FACULTY OF ENGINEERING

Scheme of Instruction & Examination

(AICTE Model Curriculum for the Academic Year 2020-2021)

and

Syllabi

B.E. V and VI Semester

of

Four Year Degree Programme

in

Automobile Engineering

(With effect from the academic year 2020 – 2021)

(As approved in the faculty meeting held on - -2020)

Issued by

Dean, Faculty of Engineering

Osmania University, Hyderabad – 500 007

2020

SCHEME OF INSTRUCTION & EXAMINATION
B.E. (Automobile Engineering) V – SEMESTER

S.No.	Course Code	CourseTitle	Schemeof Instruction				SchemeofExamination			Credits
			L	T	P/D	Contact Hours/ Week	CIE	SEE	Durationin Hours	
Theory Course										
1	PC501AE	Internal Combustion Engines	3	-	-	3	30	70	3	3
2	PC502AE	Automotive Transmission	3	-	-	3	30	70	3	3
3	PC503AE	Design of MachineComponents	3	-	-	3	30	70	3	3
4	PC503ME	Dynamics of Machines	3	-	-	3	30	70	3	3
5	PC505ME	Heat Transfer	3	-	-	3	30	70	3	3
LaboratoryCourse										
6	PC591AE	Automotive Engineering Lab	-	-	2	2	25	50	3	1
7	PC592AE	Fuels, Lubricants & Engine Testing Lab	-	-	2	2	25	50	3	1
8	PC592ME	Dynamics of Machines Lab	-	-	2	2	25	50	3	1
		Total	15	-	06	21				18

PC: Professional Core PE: Professional Elective OE: Open Elective
L: Lecture T: Tutorial P: Practical D: Drawing
CIE: Continuous Internal Evaluation SEE: Semester End Evaluation (Univ. Exam)

SCHEME OF INSTRUCTION & EXAMINATION
B.E. (Automobile Engineering) VI – SEMESTER

S.No.	Course Code	Course Title	Scheme of Instructions				Scheme of Examination			Credits
			L	T	P/D	Contact Hours/Week	CIE	SEE	Duration in Hours	
Theory Course										
1	PC601AE	Design of Automotive Components	3	-	-	3	30	70	3	3
2	PC602AE	Computer Aided Design, Analysis & Manufacturing	3	-	-	3	30	70	3	3
3	PC603AE	Production Technology	3	-	-	3	30	70	3	3
4	PE-I	Professional Elective – I (PTAV, MHEMV, EH Vehicles)	3	-	-	3	30	70	3	3
5	OE-1	Open Elective – 1	3	-	-	3	30	70	3	3
6	OE-2	Open Elective – 2	3	-	-	3	30	70	3	3
Laboratory Course										
7	PC691AE	CAD/CAM/CAE Lab	-	-	2	2	25	50	3	1
8	PC692AE	Production Technology Lab	-	-	2	2	25	50	3	1
9		Summer Internship*								2
		Total	18	00	04	22				22

Open Elective - 1 (OE601ME) : Entrepreneurship (Not for Mechanical / Prod. / Automobile)
Open Elective - 2 (OE602ME) : Industrial Robotics (Not for Mechanical / Prod. / Automobile)

PROFESSIONAL ELECTIVE - I	
PE611AE	**Performance And Testing Of Automotive Vehicles**
PE612AE	**Material Handling and Earth Moving Vehicles**
PE613AE	**Electric and Hybrid Vehicles**

PC: Professional Core PE: Professional Elective OE: Open Elective
L: Lecture T: Tutorial P: Practical D: Drawing
CIE: Continuous Internal Evaluation SEE: Semester End Evaluation (Univ. Exam)

* *At the end of VI semester students should undergo summer Internship - Credits for Summer Internship will be awarded in VII semester*

Course Code	Course Title						Core/Elective
PC501AE	**Internal Combustion Engines**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives:

- To understand air standard cycles and basic principle of operation of petrol and diesel engines.
- To understand the working of fuel supply systems of I C Engines.
- To understand the working of ignition, cooling and lubrication systems of IC Engines.
- To understand combustion process in IC engines and know different combustion chambers, supercharging and turbocharging
- To understand the performance and emission characteristics of I C Engines and latest developments in engine technology.

Course Outcomes

The student is able to

1. Calculate efficiency of air standard cycles and demonstrate working principle I C Engines.
2. Distinguish between fuel supply systems used for I C Engines.
3. Select suitable ignition, cooling and lubrication systems for any I C Engine.
4. Explain combustion phenomenon in IC engines & select combustion chamber, supercharging/ turbocharging method for the engines
5. Evaluate the performance and emission characteristics of I C Engines and explain latest developments in engine technology.

UNIT – I

BASIC THEORY

Otto Cycle, Diesel Cycle and dual cycles. Derivation for efficiency and problems solving. Constructional details of I C engines,working principles of two stroke and four stroke petrol and diesel engines. Comparison of two stroke and four stroke engines. Valve timing and port timing diagrams.

UNIT – II

FUEL SUPPLY SYSTEMS

Carburettor-Requirements, Working principle, starting, idling, acceleration and normal circuits of carburettors. Fuel feed systems- mechanical and electrical fuel feed pumps. Petrol injection, MPFI. Requirements of fuel injection, functions of components, jerk and distributor type pumps, common rail system, PTFI system pressure waves, injection lag, unit injector, mechanical and pneumatic governors, fuel injector, types of injection nozzles.

UNIT – III

Ignition System

Working of battery and magneto ignition systems, relative merits and demerits, centrifugal and vacuum advance mechanisms. Types and construction of spark plugs, electronic ignition systems.

Cooling and Lubrication System

Need for cooling system, Types of cooling system: air cooling system, liquid cooling system, forced circulation system, pressure cooling system. Lubrication system; mist, wet sump lubrication system. Properties of lubricants.

UNIT – IV

Combustion and Combustion Chambers

Combustion in SI engine: stages of combustion, flame propagation, rate of pressure rise, abnormal combustion, detonation, effect of engine variables on knock, knock rating. Types of Combustion chambers for Si Engines.

Combustion in CI Engine: Stages of combustion, delay period, factors affecting delay period, knock in CI engines. Comparison of knock in CI & SI engines. Combustion chambers- design requirements, direct and indirect injection combustion chambers.

SUPERCHARGING AND TURBOCHARGING

Importance of Supercharger and Turbocharger. Types of supercharging and Turbo charging, Limitations, Effect of Supercharging and Turbo charging on power output & efficiency of engine.

UNIT – V

ENGINE TESTING AND PERFORMANCE

Automotive and stationary engine testing and related emission standards. Engine performance and emission characteristics, variables affecting engine performance and emission, methods to improve engine performance, heat balance, performance maps. Introduction to Stratified charge engine, LHR engines, HCCI and RCCI engines, Problems.

Suggested Reading

1.Ganesan."*Internal Combustion Engines*", Tata McGraw-Hill Publishing Co., New Delhi, 2003.

2.M.L.Mathur and R. P.Sharma "*A course in Internal Combustion Engines*", DhanpatRai and Sons, 2002.

3.Dr.K.K.Ramalingam "*Internal Combustion Engines Theory and Practice*", Scitech Publications (India), Pvt. Ltd., Chennai 600 017, 2002.

4.Heywood.J.B "*Internal Combustion Engine Fundamentals*", McGraw-Hill Book Co., 1988.

