30.08.2022

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
B.E. In MECHANICAL ENGINEERING
Scheme of Teaching and Examinations 2021
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
(Effective from the academic year 2021 - 22)

V SEMESTER

Sl. No	Course and Course Code	Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
				Theory Lecture	Tutorial	/	Self -Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	T	P	S					
1	BSC 21ME51	Theory of Machines	TD: ME PSB: ME	2	2	0	0	03	50	50	100	3
2	IPCC 21ME52	Thermo-fluids Engineering	TD: ME PSB: ME	3	0	2	0	03	50	50	100	4
3	PCC 21ME53	Finite Element Analysis	TD: ME PSB: ME	2	0	2	0	03	50	50	100	3
4	PCC 21ME54	Modern Mobility and Automotive Mechanics	TD: ME PSB: ME	3	0	0	0	03	50	50	100	3
5	PCC 21MEL55	Design lab	TD: ME PSB: ME	0	0	2	0	03	50	50	100	1
6	AEC 21XX56	Research Methodology & Intellectual Property Rights	TD: Any Department PSB: As identified by University	2	0	0	0	02	50	50	100	2
7	HSMC 21CIV57	Environmental Studies	TD: Civil/ Environmental /Chemistry/ Biotech. PSB: Civil Engg	2	0	0	0	1	50	50	100	1
8	AEC 21ME58X	Ability Enhancement Course-V	Concerned Board	If offered as Theory courses: 0	2	0		01	50	50	100	1
				If offered as lab.Courses: 0	0	2		02				
								Total	**400**	**400**	**800**	**18**

Ability Enhancement Course – IV

21ME581	Basics of MATLAB(0-0-2-0)	21ME583	VFX – Visual Effects (0-2-0-0)
21ME582	Digital Marketing (0-2-0-0)		

Note: BSC: Basic Science Course, PCC: Professional Core Course, IPCC: Integrated Professional Core Course, AEC –Ability Enhancement Course INT –Internship, HSMC: Humanity and Social Science & Management Courses.
L –Lecture, T – Tutorial, P- Practical/ Drawing, S – Self Study Component, CIE: Continuous Internal Evaluation, SEE: Semester End Examination.

Integrated Professional Core Course (IPCC): refers to Professional Theory Core Course Integrated with Practical of the same course. Credit for IPCC can be 04 and its Teaching – Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). Theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by CIE only and there shall be no SEE. For more details the regulation governing the Degree of Bachelor of Engineering /Technology (BE/B.Tech.) 2021-22 may be referred.

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B.E. in MECHANICAL ENGINEERING
Scheme of Teaching and Examinations 2021
Outcome-Based Education(OBE) and Choice Based Credit System (CBCS)
(Effective from the academic year 2021 - 22)

VI SEMESTER

Sl. No	Course and Course Code	Course Title	Department (TD) and Question Paper Setting Board	Teaching Hours /Week				Examination				Credits
				Theory Lecture	Tutorial	/	Self -Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	T	P	S					
1	HSMC 21ME61	Production and Operations Management	TD: ME PSB: ME	3	0	0	0	03	50	50	100	3
2	IPCC 21ME62	Heat Transfer	TD: ME PSB: ME	3	0	2	0	03	50	50	100	4
3	PCC 21ME63	Machine design	TD: ME PSB: ME	2	2	0	0	03	50	50	100	3
4	PEC 21ME64x	ProfessionalElective Course-I	TD: ME PSB: ME	3	0	0	0	03	50	50	100	3
5	OEC 21ME65x	OpenElective Course-I	TD: ME PSB: ME	3	0	0	0	03	50	50	100	3
6	PCC 21MEL66	CNC Programming and 3-D Printing Lab	TD: ME PSB: ME	0	0	2	0	03	50	50	100	1
7	MP 21MEMP67	Mini Project		Two contact hours /week for interaction between the faculty and students.				--	100	--	100	2
8	INT 21INT68	Innovation/Entrepreneurship /Societal Internship	Completed during the intervening period of IV and V semesters.					--	100	--	100	3
								Total	**500**	**300**	**800**	**22**

Professional Elective – I

21ME641	Supply Chain Management & Introduction to SAP	21ME643	Autonomous vehicles
21ME642	Mechatronic System Design	21ME644	Internet of Things (IoT) (2-0-2-0)

Open Electives – I offered by the Department to other Department students

21ME651	Project Management	21ME653	Mechatronics
21ME652	Renewable Energy Power Plants	21ME654	Modern Mobility

Note: HSMC: Humanity and Social Science & Management Courses, **IPCC:** Integrated Professional Core Course, **PCC:** Professional Core Course, **PEC:** Professional Elective Courses, **OEC**–Open Elective Course, **MP** –Mini Project, **INT** – Internship.
L –Lecture, T – Tutorial, P - Practical / Drawing, S – Self Study Component, CIE: Continuous Internal Evaluation, SEE: Semester End Examination.

