of the temperature distribution in one dimensional fin and through composite wall.
4. Calculation of nodal displacement, the internal member forces and stresses in elements for axially loaded beam members with/without self weight, and/or temperature effect consideration.
5. Evaluation of shape functions for linear triangular element and bilinear rectangular element
6. Evaluation of stiffness matrices and force vector for axisymmetric problems
7. Calculation of nodal displacement and the internal member forces for transverse loading of beam.
8. Calculation of nodal displacement for plane trusses.

Text Books

1. "Applied Finite Element Analysis", Segerlind L. J., John Wiley and Sons New York.
2. "Concepts and Applications of Finite Element Analysis", Cook R D., Malkus D. S. and Plesha M. E., New York. John Wiley and Sons.
3. "Textbook Of Finite Element Analysis", Seshu P., New Delhi. Prentice Hall of India.

Reference Books

1. "Theory and Problems of Finite Element Analysis", Buchanan G. R., Mcgraw Hill Inc. New York, 1994.
2. "Finite Element Method-Linear Static and Dynamic Finite Element Analysis", Hughes Thomas J., New York. Dover Pub., 2007
3. "Finite Element Analysis-thermo mechanics of solids", Nicholson David W: New York. CRC Press, 2003.
4. "Finite Element Analysis in Engineering Design", Rajasekaran S., Wheeler Publication, Allahabad.
5. "Schaum's Otlines Finite Element analysis", Buchanan George R., New Delhi. Tata Mc Graw Hill Publication Co.
6. "Fundamentals of Finite Element Analysis", Hutton David V., New Delhi. Tata Mcgraw-Hill Publishing Company Ltd.

Course Outcomes:

1. Recognise the significance and importance of finite element methods to the professional design engineer.
2. Demonstrate a basic understanding of the concepts, mathematical formulation and numerical implementation
3. Formulate and solve mechanical system involving 1D elements.
4. Formulate and solve mechanical system involving 2D elements.
5. Demonstrate the ability to invoke appropriate assumptions, select proper elements and develop FEA models and interpret the numerical results in design
6. Able to identify and solve engineering problems using commercial FEA code such as ANSYS, NASTRAN

ME42122 OPTIMIZATION TECHNIQUES AND OPERATIONS RESEARCH

Credits: 03 **Teaching Scheme: 3 Hours / Week**

Unit 1: Single Variable optimization Algorithms (8 Hours)

Part A:

Optimality Criteria, Bracketing Methods: Exhaustive Search Method, Bounding Phase Method, Region Elimination Methods: Inter Halving Method, Fibonacci Search Method, Gradient Based Methods: Newton-Raphson method, Secant Method

Part B:

Review of Mathematics, Golden section search Method, Cubic search Method.

Unit 2: Multivariable and Constrained optimization Algorithms (8 Hours)

Part A:

Direct Search Methods: Evolutionary Optimization method, Gradient Based Method: Cauchy's (steepest descent) Method, Newton's Method, Lagrange Multiplier, Kuhn-Tucker Condition, Direct Search Method: Variable Elimination Method, Linearized Search Techniques: Frank-Wolfe Method

Part B:

Powell's conjugate Direction Method, Conjugate Gradient Method, Cutting Plane Method, Random Search Method

Unit 3: Linear Programming (8 Hours)

Part A:

Linear Programming, Formulation of LP Problem, Standard Form, Solution using Simplex Method. Duality. Special Conditions in LPP. Economic Interpretation of Dual, Solution of LPP using Duality concept, Dual Simplex Method. Sensitivity Analysis. Big M method,two phase method

Part B:

Solution of LPP using TORA & Solver in Excel

Unit 4: Major Topics in Operations Research (8 Hours)

Part A:

Inventory models: Classification, EOQ, Purchase Model with shortages, Purchase Model without shortages, Production Model with shortages, Production Model without shortages, Quantity Discounts, Game Theory: Game theory Introduction,Terminology, minimax and maximin principle, Saddle Point, Dominance property, Solutions with Graphical method .Queueing Theory: Introduction, terminology,Poisson single and multi-channel queueing system models: M/M/1 Model, M/M/C Model, M/Ek/1 Model

Part B:

Transportation, Scheduling Algorithms, Forecasting.

Unit 5: Evolutionary and Modern Optimization Algorithms (8 Hours)

Part A:

Introduction to Evolutionary Algorithms: Genetic Algorithm, Fuzzy Logic, Neural Network

Part B:

Shape and Topology Optimization

Text Books:

1. Singiresu S. Rao, "Engineering Optimization", New Age International (P) Ltd.,

Bombay.

2. Kalyanmoy Deb "Optimization For Engineering Design Algorithms and Examles", PHL learning Private Ltd, New Delhi

3. Paneerselvam,"Operations Research", Prentice Hall of India

4. Gupta & Hira,"Operations Research", S. Chand & Co.

Reference Books:

1. Mohan Joshi and Kannan Moudgalya , "Optimization: Theory and Practice", Narosa Publishing House, Bombay.

2. Ashok Belegundu and Tirupathi Chandrupatla, "Optimization: concepts and application engineering", Pearson Education Asia, Delhi.

3. Rajasekaran G., G. A. Vijaylakshmi Pai, "Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications", Prentice Hall of India, 2001.