5.Pulkrabek "*Engineering Fundamentals of the Internal Combustion Engines*", Practice Hall of India ,2003

Course Code	Course Title						Core/Elective
PC502AE	**Automotive Transmission**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To understand working principle of Clutches.
- To understand construction, working and classification of gear box and troubleshooting aspects
- To understand construction working, of fluid flywheel and torque converter
- To know about automatic transmission systems and their applications.
- To know the concepts of hydrostatic drive and electric drive

Course Outcomes:

After completing this course, the student will be able to

1. To know construction, working and types of clutches with trouble shooting aspects.
2. To know and analyze the construction, working and classification of gear box with trouble shooting aspects
3. Explain the working, scope and significance of fluid flywheel and torque converter.
4. Understand the scope and working of automatic transmission systems.
5. Understand hydrostatic drive And electric drive and there application

UNIT-I

CLUTCH: Need of clutch, requirements, materials, different types of clutches, principle of friction clutches, single plate, multi-plate, diaphragm, cone, centrifugal clutch, method of actuation; electromagnetic, hydraulic, vacuum, adjustment, wet and dry friction clutches clutch trouble shooting diagnosis, numerical problems

Unit-II

GEAR BOX: Functions of transmissions, necessity of gear box, gears, gear ratio and torque, types of transmission; manual and automatic transmission, sliding-mesh gear box, constant-mesh gear box, synchromesh gear box, transfer box, transaxle. Selector mechanism and; types and interlock devices, gearbox lubrication. Calculation of gear ratios for vehicles, performance characteristics in different gears. Switches and sensors - Transmission Controlled Spark (TCS), troubleshooting diagnosis and servicing and maintenance of manual transmission and transaxle.

UNIT-III

Hydrodynamic Transmission Fluid Coup Understand **ling**: Fluid coupling- principles- performance characteristics- advantages and limitations, construction details, torque capacity, slip in fluid coupling, performance characteristics.

Torque Converter

Principal of torque conversion, single, multi stage and poly phase torque converters, Automobile Torque Converter Arrangements, performance characteristics, constructional and operational details of typical hydraulic transmission drives

UNIT-IV

Automatic Transmission: Spur and internal gear type planetary gearboxes, Relative merits and demerits when compared to conventional transmission, automatic control of gears, study of typical automatic transmissions, Ford and Chevrolet drive, and automatic control of gear box. Continuously Variable Transmission (CVT)-types-Operations.

UNIT-V

HYDROSTATIC DRIVES: Principle of hydrostatic drives, different systems of hydrostatic drives, types of pumps, advantages and limitations, typical hydrostatic drives.

ELECTRIC TRANSMISSION: General arrangement and description of electric transmission, their working principle and control mechanisms and limitations

Suggested Reading

1. Heldt P.M - *Torque converters*- Chilton Book Co.-1992.
2. Newton and Steeds - *Motor Vehicle*- Illiffee Publisher- 2000
3. *Design Practices, passenger Car Automotive Transmissions*- SAE Hand book- 1994
4. K.M. Gupta, *Automobile Engineering*,, Volume 1, Umesh Publications, 2001
5. Crouse & Anglin, "*Automotive Mechanics*" McGraw hill, 10th edition

Course Code	Course Title						Core/Elective
PC503AE	**Design of Machine Components**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

The objectives of this course is to impart knowledge of

- To know the mechanical properties of materials used in mechanical systems; Component manufacturing consideration; stresses in different types of loading,
- To understand the significance of theories of failure for safe design; fatigue-factors affecting and design for fatigue. S-N diagram, Soderberg and Modified Goodman's diagrams for fatigue design. Cumulative fatigue – Miner's rule
- To understand the design principles for various load conditions for the design of components such as Shafts- solid, hollow and splined; Standard types of couplings
- To understand the design principles for various load conditions for the design of joints, joining members like bolts, weldments and rivets; Power transmission – pulleys, chains
- To understand the use of above principles for various load conditions for the design of power screws differential and Compound Screws. Design of riveted and welded joints under direct and eccentric loads

Course Outcomes

After completing this course, the student will be able to:

1. Formulate and analyze stresses and strains in machine elements andstructures in 3-D subjected to various loads. Apply multidimensional static failure criteria in the analysis and design of mechanical components.
2. Gain knowledge of fatigue failure and load-life relation
3. Analyze and design power transmission shafts carrying various elements with geometrical features. Design and analyze shafts with different geometrical features under various loading conditions. Calculate critical speed of shafts and make the design decisions accordingly.
4. Design and analyze detachable joints (bolts, keys, pins, etc.) under various loading conditions.
5. Design machine elements like power screws and screw jack considering: allowable load, materials, mode of failure, operating conditions and required life. Stresses in power screw. Design procedure of a power screw, differential and compound screws

UNIT-I

Design considerations of Machine Elements

Materials used in machine design and their specifications according to Indian Standards. Codes and standards used in design. Important mechanical properties of materials used in design. Preferred numbers. Manufacturing considerations in design. Review of types of loads and simple stresses. Stresses due to Biaxial and Triaxal loads. Factor of safety. Theories of failure. Design of components subjected to impact loading.

UNIT-II

Design for Fatigue

Fluctuating stresses, fatigue strength and endurance limit, Stress concentration factor and Notch sensitivity. Factor effecting fatigue strength. S-N diagram, Soderberg and Modified Goodman's diagrams for fatigue design. Cumulative fatigue – Miner's rule.

UNIT-III

Design of shafts

Solid, hallow and splined shafts under torsion and bending loads. Design of keys.

Design of couplings

Muff, Split muff, Flange, Flexible, Marine type couplings and slip couplings.

UNIT-IV

Design of Joints

Cotter and Knuckle joints. Design of pulleys. Design of chains drives linked and laminated chains. Design of bolts and nuts, Locking devices for nuts, Bolts of uniform strength. Bolted joints under eccentric loads. Design of gasket joints.

UNIT-V

Design of Power Screws And Screw Jack

Differential and Compound Screws. Design of riveted and welded joints under direct and eccentric loads.

Suggested Reading

1. M.F. Spotts, *Design of Machine Elements,* Pearson Edu, 7th Ed. 2003.
2. V.B. Bhandari, *Machine Design,* Tata McGraw – Hill Publ, 2004.
3. P.C. Sharma & D.K. Aggarwal, *Machine Design,* S.K. Kataria & Sons, 10th ed, 2003.
4. P. Kannaiah, *Machine Design,* Scu-Tech Publ., 2003
5. J.E.. Shigley & Charles R. Mischke, *Mechanical Engineering Design,* Tata McGraw-Hill, 6th ed., 2003.

Course Code	Course Title						Core/Elective
PC503ME	DYNAMICS OF MACHINES						Core
Prerequisite	Contact Hours per week				CIE	SEE	Credits
	L	T	D	P			
Kinematics of Machines	3	--	--	--	30	70	3

Course Objectives:

- To know effect of inertia of links, and external forces on the input torque, and forces developed at joints in typical mechanisms in motion; understand the gyroscopic couple and its effect on vehicles in motion.
- To know the working principles and characteristics of typical governors, as also the function of flywheels.
- To know the concept of unbalancing rotating and reciprocating masses in single and multi-cylinder in line and radial engines.
- To understand the phenomena of free of free and forced, including the effect of damping for single dof systems, and concepts of isolating vibration.
- To determine natural frequencies of undammed, damped and forced vibrating systems of one, two and multi degree freedom systems.