Integrated Professional Core Course (IPCC): Refers to Professional Theory Core Course Integrated with Practical of the same course. Credit for IPCC can be 04 and its Teaching – Learning hours (L : T : P) can be considered as (3 : 0 : 2) or (2 : 2 : 2). The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by CIE only and there shall be no SEE. For more details, the regulation governing the Degree of Bachelor of Engineering /Technology (BE/B.Tech) 2021-22 may be referred.

Professional Elective Courses(PEC):
A professional elective (PEC) course is intended to enhance the depth and breadth of educational experience in the

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Engineering and Technology curriculum. Multidisciplinary courses that are added supplement the latest trend and advanced technology in the selected stream of engineering. Each group will provide an option to select one course out of five course. The minimum students' strength for offering professional electives is 10. However, this conditional shall not be applicable to cases where the admission to the programme is less than 10.

Open Elective Courses:

Students belonging to a particular stream of Engineering and Technology are not entitled for the open electives offered by their parent Department. However, they can opt an elective offered by other Departments, provided they satisfy the prerequisite condition if any. Registration to open electives shall be documented under the guidance of the Program Coordinator/ Advisor/Mentor.

Selection of an open elective shall **not be allowed** if,

(i) The candidate has studied the same course during the previous semesters of the program.

(ii) The syllabus content of open electives is similar to that of the Departmental core courses or professional electives.

(iii) A similar course, under any category, is prescribed in the higher semesters of the program.

In case, any college is desirous of offering a course (not included in the Open Elective List of the University) from streams such as Law, Business (MBA), Medicine, Arts, Commerce, etc., can seek permission, at least one month before the commencement of the semester, from the University by submitting a copy of the syllabus along with the details of expertise available to teach the same in the college.

The minimum students' strength for offering open electives is 10. However, this conditional shall not be applicable to cases where the admission to the programme is less than 10.

Mini-project work: Mini Project is a laboratory-oriented course which will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications.

Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini- project can be assigned to an individual student or to a group having not more than 4 students.

CIE procedure for Mini-project:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two faculty members of the Department, one of them being the Guide. The CIE marks awarded for the Mini-project work shall be based on the evaluation of project report, project presentation skill, and question and answer session in the ratio of 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group-wise at the college level with the participation of all the guides of the project.

The CIE marks awarded for the Mini-project, shall be based on the evaluation of project report, project presentation skill, and question and answer session in the ratio 50:25:25. The marks awarded for the project report shall be the same for all the batch mates.

No SEE component for Mini-Project.

VII semester Classwork and Research Internship /Industry Internship (21INT82)

Swapping Facility

Institutions can swap VII and VIII Semester Scheme of Teaching and Examinations to accommodate research internship/ industry internship after the VI semester.

(2) Credits earned for the courses of VII and VIII Semester Scheme of Teaching and Examinations shall be counted against the corresponding semesters whether VII or VIII semester is completed during the beginning of IV year or later part of IV year of the program.

Elucidation:

At the beginning of IV year of the programme i.e., after VI semester, VII semester classwork and VIII semester Research Internship /Industrial Internship shall be permitted to be operated simultaneously by the University so that students have ample opportunity for internship. In other words, a good percentage of the class shall attend VII semester classwork and similar percentage of others shall attend to Research Internship or Industrial Internship.

Research/Industrial Internship shall be carried out at an Industry, NGO, MSME, Innovation centre, Incubation centre, Start-up, Centers of Excellence (CoE), Study Centre established in the parent institute and /or at reputed research organizations / institutes. The intership can also be rural internship.

The mandatory Research internship /Industry internship is for 24 weeks. The internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take up/complete the internship shall be declared fail and shall have to complete during the subsequent University examination after satisfying the internship

requirements.
INT21INT82 Research Internship/ Industry Internship/Rural Internship **Research internship:** A research internship is intended to offer the flavour of current research going on in the research field. It helps students get familiarized with the field and imparts the skill required for carrying out research. **Industry internship:** Is an extended period of work experience undertaken by students to supplement their degree for professional development. It also helps them learn to overcome unexpected obstacles and successfully navigate organizations, perspectives, and cultures. Dealing with contingencies helps students recognize, appreciate, and adapt to organizational realities by tempering their knowledge with practical constraints. **Rural internship:** A long-term goal, as proposed under the AICTE rural internship programme, shall be counted as rural internship activity. The student can take up Interdisciplinary Research Internship or Industry Internship. The faculty coordinator or mentor has to monitor the students' internship progress and interact with them to guide for the successful completion of the internship. The students are permitted to carry out the internship anywhere in India or abroad. University shall not bear any expenses incurred in respect of internship.