4. Winston W. L., "Operations Research: Applications and Algorithms", Duxbury Press, 1994.

5. Walsh G. R., "Methods of Optimization", John Wiley & Sons, 1975.

6.Sharma J. K.,"Operations Research Theory and Application", Pearson Education Pvt. Ltd 2ndEdition, ISBN-0333-92394-4

Course Outcomes:

1. The student will be able to understand and use the single variable optimization algorithm to solve different problems

2. The student will be able to select appropriate algorithm and implement it for multi-variable and constrained optimization problems.

3. The student will be able to formulate linear programming problem and apply different linear programming methods to solve it.

4. Students will be able to formulate managerial decision problems into inventory model, game theory problem and queueing theory problem.

5. The student will be able to use mathematical software for the solution of engineering problems with conventional and evolutionary algorithms.

ME42222 OPTIMIZATION TECHNIQUES AND OPERATIONS RESEARCH (Tutorial)

Credits: 1 **Teaching Scheme: 1 Hours / Week**

List of Tutorials:

1. Numerical examples on single variable optimization by bracketing method (Interval halving, Golden Search, Fibonacci)
2. Numerical examples on single variable optimization by open method (Single fixed point iteration, Newton Raphson, Secant Method)
3. Numerical examples on conjugate gradient method and steepest descent method of two dimensional optimization
4. Numerical examples on Lagrangian multiplier method of constrained multivariable optimization
5. Numerical examples on direct search method of constrained multivariableOptimization
6. Numerical examples on linearization method of constrained multivariable optimization
7. Use Graphical and Simplex method for solving linear programming problems.(CO1)
8. Application of Duality concept for solving linear programming problems and carried out sensitivity analysis for same problems (CO1)
9. Use Big M method and Two phase method for solving linear programming problem.
10. Different inventory model and its examples.
11. Game theory terminologies and problems on game with pure and mixed strategies. (CO4)
12. Queuing theory models and its examples. (CO5)
13. Modeling by evolutionary algorithm (GA /Fuzzy logic/Neural Network).

Text Books: ***(As per IEEE format)***

1. Singiresu S. Rao, “Engineering Optimization”, New Age International (P) Ltd., Bombay.

2. Kalyanmoy Deb “Optimization For Engineering Design Algorithms and Examles”, PHL learning Private Ltd, New Delhi

3. Paneerselvam,“Operations Research”, Prentice Hall of India

4. Gupta & Hira,“Operations Research”, S. Chand & Co.

Reference Books: ***(As per IEEE format)***

1. Mohan Joshi and Kannan Moudgalya , "Optimization: Theory and Practice", Narosa Publishing House, Bombay.
2. Ashok Belegundu and Tirupathi Chandrupatla, "Optimization: concepts and application engineering", Pearson Education Asia, Delhi.
3. Rajasekaran G., G. A. Vijaylakshmi Pai, "Neural Networks, Fuzzy Logic, and Genetic Algorithms: Synthesis and Applications", Prentice Hall of India, 2001.
4. Winston W. L., "Operations Research: Applications and Algorithms", Duxbury Press, 1994.
5. Walsh G. R., "Methods of Optimization", John Wiley & Sons, 1975.
6. Sharma J. K.,"Operations Research Theory and Application", Pearson Education Pvt. Ltd 2ndEdition, ISBN-0333-92394-4

Course Outcomes:

1. The student will be able to understand and use the single variable optimization algorithm to solve different problems

2. The student will be able to select appropriate algorithm and implement it for multi-variable and constrained optimization problems.

3. The student will be able to formulate linear programming problem and apply different linear programming methods to solve it.

4. Students will be able to formulate managerial decision problems into inventory model, game theory problem and queueing theory problem.

5. The student will be able to use mathematical software for the solution of engineering problems with conventional and evolutionary algorithms.

ME42110 :: ROBOTICS

Credits:3 **Teaching Scheme: 3 Hours / Week**

Unit 1: Introduction to Robotics **(8 Hours)**

Part A: Automation and Robotics, Robots-Anatomy, Structure and classification, Robot performance – Resolution, Accuracy and Repeatability, Homogeneous transform, D-H parameters, Euler angles.

Part B: Fixed angle representation, mapping, Inverting Homogenous transformation

Unit 2: Robot Kinematics and Dynamics **(8Hours)**

Part A: Direct kinematics of a manipulator, workspace, Inverse kinematics, Algebraic approaches to inverse kinematics, Lagrange – Euler formulation of dynamic equations of a manipulator.

Part B: Geometric approaches for inverse kinematics

Unit 3: Trajectory Planning and Manipulator Control **(8 Hours)**

Part A: Introduction to Trajectory Planning, Path description / generation, joint space and Cartesian space schemes.

Manipulator Control – Linear control of manipulators, 2nd order control systems, control law partitioning, modeling and control of a single joint, introduction to force control.

Part B:PID controllers

Unit 4: End effectors, sensors and vision systems **(8 Hours)**

Part A: tools as end effectors,

Robot Grippers:- Types of Grippers , Design aspect for gripper, Force analysis for various basic gripper system.

Sensors for Robots:- Characteristics of sensing devices, Selections of sensors, Classification and applications of sensors. Types of Sensors, Need for sensors and vision system in the working and control of a robot.