Course Outcomes:

- Analyse static and dynamic forces in slider crank and other mechanisms; determine the magnitude of gyroscopic couple and its effect on vehicles in motion.
- Evaluate the performance of various types of governors and design flywheels considering speed and energy fluctuation
- Analyse problems of balancing in rotating and reciprocating machinery.
- Evaluate the natural frequencies of single and two degree of freedom systems in free and forced vibration mode, also considering the effect of damping.
- Determine the natural frequencies and mode shapes of multi degree of freedom systems, including by Dunkerley, Raleigh and Holzer methods.

UNIT-I

Static and Dynamic Force Analysis: *Static equilibrium:* Constraint and Applied forces, Static Force analysis of Single slider crank mechanism without Friction, Principle of Superposition.

Dynamic Equilibrium: d'Alambert's Principle, Equivalent offset inertia force, Dynamic force Analysis of Slider Crank Mechanism,

Engine Force Analysis: Piston effort, Force along connecting rod, thrust on sides of cylinder, crank effort. Thrust on bearing. Dynamically Equivalent System for Connecting Rod.

Gyroscope: Gyroscopic Couple, gyroscopic effects on aeroplanes, naval ships.

Stability of two wheel vehicle only.

UNIT-II

Governors: Working principle of governor, Classification & types of governors, analysis of Watt, Porter, and Hartnell governors. Characteristics of governors:

Controlling Force, Stability, Isochronism, Sensitivity, Power and Effort of governors.

Flywheels: Functions, Differences between flywheel and governor, turning moment diagrams, flywheel analysis for I-C Engines and presses.

UNIT - III

Balancing: Static balancing, Dynamic balancing, balancing of several masses rotating in several planes, consideration of bearing forces, balancing of reciprocating masses, primary balancing shaking forces in single cylinder engine, partial balancing and its effects, secondary balancing.

UNIT - IV

Vibrations: Vibrations of Single degree freedom system (axial, transverse and torsional), Equivalent system of combination of springs, Stepped shaft, Whirling speed of shafts.

Damped Vibrations: Types of damping, Vibrations with viscous damping

Forced Damped Vibrations: Magnification factor, Resonance, Vibration isolation and Transmissibility.

UNIT –V

Vibration Analysis of Multi Degree Freedom Systems: Torsional Vibrations of Two rotor, three rotor and Geared systems. Natural frequencies of two degree freedom systems Modes of vibration approximate methods for determining natural frequencies: Dunkerley's method, Rayleigh's method. Holzer's method (only Theory).

Suggested Reading:

1. S.S. Rattan, Theory of Machines, Tata McGraw Hill, 2010
2. Thomas Bevan, the Theory of Machines, CBS Publishers & Distributors, 2004.
3. John J.Uicker, Jr. Gordon, R.Pennock, Joseph E.Shigley, Theory of Machines and Mechanisms, Oxford University Press, 2003.
4. J.S. Rao and Gupta, Theory and Practice of Mechanical Vibrations, Prentice Hall, 1984.
5. R.L.Nortan, "Kinematics and Dynamics of Machinery", Tata McGraw Education Pvt. Ltd , New Delhi, 2009.
6. Ghosh and Mallik, Theory of Mechanisms and Machines, Affiliated East-West Press, 1988.

Course Code	Course Title						Core/Elective
PC505ME	**HEAT TRANSFER**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
FLUID MECHANICS	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

The objectives of this course is to impart knowledge of

- The basic concepts of heat transfer Obtaining centroids and moments of inertia for various regular and irregular areas.
- The concepts of conduction, convection, radiation and heat exchangers applicable for commercial and industrial use
- The applications of various experimental heat transfer correlations in engineering applications.
- Thermal analysis and sizing of heat exchanger.
- solving problems on different modes of heat transfer which are related to thermal power plants, refrigeration and air conditioning

Course Outcomes

After completing this course, the student will be able to:

1. To understand the basic concepts of heat transfer.
2. To understand the concepts of heat transfer through extended surfaces.
3. To Familiarize with time dependent heat transfer and compute convective heat transfer coefficients in forced, natural convection.
4. To understand radiation heat transfer
5. To understand , heat exchangers and mechanism involved in boiling and condensation.

UNIT – I

Conduction: Modes of Heat Transfer, Laws of Heat Transfer - Fourier, Newton, Stefan-Boltzmann General conduction equation in cartesian, cylindrical and spherical coordinates, One dimensional steady state conduction through slabs, hollow cylinders and spheres with and without heat generation, Effects of variable thermal conductivity in heat transfer of one dimensional steady state conduction of plate, cylinders and spheres, Steady state heat transfer through composite slabs, cylinders and spheres, Critical radius of insulation.

UNIT – II

Fins: Heat transfer analysis of tips with heat dissipation environment - rectangular straight and pin fins, Application of fin to temperature measurement, unsteady state conduction, Lumped parameter, analysis of a body with negligible internal temperature gradients, Transient heat transfer analysis of finite slab with specified temperature and convective boundary conditions, Use of Grober and Heisler charts for solving problems of infinite slabs, cylinders and spheres.

UNIT-III

Free and forced convection: Dimensional analysis and its use in free and forced convection, Buckingham theorem, Physical significance of different dimensionless numbers, Application of Von-Karman integral equation for the analysis of thermal boundary layer in forced convection of flat plate, Reynold's analogy for flow over plane surfaces, calculation of heat transfer for flow over plates, cylinders and for flow through tubes in free and forced convection using empirical formulae.

UNIT –IV

Radiation: Definition of absorptivity, reflectivity and transmissivity, Concept of black-body and emissivity. Kirchoffs law, Planck's black body spectral distribution, Wien's and Steffan Boltzmann law, Monochromatic and total emissive power, radiant heat exchange between two gray surfaces, Shape factor, Thermal circuit for radiant heat exchange between infinite parallel plates and between concentric, cylinders, Enclosures with black and gray surfaces, Radiation shields and re-radiation surfaces.

UNIT – V

Heat Exchangers: Classification and applications of heat exchangers in industry, Analysis and design of counter flow and parallel flow heat exchanger, Fouling factors, solving problems for multi pass heat exchanger using non dimensional parameter plots.

Change of Phase: Boiling-pool boiling regimes nucleate pool boiling, effect of surface wettability on bubble contact angle, Critical heat flux, boiling in forced convection, Condensation: Film condensation, Drop wise condensation, Condensation film thickness, Heat transfer coefficient in film condensation.

Suggested Readings:

1. Holman, J.P., "Heat Transfer", McGraw Hill Publication, New Delhi, 2010 2.
2. Rajput, R.K., "Heat and Mass Transfer", S. Chand & Company Ltd, New Delhi, 2004.
3. Yadav, R., Sanjay. and Rajay., "Heat and Mass Transfer ', Central Publishing House, Allahabad, 2004
4. Sachdeva,R.C., "Fundamentals of Engineering Heat and Mass Transfer ", New Age International (P) Ltd Publishers, New Delhi,
5. Arora, S.C. and Domkandwar., "A course in Heat and Mass Transfer ", DhanpatRai& Sons, New Delhi, 2004.

Course Code	Course Title						Core/Elective
PC591AE	**Automotive Engineering Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**2**	**25**	**50**	**1**

Course Objectives

- To understand the special tools used in the lab.
- To understand the different components of the engine and its functions.
- To make the students how to assemble and dissemble the parts of engine components like piston, connecting rod, crank shaft, timing gear, timing chain, cylinder head assembly, lubrication system and cooling system.
- To understand working of cooling system, lubrication system, ignition system and SI engine fuel system.
- To measure the Ovality and taper of cylinder bore and crankshaft Run out.