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Semester - V

THEORY OF MACHINES			
Course Code	**21ME51**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2-2-0-0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

- To understand the concept of machines, mechanisms and to analyze a mechanism for displacement, velocity and acceleration at any point in a moving link.
- To understand the force-motion relationship in components subjected to external forces and analysis of standard mechanisms
- To understand the theory of gears and gear trains.
- To understand the undesirable effects of unbalances resulting from prescribed motions in mechanism.
- To understand the principles in mechanisms used for speed control and stability control.
- To compute the natural and damped frequencies of free 1-DOF mechanical systems and to analyze the vibrational motion of 1-DOF mechanical systems under harmonic excitation conditions.

Teaching-Learning Process (General Instructions)

These are sample strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1	
Introduction: Mechanisms and machines, Kinematic pairs-types, degree of freedom, Kinematic chains and their classification, Kinematic inversions, **Velocity and Acceleration analysis of planar mechanisms Graphical method:** Velocity and Acceleration Analysis of Mechanisms Velocity and acceleration analysis of four bar mechanism, slider crank mechanism. Mechanism illustrating Corioli's component of acceleration. Angular velocity and angular acceleration of links, velocity of rubbing. **Velocity and Acceleration Analysis of Mechanisms (Analytical Method):**Velocity and acceleration analysis of four bar mechanism, slider crank mechanism using complex algebra method.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Module-2	
Static force analysis: Static equilibrium, analysis of four bar mechanism, slider crank mechanism. **Dynamic force analysis**: D'Alembert's principle, analysis of four bar and slider crank mechanism. **Flywheel:** Introduction to Flywheel and calculation of its size for simple machines like punching machine, shearing machine	
Teaching-Learning Process	. 1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Module-3	

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Spur Gears: Gear terminology, law of gearing, path of contact, arc of contact, contact ratio of spur gear. Interference in involute gears, methods of avoiding interference, condition and expressions for minimum number of teeth to avoid interference. **Gear Trains**: Simple gear trains, compound gear trains. Epicyclic gear trains: Algebraic and tabular methods of finding velocity ratio of epicyclic gear trains, torque calculation in epicyclic gear trains. Discussions on applications of gear trains.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Module-4	
Balancing of Rotating Masses: Static and Dynamic Balancing, Balancing of single rotating mass by balancing masses in same plane and in different planes. Balancing of several rotating masses by balancing masses in same plane and in different planes. Discussions on applications. **Balancing of Reciprocating Masses**: Inertia Effect of crank and connecting rod, Single cylinder Engine, Balancing in multi cylinder-inline engine (primary and secondary forces). Discussions on applications **Governors:**Types of Governors; Force Analysis of Porter and Hartnell Governors. Controlling Force, Stability, Sensitiveness, Isochronism, Effort and Power. Discussion on applications.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Module-5	
Free vibrations: Basic elements of vibrating system, Types of free vibrations, Longitudinal vibrations- Equilibrium method, D'Alembert's principle, Determination of natural frequency of single degree freedom systems, Damped free vibrations: Under damped, over damped and critically damped systems. Logarithmic decrement. **Forced vibrations**: Undamped forced vibration of spring mass system, Damped forced vibrations, Rotating unbalance, Reciprocating unbalance, Vibration isolation, Critical speed. Discussions on applications.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Course outcome (Course Skill Set) At the end of the course the student will be able to : • Knowledge of mechanisms and their motion and the inversions of mechanisms • Analyse the velocity, acceleration of links and joints of mechanisms.. • Analyse the mechanisms for static and dynamic equilibrium. • Carry out the balancing of rotating and reciprocating masses • Analyse different types of governors used in real life situation. • Analyze the free and forced vibration phenomenon.	

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour)**

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks (duration 01 hours)**

- At the end of the 13th week of the semester
- The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject **(duration 03 hours)**

- The question paper will have ten questions. Each question is set for 20 marks.Marks scored shall be reduced proportionally to 50 marks
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

Suggested Learning Resources:

Books

1 Theory of Machines Kinematics and Dynamics Sadhu Singh Pearson Third edition 2019

2 Mechanism and Machine Theory G. Ambekar PHI 2009

Reference Books

1 Theory of Machines Rattan S.S Tata McGraw-Hill Publishing Company 2014

2 Mechanisms and Machines- Kinematics, Dynamics and Synthesis Michael M Stanisic Cengage Learning 2016

Web links and Video Lectures (e-Resources):

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Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Course Seminar
- Term project
- Assignment