Part B: choosing the right sensor

Unit 5: Robotic System design and applications **(8 Hours)**

Part A: Correlation between the robot design and the task to be performed, Manipulator Mechanism design, kinematic configuration, redundant and closed chain structures, Actuation schemes, position and force sensing.

Robot applications in material handling, machine loading / unloading, assembly, inspection and processing. Robot Operation: Hydraulic, pneumatic and electrical actuators, characteristics and comparison.

Part B: Non industrial application, Robot safety, Robot Programming

Text Books: ***(As per IEEE format)***

1. John J. Craig, "Introduction to Robotics – Mechanics and Control", Pearson Education Inc.

2. Groover M. P., Weiss M., Nagel R. N., Odrey N. G., "Industrial Robotics - Technology, Programming and Applications" McGraw Hill.

Reference Books: ***(As per IEEE format)***

1. Saeed Niku, ."Introduction to Robotics – Analysis, Systems and Applications", Prentice Hall of India 2003.

2. Mittal R. K. and Nagrath I. J., "Robotics and Control", Tata McGraw Hill Publishing Co. 2003.

3. Gonzalez R. C., Lee C. S. G., “Robotics - Control, Sensing, Vision and Intelligence”, McGraw Hill

Course Outcomes:

The student will be able to –

1. Familiar with the history, concept development and key components of robotics technologies.

2. Understand basic mathematic manipulations of spatial coordinate representation and transformation using matrix algebra

3. Solve basic robot forward and inverse kinematics problems.

4. Do the path planning for a simple robotic system

5. Integrate sensor technology and other external devices into the robot system.

ME42210 : ROBOTICS

Credits: 1 **Teaching Scheme: 1 Hours / Week**

List of Tutorials:

List of Tutorials

1. Problems on Homogeneous transforms
2. Problems on forward Kinematics
3. Problems on inverse kinematics
4. Problems on Lagrange – Euler formulation
5. Problems on Path Generation
6. Robot Programming

Text Books: ***(As per IEEE format)***

1. John J. Craig, "Introduction to Robotics – Mechanics and Control", Pearson Education Inc.
2. Groover M. P., Weiss M., Nagel R. N., Odrey N. G., "Industrial Robotics - Technology, Programming and Applications" McGraw Hill.

Reference Books: ***(As per IEEE format)***

1. Saeed Niku, ."Introduction to Robotics – Analysis, Systems and Applications", Prentice Hall of India 2003.
2. Mittal R. K. and Nagrath I. J., "Robotics and Control", Tata McGraw Hill Publishing Co. 2003.
3. Gonzalez R. C., Lee C. S. G., "Robotics - Control, Sensing, Vision and Intelligence", McGraw Hill

Course Outcomes:

The student will be able to –

1. Familiar with the history, concept development and key components of robotics technologies.
2. Understand basic mathematic manipulations of spatial coordinate representation and transformation using matrix algebra
3. Solve basic robot forward and inverse kinematics problems.
4. Do the path planning for a simple robotic system
5. Integrate sensor technology and other external devices into the robot system.

ME42119: NON-CONVENTIONAL ENERGY SOURCES

Credits: 3 **Teaching Scheme: 3 Hours / Week**

Unit 1: Introduction to Energy Sources **(6 Hours)**

Part A: Energy scenario, energy and development, energy consumption, energy demand and availability, energy crisis, energy and environment, sources of energy – conventional and non-conventional, non-renewable and renewable.

Part B: Need for alternative energy sources, Prospects and potential of non-conventional energy sources

Unit 2: Solar Thermal Energy **(10Hours)**

Part A: Solar radiation, solar thermal energy conversion, solar energy collectors, solar energy storage, solar energy applications, solar thermal power plant.

Part B: Passive building

Unit 3: Ocean Energy **(8 Hours)**

Part A: Ocean thermal energy conversion, open, closed and hybrid cycles.

Tidal energy conversion principle, single and double basin arrangements.

Wave energy conversion devices

Part B: Tidal power plant

Unit 4: Wind Energy **(6 Hours)**

Part A: Wind energy conversion principle, wind energy conversion systems, wind energy collectors, applications of wind energy.

Part B: Site selection considerations for wind energy applications, Material selection for geothermal power plants

Unit 5: Biomass and other alternate sources **(10 Hours)**

Part A: Biomass conversion, biogas generation, biogas plants, biomass gasification.

Geothermal energy conversion systems, hydrothermal and petrothermal resources

Magneto-hydro-dynamic (MHD) power generation principle and systems

Hydrogen as an alternative fuel

Part B: Fuel cell, Hydrogen production

Text Books: ***(As per IEEE format)***

1. G. D. Rai, Non-conventional Energy Sources, Khanna Publishers

2. S. Rao and Dr. B. B. Parulekar, Energy Technology – Nonconventional, Renewable and Conventional, Khanna Publishers

3. D. S. Chauhan and S. K. Srivastava, Non-conventional Energy Resources, New Age

Reference Books: ***(As per IEEE format)***

1. G. S. Sawhney, Non-conventional Energy Resources, PHI

2. Chetan Singh Solanki, Renewable Energy Technologies – A practical guide for beginners, PHI

3. B. H. Khan, Nonconventional energy Resources, Tata McGraw Hill Education Pvt Ltd

Course Outcomes: (Theory + Tutorial)