Course Outcomes

Aftercompletingthis course, thestudentwillbe ableto:

- Use the special tools and identify different components of the engine..
- Assemble and dissemble different engine components
- Demonstrate the working of cooling system, lubricating system ignition and fuel supply systems of SI Engine.
- Determine ovality and cylinder bore and crank shaft run out.

List of Experiments

1. Disassembling of 4 cylinder petrol engine
2. Assembling of 4 cylinder petrol engine
3. Disassembling of 6 cylinder diesel engine
4. Assembling of 6 cylinder diesel engine
5. Study of oil filter, fuel filter, fuel injection system, carburetor, MPFI
6. Study of ignition system components – coil, magneto and electronic ignition systems
7. Study of engine cooling system components
8. Study of engine lubrication system components
9. Ovality and taper measurement of cylinder bore and comparison with standard specifications
10. Ovality and taper measurement of engine crank shaft and comparison with standard specification

Suggested Reading

1. Ganesan. V "*Internal Combustion Engines*", Tata McGraw-Hill Publishing Co., New Delhi, 2003
2. M.L.Mathur and R.P.sharma "*A course in Internal Combustion Engines*", DhanpatRai and Sons, 2002
3. Dr.KK. Ramalingam "*Internal Combustion Engines Theory and Practice*", Scitech publications (India) Pnt. Ltd., Chennai 600 017, 2002

Course Code	Course Title						Core/Elective
PC592AE	**Fuels, Lubricants and Engine Testing Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**2**	**25**	**50**	**1**

Course Objectives

- To evaluate the properties of fuels and lubricants
- To know the actual Valve Timing and Port Timing Diagrams
- To understand the performance of SI and CI engines
- To prepare Heat Balance Sheet for SI and CI engines

Outcomes

Aftercompletingthis course, thestudentwillbe ableto:

1. Demonstrate the experiment to measure viscosity, flash and fire points of the given oils.
2. Explain the actual vale timing and port timing diagrams for ic engines.
3. Evaluate the performance of the engines
4. Estimate different ways of energy utilization in the engines.

List of Experiments

1. Temperature dependence of viscosity of lubrication oil by Redwood Viscometer.
2. Viscosity index of lubricating oil by Saybolt Viscometer.
3. Flash and Fire points of fuels.
4. Flash and Fire points of lubricants.
5. Valve Timing and Port Timing Diagrams.
6. Performance test on two wheeler SI engine.
7. Performance test on automotive multi-cylinder SI engine.
8. Performance test on automotive multi-cylinder CI engine.
9. Retardation test on I.C. Engine.
10. Heat Balance test on automotive multi-cylinder SI engine.
11. Heat Balance test on automotive multi-cylinder CI engine.
12. Morse test on multi-cylinder SI engine.

Note: Minimum ten experiments should be conducted in the semester.

Suggested Reading

1. Ganesan. V "*Internal Combustion Engines*", Tata McGraw-Hill Publishing Co., New Delhi, 2003
2. M.L.Mathur and R.P.sharma "*A course in Internal Combustion Engines*", DhanpatRai and Sons, 2002
3. Er. R. K. Rajput "Thermal Engineering", Laxmi Publications (P) Ltd.New DelhiNinth Edition,2013.

Course Code	Course Title						Core/Elective
PC592ME	**DYNAMICS OF MACHINES LAB**						**Core**
Prerequisite	**Contact Hours per week**				**CIE**	**SEE**	**Credits**
	L	**T**	**D**	**P**			
Theory of Machines	**--**	**--**	**--**	**2**	**25**	**50**	**1**

Course Objectives:

- To understand the effects and importance of kinematic and dynamic analysis of mechanisms
- To understand effects and analysis of Single degree freedom vibration systems
- To study the gyroscope, governors and cams
- To carry out the static and dynamic analysis of four bar mechanisms and drives

Course Outcomes:

- To experimentally quantify the effect of inertia forces in systems like flywheel, gyroscope and governors.
- To evaluate vibrational characteristics of various systems experimentally.
- To Synthesize balancing method of multi plane rotating masses.

List of Experiments

1. Centrifugal Governors: Experiment on Performance Characteristic Curves.
2. Estimation of Gyroscopic Couple & Understanding of Gyroscopic Effects on a rotating disc.
3. Static and Dynamic Balancing of Rotating Masses.
4. Determination of Moment of Inertia of Connecting Rod by compound pendulum method.
5. Damped and Undamped Torsional Vibrations of Single and Double Rotor System.
6. Single DOF (Degrees of Freedom) of Spring Mass Damper System. (Damped and Undamped Systems).
7. Free and Forced Vibration of Simply Supported Cantilever Beam.
8. Dunkerley Method to Find Fundamental Frequencies.
9. Critical Speed of Shaft.
10. Modal Analysis of Beam.
11. Cam Analysis of Cams.
12. Any Experiment explaining dynamic aspects of mechanical systems.

Additional Experiments Suggested

1. Determination of Moment of Inertia of Flywheel.
2. Experiment with Bifilar System.

Demonstration Experiments (Can't be allocated in final exams)

1. Velocity Ratios of Simple, Compound, Epicyclic and Differential Gear Trains.
2. Virtual Lab Experiment I – Governors.
3. Virtual Lab Experiment II – Natural Frequency of Cantilever beam.

Note: Minimum ten experiments should be conducted in the semester.

Course Code	Course Title						Core/Elective
PC601AE	**Design of Automotive Components**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To introduce the theoretical concepts involved and help in the development of design procedures, under various loading conditions, for the most commonly occurring components in mechanical equipments.
- To know the application of kinematic principles and design concepts for design and sizing of components of an IC engine.
- To understand the applications of
    a. springs- helical and leaf Elliptical and semi elliptical;
    b. Bearings- sliding and rolling contact of different types;
    c. Transmission elements-belts,chains, gears of different types
- To know the automotive gear box, over drive, drive line and differential.

Course Outcomes

After completing this course, the student will be able to understand and realize,

1. The concepts of designing different automotive engine components.
2. The concepts of design and design considerations for springs used in automotives like coil springs, leaf springs and the associated accessories.
3. The concepts of design and design considerations for sliding & rolling contact bearings.
4. The concepts of design and design considerations different power transmission elements like belts & belt-drives, ropes & rope-drives, chain & chain-drives and gears & gear-drives, gear-box, differential, drives like Hotchkiss drive, torque tube drive

UNIT-I

Types of cylinder, piston and valves. Design of cylinder, piston, piston pin, piston rings, tappets, push rod, rocker arms, valves. Design of connecting rod, whipping stress in connecting rod.

Design of crank shaft: Centre crank shaft, Overhung crank shaft.

UNIT-II

Springs

Introduction, Different types of springs, materials used for springs, Helical springs, Whal's factor, calculation of stress, deflection and energy stored in springs, design for static and fluctuating loads. Elliptical and semi elliptical springs: stress and deflection, Nipping of leaf springs.

.

UNIT –III

Bearings

Introduction materials used for bearings, Classification of bearings, Viscosity of lubricants, theory of hydrostatic and hydrodynamic lubrication. Design of sliding contact bearings, Design of aerostatic bearings and applications.