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Semester - V

THERMO-FLUIDS ENGINEERING (IPCC)			
Course Code	21ME52	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 13 Lab slots*	Total Marks	100
Credits	04	Exam Hours	03

**** Additional one hour may be considered as Instructional duration wherever required***

Course objectives:

Student will be able

- To understand the concepts of testing of I. C. Engines and methods to estimate Indicated, Brake and Frictional Power and efficiencies.
- To understand theory and performance Calculation of Reciprocating compressor and positive displacement pumps.
- To understand the concepts related to Refrigeration, refrigeration cycles and Air conditioning and get conversant with Psychrometric Charts, Psychrometric processes, human comfort conditions.
- Understand typical construction of a Turbo machine, their working principle, application and conversion of fluid energy to mechanical energy in Turbo machine with utilization factor and degree of reaction.
- Understand the working principle of hydraulic turbines and steam turbine

Teaching-Learning Process (General Instructions)

These are sample strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1 **8 HOURS**

Performance Testing of IC Engines: Two-stroke and Four-stroke I.C. engines - Measurement of speed, air flow, fuel consumption, Measurement of Brake Power and Indicated Power, Performance curves, Heat Balance sheet., Frictional power: various methods – Willan's line, Morse test, motoring etc.

Reciprocating Air Compressors: Operation of a single stage reciprocating compressors: work input through p-v diagram, effect of clearance and volumetric efficiency, adiabatic, isothermal and mechanical efficiencies. Multi-stage compressor, saving in work, optimum intermediate pressure, inter-cooling, minimum work for compression. Discussion on application.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving/White board

MODULE-2 **8 HOURS**

Refrigeration: Vapour compression refrigeration system; description, analysis, refrigerating effect, capacity, power required, units of refrigeration, COP, reversed Carnot cycle, vapour absorption refrigeration system and Air refrigeration system. Use of refrigeration tables and p-h chart. Classification of Refrigerants. Desirable properties of refrigerants.

Psychrometries: Atmospheric air and Psychrometric properties: DBT, WBT, DPT, partial pressure, specific and relative humidity and relation between the enthalpy and adiabatic saturation temperatures. Construction and use of psychrometric chart. Analysis of various processes: Heating, cooling, dehumidifying and humidifying. Adiabatic mixing of stream of moist air. Analysis of summer and winter air-conditioning systems. Discussion on commercial Air conditioning systems.

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Teaching-Learning Process	. 1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-3	**8 HOURS**
Introduction to Turbo machines: Classification of Turbomachines, Basic constructional details, Euler's equation for a Turbo machine, Impulse & Reaction machine - Axial flow and radial flow machines, utilization factor, degree of reaction & efficiencies of Turbo machines, **Introduction to positive displacement machines:** Classification, comparison with turbomachines. Construction and working of reciprocating pump, gear and vane pumps. Discussion on engineering applications.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving/White board

MODULE-4	**8 HOURS**
Hydraulic Turbines: Classification of hydraulic turbines, Various heads and efficiencies, working principle, Velocity triangles, work done, efficiencies etc in Pelton wheel, Francis turbine and Kaplan turbine. Draft tubes, Cavitation in reaction turbines, characteristic curves.Significance of Specific speed and Unit quantities. **Centrifugal Pumps:** Main Parts of centrifugal pump, Various heads and efficiencies, work done, minimum speed for starting centrifugal pump, Classifications- Performance characteristics of centrifugal pumps, Cavitation in pumps and NPSH. Pumps in series and parallel, casings. Discussion on engineering applications.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving/White board

MODULE 5	**8 HOURS**
Centrifugal Fans, Blowers & Compressors: types; velocity triangles, work done and degree of reaction, size & speed; vane shape & efficiency; vane shape & characteristics; actual performances characteristics; Concept of slip and slip coefficient. Discussion on engineering applications. **Steam and gas Turbines:** Impulse turbines, Staging - expression for work done in a 2-stage velocity compounded turbine-effect of blade & nozzle losses- Reaction staging- reheat factor- performance characteristics, problems using Mollier's chart & introduction to gas turbines.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

PRACTICAL COMPONENT OF IPCC

Use of modern computing tools preferred in analysis of performance and estimations

Sl.NO	**Experiments**
1	Determination of calorific value of solid/liquid fuels using Bomb Calorimeter
2	Determination of calorific value of gaseous fuels using Junker's Gas Calorimeter.
3	Performance test on single cylinder engine four/two stroke and draw Heat balance sheet
4	Performance test on multi cylinder engine, draw Heat balance sheet and perform Morse test
5	Performance test on Vapour compression refrigeration -test rig.
6	Performance test on Air conditioning-test rig.
7	Performance test on single/multi stage Reciprocating compressor.
8	Performance test on single / multi-stage centrifugal pump.
9	Performance test on Pelton turbine and draw main and operating characteristics.
10	Performance test on Franci's turbine and draw main and operating characteristics.
11	Performance test on Kaplan turbine and draw main and operating characteristics.