The student will be able to –

1. Compare different non-conventional sources of energy
2. Compute efficiency of solar energy collectors
3. Explain different ocean energy conversion systems
4. Evaluate performance of wind energy conversion system
5. Illustrate applications of biomass and geothermal energy sources

ME42219 NON-CONVENTIONAL ENERGY SOURCES (Tutorial)

Credits:1 **Teaching Scheme: 1. Hours / Week**

List of Tutorials:

List of Tutorials

1. Numericals on solar radiation
2. Numericals on efficiency calculations of solar collectors
3. Numericals on ocean energy conversion
4. Numericals on wind energy conversion
5. Numericals on geothermal/biomass energy conversion

Text Books: ***(As per IEEE format)***

1. G. D. Rai, Non-conventional Energy Sources, Khanna Publishers

2. S. Rao and Dr. B. B. Parulekar, Energy Technology – Nonconventional, Renewable and Conventional, Khanna Publishers

3. D. S. Chauhan and S. K. Srivastava, Non-conventional Energy Resources, New Age

Reference Books: ***(As per IEEE format)***

1. G. S. Sawhney, Non-conventional Energy Resources, PHI

2. Chetan Singh Solanki, Renewable Energy Technologies – A practical guide for beginners, PHI

3. B. H. Khan, Nonconventional energy Resources, Tata McGraw Hill Education Pvt Ltd

Course Outcomes: (Theory + Tutorial)

The student will be able to –

1. Compare different non-conventional sources of energy

2. Compute efficiency of solar energy collectors

3. Explain different ocean energy conversion systems

4. Evaluate performance of wind energy conversion system

5. Illustrate applications of biomass and geothermal energy sources

ME 42120 :: AUTOMOBILE ENGINEERING

Credits: 3 **Teaching Scheme: 3 Hours / Week**

Unit I : Basic Concepts, Engines and Clutches (8Hrs.)

(A) Vehicle specifications, classification, layout, applications.

Engine components, basic engine nomenclature, engine classification, working of four stroke & two stroke engines, valve timing diagrams, port timing diagrams, engine selection criteria for different automotive applications,

Clutches : purpose of clutch, classification, single plate clutch, multiple plate clutches, centrifugal clutch, cone clutch, diaphragm spring clutch, vacuum operated clutch, clutch plate, lining material.

(B) Preventive maintenance, trouble shooting and diagnosis of clutches.

Automotive Electricals - Battery, Ignition system.

Unit II : Gearbox (8Hrs.)

(A) Function, various resistances, tractive effort, performance curves, power required for acceleration and gradiability, selection of gear ratio, sliding mesh gearbox, constant mesh gearbox and synchromesh gearbox, epycyclic gearbox, torque convertor, automatic transmission, overdrive.

(B) Preventive maintenance, trouble shooting and diagnosis of gearbox.

Automotive Electricals - Starting system

Unit III:Steering System, Wheels and Tyres (8Hrs.)

(A) Purpose, requirement, steering mechanisms, wheel alignment and wheel balancing, centre point steering, cornering force, slip angle, scrub radius, steering characteristics, steering gearboxes, power steering.

(B) Preventive maintenance, trouble shooting and diagnosis of steering system.

Wheels and Tyres.

Unit IV: Propeller Shaft, Universal joints, Differential and Rear Axle (8 Hrs.)

(A) Propeller shaft, universal joints, final drive, differential and their types, rear axle arrangements, two speed rear axle, single, double and triple reduction rear axles. driving thrust, torque reaction, Hotchkiss drive, Torque tube drive.

(B) Preventive maintenance, trouble shooting and diagnosis of propeller shaft, universal joints, differential and rear axle.

Automotive Electricals - Charging system.

Unit V: Suspension System and Braking System (8Hrs.)

(A) Suspension System

Object, various types of springs, shock absorbers, sprung weight and unsprung weight, basic suspension movements, conventional suspension system, independent suspension systems, air suspension, hydrolastic suspension, hydra-gas suspension, interconnected suspension, self leveling suspension.

Braking System

Purpose, stopping distance and time, brakingforce, brake efficiency, classification, mechanical, hydraulic, air brakes, servo-braking systems, antiskid braking system.

(B) Preventive maintenance, trouble shooting and diagnosis of suspension system and braking system.

Automotive Electricals - Dashboard instruments.

Text Books:

1. K.Newton, W.Steeds & T.K.Garrett, 'The Motor vehicle', 'BUTTERWORTHS' London.

2. Singh Kripal, ‘Automobile Engineering’, Vol.I and Vol. II, Standard Publishers Distributors.

3. R.K. Rajput, A Textbook of Automobile Engineering, LaxmiPublications (Pvt.) Ltd.

Reference Books

1. Narang G.B.S., ‘Automobile Engineering’, S.Chand and Company (Pvt.) Ltd.
2. Harbans Singh Reyat, ‘The Automobile’ S.Chand and Company (Pvt.) Ltd.
3. William H. Crouse and Donald L.Anglin, ‘Automotive Mechanics’, Tata McGraw Hill Publishing Company.
4. Joseph Heitner, ‘Automotive Mechanics’, C.B.S. Publisher and Distributors.
5. A.W.Judge, ‘Automotive systems’, Vol. 1 to 8.
6. AA Book of Car.