Rolling contact bearings

Types of rolling element bearings and their constructional details, static load carrying capacity, dynamic load carrying capacity. Load life relationship, selection of bearing life. Design of cyclic loads and speeds.

UNIT – IV

Design of Transmission Elements-Belts

Stress calculation in flat belt-selection criteria for V-Belt-& Design of Pulleys. Chains: Length and Pitch calculation.

Gears: Introduction to gear drives, different types of gears, materials used for gears. Spur gear design: beam strength of gear tooth, Lewis equation, wear strength of gear tooth, dynamic loads on gear tooth- Buckingham equation. Basic design of Helical, Bevel and worm gears.

UNIT –V

Design of automotive gear box

Selection of type of gears-type of gear train-design of gear shaft& corresponding bearings.

Design of over drive

Gear ratio calculations.

Design of drive line

Hotchkiss drive-Torque tube drive – Torque & Force calculations.

Differential

Speed ratio and torque calculations.

Suggested Reading

1. V.Bhandari, "*Machine Design"*, Tata McGraw Hill publication,
2. R.K. Jain, *"Machine Design",* Khanna Publishers, New Delhi, 1997.
3. P.C.Sharma and D.K.Aggarwal, "*Machine Design"*, S.K.Kataria & sons, 2003
4. A.Kolchin and V.Demidov, *"Design of Automotive Engines"*, MIR Publishers, Moscow, 1984.
5. J.E.Shigley , C.R.Mischke, *"Mechanical Engineering Design"* Tata Mc Graw hill publications.

Course Code	Course Title						Core/Elective
PC602AE	**Computer Aided Design Analysis And Manufacturing**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To know the basic design process design criteria to find alternative solution understand parametric representation of cubic spline, Bezier and B-spline curves along with concepts of NURBS.
- To understand the concepts of surface modeling, analytical surface, solid modeling and threir different approaches like C- rep and B-rep along with mass property calculations mechanical tolerance.
- To know the principals of CAD database and its structure and learn the different neutral formats, like IGES and PDES and basics of FEA.
- To know the different types of numerical control machine tools, its features and elements, CAD/CAM integration and rapid prototyping concepts.

Course Outcomes

After completing this course, the student will be able to:

1. Basic design process and geometric elements.
2. Different 2D transformations like translation, scaling, rotation, shearing and reflection.
3. CAD DATA base,basics of FEA, features and elements of numerical control machines.
4. Computer numerical control and Industrial Robots.
5. Computer aided inspection and quality control

UNIT-I

Design Processes

Computer Aided Design and Computer Aided Manufacturing, Design Process, Product life cycle. Design criteria, CAD Hardware and Workstation.

Geometric Modeling

Wire frame entities and their definition, Interpolation and Approximation curves. Concept of parametric and non-parametric representation of a circle and helix curves, properties of splines.

Synthetic Curves

Parametric representation of cubic spline, Bezier and B-spline curves, properties and characteristics. Concept of NURBS.

UNIT-II

Surface Modeling

Analytic surfaces: Definitions of planar, surface of revolution, Tabulated cylinder, synthetic surfaces: Cubic and Bezier surfaces, coons surface.

Solid Modeling

C-rep and B-rep approaches, feature based and parametric modeling.

2D Transformations

Translation, Scaling and Rotation about arbitrary points, Shearing and Reflection.

UNIT-III

Design Applications

Mass property calculations, Mechanical tolerancing, Finite Element Analysis, Design Review.

CAD Database and Data exchange

CAD Database and structure, CAD Exchange format: IGES, STEP and STL format.

Introduction to Finite element analysis
Introduction, basic concepts, discretization, element types, nodes and degrees of freedom mesh generation, constraints, loads, preprocessing, and application to static analysis.

UNIT-IV
Numerical Control Machine Tools
Features and elements of NC, Positional, paraxial and contouring types. Definitions of axes. Definitions of interpolation, post-processor, preparatory and miscellaneous functions, Canned cycles, Tool length and cutter radius compensation. Manual and computer aided part programming (APT) for simple components, programming with MACROS.
Computer Numerical Control
CNC, DNC and Adaptive control systems. Typical configurations and relative features. Machining centers.

UNIT-V
Industrial Robots
Robot Anatomy, Configurations, Controls, Drivers, Programming methods and Applications.
CAPP
Variant and Generative process planning.
FMS&CMS
Building blocks of Flexible Manufacturing systems and their control, Elements of CIMS.
Computer Aided Inspection and QC
Coordinate Measuring Machine, Non contact inspection: Machine vision, Scanning Laser Beam Devices, Quality control.
CAD/CAM Integration, Turkey CAD/CAM Systems, Introduction to Rapid Prototyping Technique, Reverse Engineering.

Suggested Reading
1. Arvid R. Eide, Roland D. Jenison, Lane H. Mashaw, Larry: / Mprtji[. *"Introduction to Engineering Desingg'* McGraw Hill, 1998.
2. Ibrahim Zeid, *CAD/CAM, Theory and Practice,* McGraw Inc. New York, 1991.
3. Grover, MP and Zimmeers E.W. *CAD/CAM,* Prentice Hall of India, 1989.
4. Rao, P.N/ *CAD/CAM: Principles and applications,* 2nd Edition, Tata McGraw Hill, New Delhi, 2004.
5. Yoram Koren, *Computer Control of Manufacturing Systems,* McGraw Hill Int., New York, 1994.

Elanchezhian, C. Sunder Selwyn, T. Shanmuga Sunder, G. *computer Aided Manufacturing,* Laxmi Publications (P) Ltd., 2nd Edition, New Delhi, 2007

Course Code	Course Title						Core/Elective
PC603AE	**Production Technology**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

The objectives of this course is to impart knowledge of

- To know the different manufacturing processes required to develop mechanical components and identify various process parameters and their effect on defined process characteristics.
- To understand the effect of sand properties on the sand mould and the development of products using casting methods;
- To understand the welding process and the different methods used for joining the similar and dissimilar metals.

  To know the metal forming concepts and the methods used in obtaining mechanical components; Selection of cutting tools and process parameters for obtaining desired machining characteristics.

Course Outcomes

After completing this course, the student will be able to:

1. Understand the basic working principles of casting, forming and welding.
2. Select manufacturing processes for engineering applications and identify plastics for different applications
3. Analyze problems in Forging, Rolling, Drawing and Extrusion.
4. Select suitable machining process for suitable materials

UNIT-I

Metal Casting

Moulding sand, properties, moulding methods, moulding machines, patterns, types of patterns, pattern materials, pattern allowances, steps involved in making a casting.

Special Casting Processes

Shell moulding, CO_2 process, Continuous casting, die casting, investment casting, centrifugal casting, centrifuging, Defects in casting, causes and remedies.

UNIT-II

Metal Joining

Classification of welding process, Electrode and its specification, Oxy acetylene gas welding, types of flames, oxy acetylene gas cutting.

Arc welding processes

SMAW, SAW, GMAW, TPA, atomic hydrogen welding, plasma arc welding.

Solid State Welding Processes

Friction welding, forge welding, explosive welding, ultrasonic welding.

Resistance Welding Processes

Spot, projection, seam, butt, upset and flash welding process. Introduction to soldering, brazing, braze welding. Defects in welding, causes and remedies.

UNIT-III

Metal Forming: Stress,Strain in elastic and plastic deformation, hot working, cold working.

Rolling

Principle of rolling, types of rolling mill, two high rolling mill, three high rolling mill, cluster rolling mill, planetary roll mill, advantages and limitations of rolling.