12	Performance test on centrifugal blower and draw performance characteristics for different vane shapes.
13	Demonstration on Computerised IC Engine test rig for its performance and analysis.

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- Apply the concepts of testing of I. C. Engines and evaluate their performance, and evaluate the performance of Reciprocating compressor.
- Apply and analyse the concepts related to Refrigeration and Air conditioning, and get conversant with Psychrometric Charts, Psychrometric processes, human comfort conditions.
- Explain the construction, classification and working principle of the Turbo machines and apply of Euler's turbine equation to evaluate the energy transfer and other related parameters. Compare and evaluate the performance of positive displacement pumps.
- Classify, explain and analyse the various types of hydraulic turbines and centrifugal pumps.
- Classify, explain and analyse various types of steam turbines and centrifugal compressor.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks (duration 01 hour)**

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test **(duration 03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks.
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

- The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be reduced proportionally to 50 marks
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3

sub-questions), **should have a mix of topics** under that module.

- The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included. The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Text Books

1. Engineering Thermodynamics P.K. Nag Tata McGraw Hill 6th Edition 2018
2. Applications of Thermodynamics V.Kadambi, T. R.Seetharam, K. B. Subramanya Kumar Wiley Indian Private Ltd 1st Edition 2019
3. Turbo machines M. S. Govindegowda and A. M. Nagaraj M. M. Publications 7Th Ed, 2012
4. Thermodynamics Yunus A, Cengel, Michael A Boles Tata McGraw Hill 7th Edition
5. An Introduction to Energy Conversion, Volume III, Turbo machinery, V. Kadambi and Manohar Prasad New Age International Publishers reprint 2008
6. Turbo Machines B.U.Pai Wiley India Pvt, Ltd 1st Edition

Reference Books

1. Principles of Engineering Thermodynamics Michael J, Moran, Howard N. Shapiro Wiley 8th Edition
2. An Introduction to Thermodynamics, Y.V.C.Rao Wiley Eastern Ltd 2003.
3. Thermodynamics Radhakrishnan PHI 2nd revised edition
4. I.C.Engines M.L.Mathur& Sharma. Dhanpat Rai& sons- India
5. Turbines, Compressors & Fans S. M. Yahya Tata McGraw Hill Co. Ltd 2nd edition, 2002
6. Principals of Turbo machines D. G. Shepherd The Macmillan Company 1964
7. Fluid Mechanics & Thermodynamics of Turbo machines S. L. Dixon Elsevier 2005

Web links and Video Lectures (e-Resources):

E- Learning

- Nptel.ac.in
- VTU, E- learning
- MOOCS
- Open courseware

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- **Course seminar**
- **Term project**

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Semester - V

FINITE ELEMENT ANALYSIS			
Course Code	21ME53	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2-0-2*-0	SEE Marks	50
Total Hours of Pedagogy	25 hrs +13 practical sessions	Total Marks	100
Credits	03	Exam Hours	03
** Additional One hour may be considered for instructions if required*			

Course objectives:

Students will be able

- To learn the basic principles of finite element analysis procedure
- To understand heat transfer problems with application of FEM.
- Solve 1 D, 2 D and dynamic problems using Finite Element Analysis approach.
- To learn and apply finite element solutions to structural, thermal, dynamic problem to develop the knowledge and skills needed to effectively evaluate finite element analyses.

Teaching-Learning Process (General Instructions)

These are sample strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Adopt flipped classroom teaching method.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1

Introduction to Finite Element Method: General steps of the finite element method. Engineering applications of finite element method. Advantages of the Finite Element Method.

Potential energy method, Displacement method of finite element formulation. Convergence criteria, Discretization process, ***Rayleigh Ritz method, Galerkin's method (for study purpose only)***

Types of elements: 1D, 2D and 3D, Node numbering, Location of nodes. Strain- displacement relations, Stress-strain relations, Plain stress and Plain strain conditions, temperature effects.