Course Outcomes:

The student will be able to-

1.Describe construction, working and other details of Internal Combustion Engines, Clutches,Battery and Ignition system

2. Demonstrate knowledge aboutconstruction, workingand other details of different Gearboxes and Starting system

3.Understand and explain aboutconstruction, workingand other details of Steering system, Wheels and Tyres

4.Demonstrate knowledge aboutconstruction, working, and other details of Propeller Shaft, Universal joints, Differential, Rear Axle andCharging system

5. Describe construction, working and other details ofSuspension System, Braking System andDashboard instruments

ME 42220:: AUTOMOBILE ENGINEERING

Credits: 01 **Teaching Scheme: 1 Hour / Week**

List of Tutorials:

1) Study and report on preventive maintenance, trouble shooting and diagnosis of clutches.

2) Study and report on preventive maintenance, trouble shooting and diagnosis of gearbox.

3) Study and report on preventive maintenance, trouble shooting and diagnosis of steering system.

4) Study and report on preventive maintenance, trouble shooting and diagnosis of universal joints, differential and rear axle.

5) Study and report on preventive maintenance, trouble shooting and diagnosis of suspension system.

6)Study and report on preventive maintenance, trouble shooting and diagnosis of braking system.

Text Books:

1. K.Newton, W.Steeds&T.K.Garrett, 'The Motor vehicle', 'BUTTERWORTHS' London.

2. Singh Kripal, 'Automobile Engineering', Vol.I and Vol. II, Standard Publishers Distributors.

3. R.K. Rajput, A Textbook of Automobile Engineering, Laxmi Publications (Pvt.) Ltd.

Reference Books

1. Narang G.B.S., 'Automobile Engineering', S.Chand and Company (Pvt.) Ltd.
2. Harbans Singh Reyat, 'The Automobile' S.Chand and Company (Pvt.) Ltd.
3. William H. Crouse and Donald L.Anglin, 'Automotive Mechanics', Tata McGraw Hill Publishing Company.
4. Joseph Heitner, 'Automotive Mechanics', C.B.S. Publisher and Distributors.
5. A.W.Judge, 'Automotive systems', Vol. 1 to 8.
6. AA Book of Car.

Course Outcomes:

The student will be able to-

1. Understand and explain about preventive maintenance, trouble shooting and diagnosis of clutches.

2. Understand and explain about preventive maintenance, trouble shooting and diagnosis of gearbox

3. Understand and explain about preventive maintenance, trouble shooting and diagnosis of steering system.

4. Understand and explain about preventive maintenance, trouble shooting and

diagnosis of universal joints, differential and rear axle.

5. Understand and explain about preventive maintenance, trouble shooting and

diagnosis of suspension system and braking system.

ME 42124: HYBRID-ELECTRIC VEHICLES – PERFORMANCE AND ENVIRONMENT IMPACT

Credits: 03 **Teaching Scheme: 3 Hours / Week**

Unit I **(8 Hrs)**

GLOBAL GROUND TRANSPORTATION SECTOR

A. Motivation for Hybrids, Increase in Transportation Demand, Motivation and Plant to Well Analysis, Well to Plant Analysis and Well To Wheel analysis, Comparison of Conventional Vs. Hybrid Vehicles, Factors Affecting Vehicle Fuel Economy

Unit II **(8 Hrs)**

DEFINITION OF HYBRIDIZATION AND HYBRID VEHICLES

A. What is a Hybrid Electric Vehicle, Hybridization Basics, Hybrid Vehicle Classifications

Unit III **(8 Hrs)**

VEHICLE DYNAMICS AND ENERGY FLOW

A. Vehicle Requirements, Introduction to Autonomie, Introduction to Autonomie

Interactive Elements:
Project

Unit IV

(8Hrs)

HYBRID DRIVETRAIN CHARACTERIZATION

A. System Components, Typical ICE Engine Efficiency Maps, System Components: Electric Motors, System Components: Energy Storage, System Components for Different HEV Architectures

Interactive Elements:
Project

Unit V

(8Hrs)

HYBRID ARCHITECTURES

A. Vehicle Powertrain Architecture, HEV Base Operational Definitions, Hybrid Architecture Selection, Architecture and Component Selection

Interactive Elements:
Project

Text Books: Transcripts, slides and demonstration of Purdue Next online course

Reference Books: Transcripts, slides and demonstration of Purdue Next online course

Course Outcomes: (Theory +Tutorial)

The student will be able to –

- Demonstrate general overview of the need for hybrid-electric vehicles for transportation, overall fuel consumption and environmental improvement possible using HEVs.
- Demonstrate and evaluate various architectures of HEVs.
- Analyze various architectures of HEVs.
- Demonstrate and evaluate various components of HEVs
- Design the HEV with energy balance, sizing and well to wheel analysis

ME 42124 HYBRID-ELECTRIC VEHICLES – PERFORMANCE AND ENVIRONMENT IMPACT (Tutorial)

Credits: 1 **Teaching Scheme: 1Hours / Week**

List of Tutorials:

1. Technical analysis of project problem statement (CO 4 and CO 5)
2. Basic calculations of the project problem statement (CO 4 and CO 5)
3. Demonstration and Application of MAT LAB coding required for the project (CO 4 and CO 5)
4. Formulation of the MATLAB code for the project (CO 4 and CO 5)
5. Results and discussion of the Code outcomes (CO 4 and CO 5)

Text Books: Transcripts, slides and demonstration of Purdue Next online course

Reference Books: Transcripts, slides and demonstration of Purdue Next online

Course Outcomes: (Theory +Tutorial)

The student will be able to –

1. Demonstrate general overview of the need for hybrid-electric vehicles for transportation, overall fuel consumption and environmental improvement possible using HEVs.
2. Demonstrate and evaluate various architectures of HEVs.
3. Analyze various architectures of HEVs.
4. Demonstrate and evaluate various components of HEVs
5. Design the HEV with energy balance, sizing and well to wheel analysis

ME40106 VIBRATION ANALYSIS

Credits:03 **Teaching Scheme: 3 Hours / Week**

Unit 1: Gyroscope **(8 Hours)**

Part A:

GYROSCOPE: Principles of gyroscopic action, precession, gyroscopic couple, effect of gyroscopic couple on ships, aero plane and vehicles etc.

Part B: Gyro based Instruments, Applications

Unit 2: Balancing **(8 Hours)**

Part A: Balancing: Balancing of rotating masses in one and several planes, balancing of reciprocating masses in single and multi cylinder engines—inclined, radial and Vee type. Primary and secondary balancing analysis. Concept of direct and reverse cranks. Static and dynamic balancing machines.

Part B: Study of an actual Dynamic balancing machine used for Automobile wheel alignment and balancing.

Unit 3: Free Vibration **(8 Hours)**

Part A:Introduction to vibration:

Elements of a vibratory system, S.H.M., degrees of freedom and modeling of a system, Concept of linear and non-linear systems, equivalent spring, damper and inertia for linear and torsional systems.

Single degree of freedom system:

Undamped free vibration, natural frequency, initial conditions, damped free vibrations , over damped , critically damped and under damped vibrations, logarithmic decrement , viscous damping and dry friction / Coulombs damping.

Part B: Study of an actual Single DOF System with and without damping.

Unit 4: Forced Damped Vibration **(8 Hours)**

Part A:

Forced Damped Vibration:

Single degree of freedom system, rectilinear and torsional forced vibrations --- harmonic excitation, excitation due to reciprocating and rotating unbalance, magnification factor, resonance, phase angle, base excitation, force and motion transmissibility, vibration isolation.

Two Degrees of Freedom System Free Vibrations:

Introduction, Formulation of equations, elastic and inertial couplings, stiffness and mass

matrix, characteristics matrix and determinant, natural frequencies and mode shapes, orthogonality of mode shapes, principal coordinates, two and three rotor system.

Part B: Study of an actual Multi DOF System with and without damping.

Unit 5: Vibration Measurements and Whirling of Shafts (8 Hours)

Part A:

Measurement of displacement, velocity, acceleration, frequency and damping. Different types of pick-ups, exciters, vibration meter, periodic motion and Fourier analysis, FFT Spectrum Analyzer, Introduction to vibration analysis of machine tools, centrifugal pumps and turbines.

Part B: Critical Speed: whirling of horizontal and vertical shafts carrying single rotor. Damped and undamped systems.

Text Books:

1. Shigley J. E. and Uicker J. J., Theory of Machines and Mechanisms,International Edition, McGraw Hill Inc
2.Grover G. K., Mechanical Vibrations , Nem Chand and Bros
3.R. S. Khurmi, Theory of Machines , Khanna Publications.

Reference Books:

1.Seto W. W., Mechanical Vibrations, Schaum Publishing Co, New York.
2.Hannah and Stephans, Mechanics of Machines, Edward Aronold Publication
3.Meirovitch, Elements of Mechanical Vibrations , Tata McGraw Hill
4.Rao S. S., Mechanical Vibrations , Addison Wiley Publishing Co, World Student Series.
5.Thomas Bevan, Theory of Machines, CBS Publications.
6.Ghosh and Malik, Theory of Mechanism and Machines , East West Pvt. Ltd

Course Outcomes:

The student will be able to –

1. Students will be able to solve the balancing problems related to rotor system, multi-cylinder in-line engine and radial engine.
2. Students will be able to calculate the gyroscopic couple value and predict its effect related to planes, ships and automobiles.
3. Students will be able to develop and solve the mathematical model of one / two degrees of freedom system to calculate natural frequency/s.
4. Students will be able to perform the analysis of vibratory system under free and forced vibration conditions.
5. Students will be able to select the instruments for a vibration measurement and analyze the measured data.

ME 40108 REFRIGERATION AND AIR-CONDITIONING

Credits: 03 **Teaching Scheme: -** Theory 3 Hrs/Week
Prerequisites: Nil

Unit I Vapour Compression Refrigeration System (8 Hrs)

Part A

Introduction of Refrigeration – Second Law Interpretation, Reverse Carnot Cycle (RCC), Limitations of RCC with vapour as refrigerant, Modifications in RCC with vapour as refrigerant, Dry and Wet compression, Isenthalpic and Isentropic expansion, Ideal vapour compression cycle (VCC), effect of operating parameters on VCC, use of p-h charts, actual vapour compression cycle, method to improve COP of Vapour Compression Cycle, Introduction to multistage systems

Part B

Single stage compression with two evaporators, two stage compression with liquid intercooler.