Forging

Principle of forging, forging operations, types of forging – Smith forging, drop forging, press forging, machine forging, advantages and limitations of forging.

Extrusion

Principle of extrusion, forward extrusion, backward extrusion, tube extrusion, hydrostatic extrusion, impact extrusion.

Drawing

Principle of drawing, wire drawing, tube drawing.

Sheet Metal Working

Blanking, piercing, bending and deep drawing.

Processing of plastics - Blow moulding and injection moulding.

UNIT-IV

Metal Cutting and Machine Tools

Elements of cuttingprocess, cutting tool materials and its properties, nomenclature and geometry of single point cutting tool, chip formation, types of chips, chip breakers.

Machining

Orthogonal and oblique cutting, Merchant analysis, tool life, cutting fluids, Machinability.

UNIT-V

Machine Tools

Lathe- Principle of working, specification, types, operations performed. Lathe attachments, work holding and tool holding devices, taper turning methods – tail stock set over method, compound swivel method, special attachment method,. Capstan and turret lathes.

Types – Specification, working principle, operations performed in shaping, slotting, milling, planning, drilling and boring machines. Introduction to lapping, honing and super finishing operations.

Suggested Reading

1. P.N. Rao, *Manufacturing Technology,* Tata McGraw Hill Publishers, 2nd Edition, 1990
2. Amitaba Ghosh, Malik, *Manufacturing Science,* Assoc. East West Press Pvt. Limited, 4th Edition, 1991.
3. Roy A Lindberg, *Materials & Processes of Manufacturing,* Prentice Hall of India, 5th Edition, 1992.
4. Serope Kalpakjain, *Manufacturing Engineering and Technology,* Addison Wesley Publishing Company.

P.N. Rao, *Manufacturing Technology – Metal Cutting & Machine Tools*, Tata Mc.Graw Hill Publishers, 2nd Edition, 1990.

Course Code	Course Title						Core/Elective
PE611AE	**Performance And Testing Of Automotive Vehicles**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To know the estimation of power requirements considering factors such as power train, vehicle accelerations, terrain, and ambient conditions.
- To understand the engine performance characteristics, and parameters affecting efficiency and fuel economy; characteristics of clutches and gear transmission; Steering and brake controls and suspension features
- To understand the testing procedures for major components like suspension, brakes, engine vibrations, fuel economy and road handling including durability, maximum speed, brake testing on roads, hill climbing and ride comfort.

Course Outcomes

After completing this course, the student will be able to:

1. To Develop Basic Interest About Vehicle Performance
2. Identify The Differences Between Various Transmissions.
3. An Ability To Identify, Formulate & Solve Engine Performance Problems.
4. To Identify Formulate & Solve Related Vehicle Control System Problems
5. To Provide Students With Sound Foundation In Vehicle Components Like Clutch, Suspension, Braking, Steering & Engine.

UNIT-I

Vehicle Performance Estimation & Prediction

Aerodynamic drag, methods of estimation of resistance to motion, power requirement for propulsion, power plant characteristics. Transmission related requirements, arrangement of power train. Vehicle controls, vehicle acceleration, maximum speed, and gradiability drive systems comparison, hill climbing, handling and ride characteristics on different road surfaces. Effect of pressure, temperature and humidity on power output.

UNIT-II

Vehicle Transmission Performance

Characteristics & features of friction clutches, mechanical gear transmission & Epicyclic gear boxes.

UNIT-III

Operational Performance

Engine performance & operating characteristics, Operation at full load and part load conditions, fuel economy, effect of vehicle condition, tyre and road condition, traffic condition and driving habits on fuel economy, vehicle safety.

UNIT-IV

Control Systems

Braking arrangements & Characteristics, weight transfer, steering arrangements, rigid & independent suspension, roll centre, torsion bar, stabilizer, radius bar.

UNIT-V

Vehicle Performance Testing: Laboratory Testing

Testing of major components of vehicle like clutch, suspension, braking, steering etc., Engine testing – noise, vibrations, emission, power & fuel consumption, Vehicle testing on chassis dynamometers, Road and Track Testing, Initial inspection, running in and durability, extensive driving, maximum speed & acceleration, Brake testing on the road, Hill climbing, handling & ride characteristics on different road surfaces, ride comfort. Corrosion testing, fault finding tests.

Suggested Reading

1. Gousha H. M., "Engine Performance Diagnosis & Tune Up Shop Manual"
2. J. G. Giles, "Vehicle Operation & Performance".
3. W. H. Crouse & D. L. Anglin, "Motor Vehicle Inspection".
4. SAE Transactions Papers – 831814 / 820346 / 820367 / 820371 / 820375
5. CIRT & VRDE Manuals

Course Code	Course Title						Core/Elective
PE612AE	**Material Handling and Earth Moving Vehicles**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

The objectives of this course is to impart knowledge of

- Introduced the heavy earth moving vehicles and material handling equipments
- To know the working of different types of off road vehicles
- To understand the working and construction of the hoisting equipment
- Classify the off road vehicle

Course Outcomes

After completing this course, the student will be able to:

1. Students able to distinguish the on road and off road vehicle and understand the complexity in off road vehicles.
2. Understand Working and construction of the machines and equipment
3. Maintain and repair condition of working machines and equipment, for scheduling to maintenance

UNIT-I

MATERIAL HANDLING SYSTEMS

Design and construction of various components of mechanical handling conventional belt conveyors, high angle conveyors, cable belt conveyor, chain conveyors, stackers, Re-claimers, wagon loaders, wagon tipplers, bucket elevators, bins, bunkers, silos, selection, productivity and power calculations conveyors.

UNIT-II

HOISTING EQUIPMENTS

Mobile jib cranes–different types, EOT cranes, pillar cranes, lower cranes, gantry cranes, radial cranes. Hoist, Travel and slew mechanisms of mechanical handling equipment. Stability of mobile cranes. Programmable and flexible load handling devices, automation in the handling of material

UNIT-III

CLASSIFICATION AND REQUIREMENTS OF OFF ROAD VEHICLES

Land clearing machines Earth moving machines shovels - drag lines - ditchers - capacity of shovels. Land clearing machines: Bush cutter, tree dozer, rippers.

UNIT-IV

TRANSPORT EQUIPMENT

Powered equipment, Tractors and Trailers, Platform lift trucks, Fork lift trucks, containers and Supports. Hauling equipment: Types of dump trucks, On-high way vehicles, Off high way vehicles. Tractors,*Applications of tractors, Rating of Tractors, Wheeled and Crawler tractor, recent trends in* tractor design

UNIT-V

EARTH MOVING MACHINES

Bulldozers, cable and hydraulic dozers. Crawler track, running and steering gears, scrapers, drag and self-Powered types - dump trucks and dumpers - loaders, singlebucket, multi bucket and rotary types - power and Capacity of earth moving machines .Scrapers, elevating graders, self-powered scrapers and graders. Shovels and Ditchers: Power shovel, revolving and stripper

Suggested Reading

1. *Material Handling Equipment; N Rudenko*
2. *Conveyors and Related Equipment, Spivakovosky, V. Dyachk*
3. *Abrosimov. K. Bran berg.A. and Katayer.K., Road making Machinery, MIR Publishers,*
4. *Moscow, 1971*
5. *Wang.J.T., Theory of Grand vehicles, John Wiley & Sons, New York, 1987.*
6. *Off the road wheeled and combined traction devices - Ashgate Publishing Co. Ltd. 1998*
7. *R.L. Peurifoy, Construction Planning Equipment and Methods, McGraw Hill Publishers, 1956*
8. *Mahesh Varma, Construction Equipment and its Planning and Applications, Metropolitan Books Co., Delhi, 2004*
9. *Materials Handling Equipment, MPAlexand Rov, MIR Publishers.*