Interpolation models: Simplex, complex and multiplex elements, linear interpolation polynomials in terms of global coordinates 1D, 2D, 3D Simplex Elements.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-2

Introduction to the stiffness (Displacement) method: Introduction, One-Dimensional Elements-Analysis of Bars and Trusses, Linear interpolation polynomials in terms of local coordinate's for1D, 2D elements. Higher order interpolation functions for 1D quadratic and cubic elements in natural coordinates, Constant strain triangle, Four-Noded Tetrahedral Element (TET 4), Eight-Noded Hexahedral Element (HEXA 3 8), 2D iso-parametric element,

Numerical Problems: Solution for displacement, stress and strain in 1D straight bars, stepped bars and tapered bars using elimination approach and penalty approach

Teaching-Learning Process	. 1. Power-point Presentation, 2. Video demonstration or Simulations,

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	3. Chalk and Talk are used for Problem Solving./White board
MODULE-3	
Beams and Shafts: Boundary conditions, Load vector, Hermite shape functions , Beam stiffness matrix based on Euler-Bernoulli beam theory, Numerical problems on simply supported, fixed straight and cantilever beams, propped cantilever beams with concentrated and uniformly distributed load. **Torsion of Shafts**: Finite element formulation of shafts, determination of stress and twists in circular shafts.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
MODULE-4	
Heat Transfer: Basic equations of heat transfer: Energy balance equation, Rate equation: conduction, convection, radiation, 1D finite element formulation using variational method, Problems with temperature gradient and heat fluxes, heat transfer in composite sections, straight fins. **Fluid Flow**: Flow through a porous medium, Flow through pipes of uniform and stepped sections, Flow through hydraulic networks.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
MODULE 5	
Axi-symmetric Solid Elements: Derivation of stiffness matrix of axisymmetric bodies with triangular elements, Numerical solution of axisymmetric triangular element(s) subjected to surface forces, point loads, angular velocity, pressure vessels. **Dynamic Considerations**: Formulation for point mass and distributed masses, Consistent element mass matrix of one dimensional bar element, truss element, triangular element, beam element. Lumped mass matrix of bar element, truss element, Evaluation of eigen values and eigen vectors, Applications to bars, stepped bars, and beams.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

PRACTICAL COMPONENT

Sl.NO	Experiments
1	**Introduction to FEA software , Pre-processing tools, Solver tools and Post-processing tools.**
2	Analysis of Bars of constant cross section area, tapered cross section area and stepped bar subjected to Point forces, Surface forces and Body forces(Minimum 2 exercises of different types)
3	Analysis of trusses (Minimum 2 exercises of different types)
4	Analysis of Beams – Simply supported, cantilever, Propped cantilever beams with point load , UDL, beams with varying load etc.
5	
6	Stress analysis of a rectangular plate with a circular hole.
7	Thermal Analysis – 1D & 2D problem with conduction and convection boundary conditions (Minimum 2 exercises of different types)
8	
9	Dynamic Analysis to find: Natural frequency of beam with fixed – fixed end condition, Response of beam with fixed – fixed end conditions subjected to forcing function

10	Dynamic Analysis to find: Natural frequency of bar, Response of Bar subjected to forcing functions
11	Demonstrate the use of graphics standards (IGES, STEP etc) to import the model from modeler to solver.
12	Demonstrate one example of contact analysis to learn the procedure to carry out contact analysis.
13	Demonstrate at least two different types of example to model and analyze bars or plates made from composite material.

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- Identify the application and characteristics of FEA elements such as bars, beams, plane and isoparametric elements.
- Develop element characteristic equation and generation of global equation.
- Formulate and solve Axi-symmetric and heat transfer problems.
- Apply suitable boundary conditions to a global equation for bars, trusses, beams, circular shafts, heat transfer, fluid flow, axi-symmetric and dynamic problems.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks (duration 01 hour)**

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

CIE for the practical component

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The **15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test **(duration 03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks.

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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SEE for

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

- The question paper will have ten questions. Each question is set for 20 marks.Marks scored shall be reduced proportionally to 50 marks
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included. The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Textbooks

1. A first course in the Finite Element Method, Logan, D. L, Cengage Learning, 6th Edition 2016.
2. Finite Element Method in Engineering, Rao, S. S, Pergaman Int. Library of Science 5th Edition 2010.
3. Finite Elements in Engineering Chandrupatla T. R PHI 2nd Edition 2013

Referencebooks

1. Finite Element Method, J.N.Reddy, McGraw -Hill International Edition.
2. Finite Elements Procedures Bathe K. J PHI

Web links and Video Lectures (e-Resources):

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- **Course seminar**
- **Term project**

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V Semester

MODERN MOBILITY & AUTOMOTIVE MECHANICS			
Course Code	**21ME54**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand the different chassis design & main components of automobile
- To understand the working of transmission and control system employed in automobiles
- To understand the automotive pollution and alternative automotive technologies under trail
- To understand the upcoming electric vehicle technology

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

1. Explain clearly through Power Point presentations
2. showing live Videos for working of components
3. Demonstration of live working of components through cut section models
4. Inspecting live vehicles
5. Visiting nearby service centres