Unit II Refrigerants and Components of Vapour Compression Refrigeration (VCR) System (8 Hrs)

Part A

Classification of refrigerants, Desirable properties of refrigerants, Designation of refrigerants, primary and secondary refrigerants, Ozone depletion potential (ODP) Global warming potential (GWP), Montreal protocol, Kyoto protocol

Compressor - Hermetic, scroll, screw, rotary and centrifugal; Condenser - air cooled, water cooled; Evaporator – flooded, direct expansion; Expansion Device - capillary tube, automatic expansion valve, thermostatic expansion valve

Part B

Alternative Refrigerants, Azeotropes, Total equivalent warming impact (TEWI), Shell and tube type of Chillers

Unit III Vapour Absorption and Gas Cycle Refrigeration (8 Hrs)

Part A

Vapour Absorption Refrigeration

Introduction to vapour absorption, Simple vapour absorption system, COP of simple vapour absorption system, Desirable properties of refrigerant and absorbent, Requirements of ideal refrigerant-absorbent mixture, Actual vapour absorption system, water ammonia system and lithium bromide system, Comparison between Vapour Compression and Vapour Absorption systems, T-ξ and h-ξ diagrams

Gas Cycle Refrigeration

Limitations of RCC with gas as refrigerant, Modifications in RCC with gas as refrigerant, Bell Coleman cycle, Aircraft refrigeration - simple, boot strap, reduced ambient, regenerative

Part B

Electrolux Refrigerator, Dry Air Rated Temperature, Vortex tube refrigeration

Unit IV Psychrometry (8 Hrs)

Part A

Introduction, Psychrometric properties, Use of Psychrometric chart, Psychrometric processes, Application of first law to psychrometric process, Adiabatic saturation, Sensible heat Factor (SHF), Application of psychrometric processes in Air-conditioning equipment - Apparatus Dew Point (ADP), Bypass factor of coil, Air Washer,

Part B

Mixing of Air, Evaporative cooling, Optimum effective temperature and comfort charts.

Unit V Air-Conditioning (8 Hrs)

Part A

Thermodynamics of human body, Metabolism of human body, Human Comfort, Factors influencing comfort, Concept of effective temperature

Air conditioning Systems - Unitary, Zoned and Central; Summer, Winter and Year-round

Part B

Optimum effective temperature and comfort charts, Applications of Air conditioning in Industry and Transport

Text Books

1. Khurmi R. S., Gupta J. K ,"Refrigeration and Air conditioning", S. Chand Publication (Fifth edition).
2. Arora C. P., "Refrigeration and Air conditioning", Tata McGraw Hill Co., New Delhi.
3. Dossat Ray J, "Refrigeration and Air conditioning", Wiley Eastern Limited.

Reference Books

1. Arora S. C. and Domkundwar S., "Refrigeration and Air conditioning, Dhanpatrai and Sons, New Delhi.
2. Manohar Prasad, "Refrigeration and Air conditioning", Wiley Eastern Limited.
3. Anantanrayanan ,"Refrigeration and Air conditioning", Tata McGraw Hills Co., New Delhi.
4. Edward Pita, "Energy approach to Air-conditioning", Wiley Eastern Ltd.

Course Outcomes:

1. To learn fundamental concepts of vapour compression refrigeration systems and its applications.
2. To learn about different refrigerants, concept of ODP, GWP, TEWI and components of refrigeration system.
3. To learn fundamental concepts of vapour absorption and gas cycle refrigeration systems and its applications.
4. Students will be able to apply psychrometric calculations/chart and analyze psychrometric processes for summer and winter air conditioning.
5. To learn fundamental concepts of Air conditioning systems and its applications in industry.

ME40306 VIBRATION ANALYSIS LAB

Credits: 1 **Teaching Scheme: 2 Hours / Week**

List of Practicals (any ten):

1. Verification of principle of gyroscope and gyroscopic couple, magnitude.
2. Study of any two gyro controlled instruments.
3. To study the dynamic balancing machine and to balance a rotor. (e. g. rotor of electric motor, flywheel, fan etc.)
4. To determine the natural frequency of damped vibration of single degree freedom system and to find its damping coefficient.
5. To verify natural frequency of torsional vibration of two rotor system and position of node.
6. To determine critical speed of single rotor system.
7. To determine resonance frequency of transverse vibration of beam.
8. To determine the frequency response curve under different damping conditions for single degree freedom system of vibration.
9. To determine shock absorber transmissibility curve.
10. Determination of natural frequencies and damping in a mechanical component/assembly with vibration shaker.
11. Determination of natural frequencies and damping in a mechanical component/assembly with impact hammer
12. Determination of fatigue life of a mechanical component with vibration shaker.
13. Determination of vibration transmissibility under random vibrations.

Text Books:

1. Shigley J. E. and Uicker J. J., Theory of Machines and Mechanisms,International Edition, McGraw Hill Inc
2.Grover G. K., Mechanical Vibrations , Nem Chand and Bros
3.R. S. Khurmi, Theory of Machines , Khanna Publications.