Good year hand book of belting, conveyor and elevator

Course Code	Course Title						Core/Elective
PE613AE	**Electric and Hybrid Vehicles**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course objectives:

- To Understand electric vehicle technology
- To Understand electric vehicle battery technology and control systems
- To know the classification drives in hybrid vehicles their principles and merits
- To know different power sources used in hybrid vehicles
- To know Electric propulsion systems and fuel cells

Course Outcomes:

After completing this course, the student will be able to

1. Know-how of power plants used in Electric vehicles and their significance.
2. To provide exposure to electric vehicle battery technology and control systems.
3. Able to classify drives in hybrid vehicles their principles and merits
4. Understand different power sources used in hybrid vehicles
5. Understand Electric propulsion systems and fuel cells

UNIT - I

INTRODUCTION: Electric vehicles; early systems, charging techniques for lead acid batteries, charging techniques for nickel based batteries, charging techniques for non aqueous batteries, Battery state of charge measurement, battery management, connection methods, battery exchange. Economic and environmental comparison of alternative vehicle options. Electric vehicles; configuration of EVs, performance, traction motor characteristics, tractive effort and transmission requirements.

UNIT- II

BATTERIES: Storage batteries; advanced lead acid, metal foil lead acid, nickel - iron, nickel - zinc, nickel - cadmium, sodium - sulphur, sodium - nickel chloride, lithium - iron sulphide, lithium - solid polymer, lithium - ion, aluminum - air and zinc - air.

ELECTRIC PROPULSION SYSTEMS: DC motor drives, chopper control of DC motors. Drive train configuration and design objectives, control strategies. EV conversion process. Controller; overview, solid state controller,

UNIT - III

HYBRID DRIVES: Introduction, features , functional classification, start/stop system, mild hybrid, full hybrid, plug-in-hybrid, batteries for hybrid vehicles, optimization of hybrid configurations. Changing modes for conductive charging. Super capacitor, fuels cells, solar cells, the flywheel, the hydraulic accumulator, compressed air storage, thermal energy storage, non battery energy sources.

UNIT - IV

HYBRID ELECTRIC VEHICLES(HEVS) AND DRIVE STRUCTURES: Concept of electric drive train, architecture of hybrid electric drive train, series hybrid drive, parallel hybrid electrical drive train, parallel hybrid drive train with torque coupling, power split hybrid drive, speed coupling, hybrid drive train with torque and speed coupling. Control of hybrid vehicles.

UNIT - V

FUEL CELLS: Fundamentals, operating principles of fuel cells, fuel cell system characteristics, fuel cell technologies, non-hydrogen fuel cells, fuel cell hybrid electric drive train design,

Electric and Hybrid Vehicles - Case Studies: Honda Insight, Chevrolet Volt, GM EV1, Nissan Leaf, Toyota RAV 4 EV and Ford; Think City

Suggested Reading

1. Iqbal Husain, "Electic and Hybrid vehicles Design Fundamentals" , CRC Press, second enition 2013
2. James Larminie, John Lowry, "Electric vehicle techonology Explained" 2nd Ed.,Wiley 2012
3. Vehicular Electrical Power Systems – Emadi, Ehasni, Mercel (Marcel Dekker)
4. Electronic Engine Controls – Steve V Hatch(Cengage learning)
5. Electric and Hybrid vehicles – Pistoia (Elsevier)
6. Fuel cells principles and applications - B.Vishwanath, M. Aulice Scibion (University Press)
7. Electrical vehicle machine and drives – K.T.Chau (Wiley).

Course Code	Course Title						Core / Elective
OE601ME	**Entrepreneurship**						**Open Elective-II**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**-**	**-**	**-**	**30**	**70**	**3**

Course Objectives

- To motivate students to take up entrepreneurship in future
- To learn nuances of starting an enterprise & project management
- To understand the design principles of solar energy systems, their utilization and performance evaluation
- To understand the behavioural aspects of entrepreneurs and time management

Course Outcomes

At the end of the course, the students will be able to

1. Understand Indian Industrial Environment, Entrepreneurship and Economic growth, Small and Large Scale Industries, Types and forms of enterprises.
2. Identify the characteristics of entrepreneurs, Emergence of first generation entrepreneurs, Conception and evaluation of ideas and their sources.
3. Practice the principles of project formulation, Analysis of market demand, Financial and profitability analysis and Technical analysis.
4. Apply the concepts of Project Management during construction phase, project organization, project planning and control using CPM, PERT techniques
5. Understand the Behavioural aspects of entrepreneurs, Time Management, Various approaches of time management, their strengths and weakness. The urgency addiction and time management matrix.

UNIT-I

Indian Industrial Environment-competence, Opportunities and Challenges. Entrepreneurship and Economic growth. Small Scale Industry in India, Objectives, Linkage among small, medium and heavy industries. Types of enterprises.

UNIT-II

Identification and characteristics of entrepreneurs. Emergence of First generation entrepreneurs, environmental influence and women entrepreneurs. Conception and evaluation of ideas and their sources. Choice of Technology - Collaborative interaction for Technology development.

UNIT-III

Project formulation, Analysis of market demand, Financial and profitability analysis and Technical analysis, project financing in India.

UNIT-IV

Project Management during construction phase, project organization, project planning and control using CPM, PERT techniques. Human aspects of project management. Assessment of tax burden.

UNIT-V

Behavioural aspects of entrepreneurs: Personality - determinants, attributes and models. Leadership concepts and models. Values and attitudes. Motivation aspects. Change behaviour. Time

Management: Various approaches of time management, their strengths and weaknesses. The urgency addiction and time management matrix.

Suggested Readings:

1. Vasant Desai, *"Dynamics of Entrepreneurial Development and Management",* Himalaya Publishing House, 1997
2. Prasanna Chandra, *"Project-Planning, Analysis, Selection, Implementation and Review",* Tata McGraw-Hill Publishing Company Ltd. 1995.
3. Stephen R. Covey and A. Roger Merrill, *"First Things First",* Simon and Schuster Publication, 1994.
4. G.S. Sudha, *"Organizational Behaviour",* 1996.
5. Robert D. Hisrich, Michael P. Peters, *"Entrepreneurship",* Tata Me Graw Hill Publishing Company Ltd., 5lh Ed., 2005.

Course Code	Course Title						Core / Elective
OE602ME	**INDUSTRIAL ROBOTICS**						**Elective**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**3**	**0**	**0**	**0**	**30**	**70**	**3**

Course Objectives

- To familiarize the student with the anatomy of robot and their applications.
- To provide knowledge about various kinds of end effectorsusage.
- To equip the students with information about various sensors used in industrial robots.
- To make the student understand the importance of spatial transformation of robots using forward and inverse kinematics.
- To specify and provide the knowledge of techniques involved in robot vision in industry.
- To equip students with latest robot languages implemented in industrial manipulators.