Module-1	**Chassis & Power Plant**
History of Automobile, Classification of Automobile w.r.t Usage, Chassis, Body, Power Sources, capacity, main components of Internal Combustion Engines and their Functions, Fuel supply system, Cooling System, Lubrication System & Ignition System, Engine Management System, super charged engines, hybrid engines, modern GT engines	
Teaching-Learning Process	Power Point presentations Live Videos for working of components Explaining through live components in class room

Module-2	**Transmission & Suspension System**
Clutches; Plate Clutches, Cone Clutch, Centrifugal Clutch, Fluid Flywheel **Gear Box;** Gear Shifting mechanism, synchromesh Gear box, Torque converter, Automatic Manual Transmission (AMT), Automatic Transmission (AT), intelligent manual Transmission (IMT) Continuously Variable Transmission (CVT), Infinitely Variable Transmission (IVT)- Working of Differential, Rear Axle types &construction. **Suspension** – layout & working of Hydraulic& Air suspension, Independent suspension, Functions& advantages of Leaf Spring, Coil Spring, Telescopic Shock Absorber, Torsion Bar	
Teaching-Learning Process	Power Point presentations Live Videos for working of components Explaining through live components in class room

Module-3	**Control & Safety systems**
Steering system- mechanisms & Linkages, Steering gear boxes- Rack & pinion, worm & wheel construction & working,, power Steering construction & working, steering geometry, Wheel balancing **Braking System**- Mechanism and Linkages; Mechanical Brakes, Hydraulic Brakes, Power Brakes, Parking brakes, ABS, **Safety system** – Safety measures in modern vehicle – safety frames – working of - air bags, seat belt, collapsible steering, spoilers, defoggers, fire safety measures in heavy vehicles, bullet proof vehicles	
Teaching-Learning	Power Point presentations Live Videos for working of components

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Process	Explaining through live components in class room
Module-4	**Automotive Emission & Alternate Vehicles**
Exhaust gas pollutants and their effects on environment, Emission norms, IC engine fuels types, extraction& availability, BIO Fuels – Production and impact. Ethanol engines, CNG vehicles- operation, advantages& disadvantages, over view of Hydrogen - fuel cell vehicles, advantages & disadvantages, IC engine/ electric hybrid vehicles over view, layout, transmission & control system, solar powered vehicles- wind powered vehicles, super capacitors, supply rails	
Teaching-Learning Process	Power Point presentations Live Videos for working of components
Module-5	**Electric Vehicles& Storage Batteries**
Electric vehicles principle and components- layout of two & 4 wheeler, Motors used in Electric vehicles –types- over view of construction and working, power transmission & control system in Electric vehicles. Batteries –construction & working principle of Lead acid, nickel based, sodium based, Lithium & Metal Air batteries. Battery charging types and requirements, battery cooling, fire safety measures in EV vehicles	
Teaching-Learning Process	Power Point presentations Live Videos for working of components

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

5. Understand the working of different systems employed in automobile
6. Analyse the limitation of present day automobiles
7. Evaluate the energy sources suitability
8. Apply the knowledge for selection of automobiles based on their suitability

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour)**

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks (duration 01 hours)**

- At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(To have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject **(duration 03 hours)**

- The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be reduced proportionally to 50 marks
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

Suggested Learning Resources:

Books

- Electric Vehicle Technology Explained James Larminie Oxford Brookes University, Oxford, UK John Lowry Acenti Designs Ltd., UK
- Automobile engineering, Kirpal Singh, Vol I and II (12th Edition) Standard Publishers 2011 2
- Automotive Mechanics, S. Srinivasan, (2nd Edition) Tata McGraw Hill 2003.
- Automotive Systems & Modern Mobility by Dr T Madhusudhan, et al., Cengage publications
- Automotive mechanics, William H Crouse & Donald L Anglin (10th Edition) Tata McGraw Hill Publishing Company Ltd., 2007.
- Modren Electric, Hybrid Electric, and Fuel Cell Vehicles,MehrdadEhsani, YiminGao, CRC Press, Taylor & Francis Group
- Automotive mechanics: Principles and Practices, Joseph Heitner, D Van Nostrand Company, Inc
- . Fundamentals of Automobile Engineering, K.K.Ramalingam, Scitech Publications (India) Pvt. Ltd. 4.
- Automobile Engineering, R. B. Gupta, SatyaPrakashan,(4th Edition) 1984.