Reference Books:

1.Seto W. W., Mechanical Vibrations, Schaum Publishing Co, New York.
2.Hannah and Stephans, Mechanics of Machines, Edward Aronold Publication
3.Meirovitch, Elements of Mechanical Vibrations , Tata McGraw Hill
4.Rao S. S., Mechanical Vibrations , Addison Wiley Publishing Co, World Student Series.
5.Thomas Bevan, Theory of Machines, CBS Publications.
6.Ghosh and Malik, Theory of Mechanism and Machines , East West Pvt. Ltd

ME 40308 REFRIGERATION AND AIR-CONDITIONING LAB

Credits: 01 **Teaching Scheme: 1 Hours / Week**

List of Practicals:

1. Trial on vapour compression test rig. (CO 1 and 2)
2. Trial on ice plant. (CO 1 and 2)
3. Trial on vapour compression cycle of air conditioning test rig. (CO 1 and 2)
4. Analysis of psychrometric processes using air conditioning test rig. (CO 1 and 2)
5. Determination of COP of vapour absorption system. (CO 1 and 2)
6. Study of transport refrigeration systems. (CO 3)
7. Study various controls of refrigeration and air conditioning systems. (CO 3)
8. Study of various ducts employed in air conditioning systems. (CO 3)
9. Visit to cold storage plant. (CO 3)
10. Visit to central air conditioning plant. (CO 3)

Text Books

1. Khurmi R. S., Gupta J. K "Refrigeration and Air conditioning", S. Chand Publication (Fifth edition)
2. Arora C. P., "Refrigeration and Air conditioning", Tata McGraw Hill Co., New Delhi
3. Dossat Ray J, "Refrigeration and Air conditioning", Wiley Eastern Limited

Reference Books

1. Arora S. C. and Domkundwar S., "Refrigeration and Air conditioning, Dhanpatrai and Sons, New Delhi.
2. Manohar Prasad ,"Refrigeration and Air conditioning", Wiley Eastern Limited.
3. Anantanrayanan, "Refrigeration and Air conditioning", Tata McGraw Hills Co., New Delhi.
4. Edward Pita, "Energy approach to Air-conditioning", Wiley Eastern Ltd.

Course Outcomes:

1. Demonstrate hands-on knowledge of the refrigeration systems.
2. Perform experimental analysis of refrigeration and air conditioning systems, analyze the results and draw conclusions.
3. Correlate the refrigeration and air conditioning concepts with the industrial applications

ME47303 PROJECT STAGE-2

Credits: 04 **Teaching Scheme : 2 Hours / Week**

The project work could be of the following nature: Design/development and Fabrication of models. Machines and prototypes based on new ideas, robotic and automation systems. Experimental set ups, test rigs/ equipments.

Thermal Systems

Energy audit/conservation studies

Extensive computational analysis of problems relevant to mechanical engineering,

CAD/CA M/CAE

Modeling/simulation of product(s), mechanism(s) or system(s) and its validation or

Comparison with available bench marks I results

The project work shall be taken up individually or in a group consisting of not more than 4 students.

A report containing maximum 30 pages shall be submitted based on the background. need and scope of the project. project specifications, activities involved in the project and activity plan. study of literature and basic theory. and work completed (if any).

Guidelines:

- Report shall be typed or printed.
- Figures and tables shall be on separate pages and attached at respective positions.
- Project title and approval sheets shall be attached at the beginning of the report followed by index and synopsis of the project.

• References shall be mentioned at the end followed by appendices (if any).

• When a group of students is doing a project. names of all the students shall be included on every certified report copy.

• Each group of students shall submit two copies of reports to the institute and one copy shall be prepared for each individual student.

Course Outcomes:

The student will be able to –

1) Student will be able to define methodology for executing the project work

2) Student will be able to apply theoretical concepts for solving the project problem

3) Students will be able to decide and apply the manufacturing techniques and instrumentation for the development of working / process model

ME47304 PROJECT STAGE-3

Credits: 06 **Teaching Scheme: 3 Hours / Week**

The project work could be of the following nature:

Design/development and Fabrication of models. Machines and prototypes based on new ideas, robotic and automation systems, Experimental set ups. Test rigs equipments.

Thermal Systems

Energy audit conservation studies

Extensive computational analysis of problems relevant to mechanical engineering.

CAD/CAM/CAE

Modeling/simulation of product(s). mechanism(s) or system(s) and its validation or comparison with available bench marks I results

The project work shall be taken up individually or in a group consisting of not more than 4 students.

A report containing maximum 50 pages shall be submitted based on the background. Need and scope of the project, project specifications, activities involved in the project and activity plan. Study of literature and basic theory, and work completed (if any)

Guidelines:

1. Report shall be typed or printed.

2. Figures and tables shall be on separate pages and attached at respective positions.

3. Project title and approval sheets shall be attached at the beginning of the report followed by index and synopsis of the project.

4. References shall be mentioned at the end followed by appendices (if any).

5. When a group of students is doing a project, names of all the students shall be included on every certified report copy.

Each group of students shall submit two copies of reports to the institute and one copy shall be prepared for each individual student.

Course Outcomes:

The student will be able to –

1. Student will be able to develop the procurement skills
2. Students will be able to assemble and demonstrate the working model
3. Students will be able to develop skills of technical report writing and presentation