Course Outcomes

- Able to demonstrate knowledge of the relationship between mechanical structures of industrial robots and their operational workspace characteristics and have an understanding of the functionality and limitations of robot actuators and sensors.
- Able to demonstrate an ability to apply spatial transformation to obtain forward/Inverse kinematics equation of robot manipulators using analytical/numerical/simulation tools.
- Able to apply knowledge and choose the best & economically suitable sensors/end effectors required for specific applications.
- Able to understand the importance of robot vision and apply the learnt techniques to get the required information from input images.
- Able to design and develop a industrial robot for a given purpose economically.
- Appreciate the current state and potential for robotics in new application areas.

UNIT – I

Introduction to Robotics: Basic structure of Robots. Degree of freedom of Robots, Work envelope, Classification of Robots based on Drive Technology, Work-Envelope and motion control methods. Application of Robots in Industry, Repeatability, Precision and Accuracy as applied to Robots, Specifications of robots used for various applications. End effectors, Grippers: Mechanical grippers, pneumatic and hydraulic grippers, magnetic grippers, vacuum grippers, RCC grippers, Two fingered and three fingered grippers, internal grippers and external grippers, Selection and design considerations.

UNIT – II

Requirements of a Sensor: Principles and Applications of the following types of sensors- Position of sensors (Piezo electric sensor, LVDT, Resolvers, Optical encoders, Pneumatic position sensors), Range sensors (Triangulation principle, Structured, Lighting approach, Time of flight range finders, Laser range meters), Proximity sensors (Inductive, Hall effect, Capacitive, Ultrasonic and Optical proximity sensors), Touch sensors (Binary sensors, Analog sensors), Wrist Sensors, Compliance Sensors, Slip Sensors.

UNIT – III

Kinematic Analysis of Robots: Rotation matrix. Homogeneous transformation matrix, Denavit&Hartenberg representation, Euler and RPY angles representation. Representation of absolute position and orientation in terms of joint parameters, Direct Kinematics of manipulators, Inverse kinematics of Robot arm for position and orientation. Redundancy in Robots, Static force analysis

UNIT-IV

Introduction to Techniques used in Robot Vision: Image acquisition, illumination techniques, imaging geometry, basic relationship pixels, preprocessing, segmentation & description of 3-dimensional structures, their recognition and interpretation. Types of Camera, frame grabbing, sensing and digitizing image data, Signal conversion, Image Storage, Lighting techniques, Image processing and analysis, Data reduction, Segmentation, Feature extraction, Object recognition, and various algorithms, Applications, Inspection, identification, visual serving and navigation.

UNIT – V

Robot Programming Languages: Characteristics of robot level languages, task level languages. Teach pendant programming, Lead through programming, Robot programming languages, VAL programming, Motion commands, Sensor commands. End effecter commands, Simple programs. RGV, AGV, Implementation of robots in industries, various steps, Safety considerations for robot operations. Economic analysis of robots, Pay back method, EUAC method and Rate of return method

Suggested Readings:

1. Groover M P, **"Industrial Robotics"**, McGraw Hill Publications,1999.
2. Fu. K.S., GonZalez R.C., Lee C.S.G. "**Robotics, Control-sensing vision and Intelligence**", McGraw Hill, Int. Ed.,1987.
3. Spong and Vidyasagar, "**Robot Dynamics & Control**", John Wiley and Sons,Ed.,1990.
4. Mittal and Nagrath, "**Industrial Robotics**", Tata McGraw Hill Publications,2004.
5. Saha&Subirkumarsaha, '**Robotics'**, TMH,India.

Course Code	Course Title						Core/Elective
PC691AE	**CAD/ CAM/ CAE LAB**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**2**	**25**	**50**	**1**

Course Objectives

- To become familiar with Full-Scale CAD Software systems designed for geometric modelling of engineering components.
- Gaining knowledge of Analysis of mechanical components under static conditions using Finite Element Techniques.
- Becoming familiar with CNC machine tools, Its features and elements, practice manual part programming using miscellaneous and preparatory functions (M & G codes).
- Getting exposed to the manufacturing process through flexible manufacturing Systems.

Course Outcomes

After completing this course, the student will be able to:

1. Apply CAD software for the geometric modelling of components
2. Analyse mechanical components by using Finite Element techniques
3. Apply M & G codes in part programming used for CNC machine tools.
4. Demonstrate flexible manufacturing system.

List of Experiments

CAD

1. Practice in the use of some of the packages like: Pro-E / I-DEAS / Solid works / MDT / Inventor / CATIA etc., for Geometric modeling of simple parts (sketching).
2. Part modeling and assembly of simple parts using any of the above packages.
3. Mass properties and Sectional properties of a part and Assembly.

CAE

4. Static Analysis of Plane Truss and 2D beam for different type of loads using ANSYS / NASTRAN / ADINA etc
5. Static analysis of 2D beam for different types of loads using beam elements

CAM

6. Facing, Turning, Step turning, Taper turning on CNC Lathe
7. Pocketing and Contouring on CNC milling
8. Programming for integration of various CNC machines, robots and material handling systems

Course Code	Course Title						Core/Elective
PC692AE	**Production Technology Lab**						**Core**
Prerequisite	Contact Hours per Week				CIE	SEE	Credits
	L	T	D	P			
-	**-**	**-**	**-**	**2**	**25**	**50**	**1**

Course Objectives

- To understand different manufacturing processes required to develop mechanical components and identify various process parameters and their effect on defined process characteristics.
- To gain knowledge about different metal cutting operations on varied machines, selection of cutting tools and process parameters for obtaining desired machining characteristics.
- To appreciate the effect of sand properties on the sand mould and the development of products using casting methods; phenomenon of welding process and the different methods used for joining the similar and dissimilar metals.
- To understand Metal forming concepts and the methods used in obtaining mechanical components.

Course Outcomes:

After completing this course, the student will be able to:

1. Develop mechanical components by using different manufacturing processes
2. Select cutting tools and process parameters for metal cutting operations.
3. Develop casting products by using different casting methods.
4. Demonstrate metal forming process.

List of Experiments

Metal Cutting

1. Perform Step turning & Taper turning operations for a given dimension on Lathe Machine.
2. Perform Thread Cutting & Knurling operation s for a given dimension on Lathe Machine.
3. Perform drilling & tapping operations on the PCD of a given cylindrical component on Radial Drilling Machine.
4. Develop a gear for a given dimension on milling Machine.

Foundry

5. Single piece pattern making with wood as material considering allowances (Draft, Shrinkage and Machining).
6. Green sand mould making processes with complete sprues, gates ,riser design.
7. Testing of green sand properties.
8. Melting ad casting of aluminum metal

Welding

9. Prepare a butt joint using arc welding process and determine deposition efficiency of electrodes.
10. Exercises using TIG and MIG welding processes.

Forming

11. Evalution of formability using Erichsen Cupping test.
12. Performing blanking and piercing operations using Mechanical / fly presses.
13. Manufacturing of simple component using Plastic Injection Moulding machine

Suggested Reading:

P.N. Rao, Manufacturing Teachnology, Tata McGraw Hill Publishers,2nd Edition, 1990

2.Amitaba Ghosh, Malik, Manufacturing Science, Assoc. East West Press Pvt. Limited, 4th Edition,1991.

3.Roy A Lindberg, Materials & Processes of Manufacturing, Prentice Hall of India, 5th Edition,1992.

4.P.N.Rao,Manufacturing Technology-Metal Cutting $& Machine Tools, Tata Mc.Graw Hill Publishers, 2nd Edition,1990.

Note: Minimum ten experiments should be conducted in the semester