Web links and Video Lectures (e-Resources):

https://archive.nptel.ac.in/courses/107/106/107106088/ https://onlinecourses.nptel.ac.in/noc20_de06/preview https://www.digimat.in/nptel/courses/video/107106088/L01.html https://nptel.ac.in/courses/107106088 https://www.youtube.com/watch?v=LZ82iANWBL0&list=PLbMVogVj5nJTW50jj9_gvJmdwFWHaqR5J
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning • Operate the cut section models of complete vehicle chassis and observe the working of all components • Dismantle & Assemble the Automotive Engine, Gear Box, Clutch, brakes • Prepare the posters of automobile chassis & display • Visit nearby automobile showrooms/ service station • Prepare a comparison statement of different automobiles using specification provided by respective manufacturers • Visit auto expo

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Semester V

DESIGN LAB			
Course Code	21MEL55	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0-0-2*-0	SEE Marks	50
Credits	01	Exam Hours	03

**** Additional one hour may be considered for instructions if required.***

Course objectives:

The students will be able

- To understand the concepts of natural frequency, logarithmic decrement, damping and damping ratio.
- To understand the techniques of balancing of rotating masses and influence of gyroscopic couple.
- To verify the concept of the critical speed of a rotating shaft.
- To illustrate the concept of stress concentration using Photo elasticity.
- To appreciate the equilibrium speed, sensitiveness, power and effort of a Governor.
- To illustrate the principles of pressure development in an oil film of a hydrodynamic journal bearing.
- To visualize different mechanisms and cam motions

Modern computing techniques are preferred to be used wherever possible.

Sl.NO	Experiments
1	Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree of freedom vibrating systems (longitudinal and torsional)
2	Balancing of rotating masses
3	Determination of critical speed of a rotating shaft
4	Determination of equilibrium speed, sensitiveness, power and effort of Porter/Proell /Hartnel Governor.
5	Determination of Pressure distribution in Journal bearing
6	Study the principle of working of a Gyroscope and demonstrate the Effect of gyroscopic Couple on plane disc
7	Study of different types of cams, types of followers and typical follower motions. Obtain cam profile for any two types of follower motions and types of follower
8	
9	Determination of Fringe constant of Photo-elastic material using. a) Circular disc subjected to diametral compression. b) Pure bending specimen (four-point bending).
	Demonstration Experiments (For CIE)
10	**Demonstration and study of operation of different Mechanisms and their Inversions:** Slider crank chain, Double slider crank chain and its inversions, Quick return motion mechanisms- Peaucellier's mechanism. Geneva wheel mechanism, Ratchet and Pawl mechanism, toggle mechanism, pantograph, Ackerman steering gear mechanism.
11	
12	Demonstration of stress concentration using Photo-elasticity for simple components like plate with a hole under tension or bending, circular disk with circular hole under compression,

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Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- Compute the natural frequency of the free and forced vibration of single degree freedom systems, critical speed of shafts.
- Carry out balancing of rotating masses and gyroscope phenomenon.
- Analyse the governor characteristics.
- Determine stresses in disk, beams and plates using photo elastic bench.
- Determination of Pressure distribution in Journal bearing
- Analyse the stress and strains using strain gauges in compression and bending test
- To realize different mechanisms and cam motions

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination(SEE).

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners

jointly. Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners. General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners) Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero. The duration of SEE is 03 hours Rubrics suggested in Annexure-II of Regulation book
Suggested Learning Resources: 1. Theory of Machines, Rattan S.S , Tata McGraw-Hill Publishing Company, 2014 2. Experimental Stress analysis, M. M. Frotch, McGraw-Hill

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BASICS OF MATLAB			
Course Code	21ME581	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2*:0	SEE Marks	50
Credits	01	Exam Hours	02
Additional one hour may be considered for instructions, if required			

Course objectives:

1. To know about fundamentals of MATLAB tool.
2. To provide an overview to program curve fitting & solve Linear and Nonlinear Equations.
3. To understand the concept and importance of Fourier transforms.
4. To gain knowledge about MATLAB Simulink & solve Electrical engineering problems.

Sl.NO	Experiments
1 2	**Introduction to MATLAB Programming:** Basics of MATLAB Programming, array operations in MATLAB, loops and execution of control, working with files: Scripts and functions, plotting and programming output, examples.
3 4	**Numerical Methods and their applications: Curve Fitting: Straight line fit, Polynomial fit.**
5 6	**Numerical Integration and Differentiation:** Trapezoidal method, Simpson method.
7 8	**Linear and Nonlinear Equations:** Eigen values, Eigen vectors, Solution of linear algebraic equations using Gauss Elimination and LU decomposition, Solution of nonlinear equation in single variable using Gauss-Siedal and Newton-Raphson method.
9 10	**Ordinary Differential Equations:** Introduction to ODE's, Euler's method, second order RungaKutta method, MATLAB ode45 algorithm in single variable and multivariables. **Transforms:** Discrete Fourier Transforms,
11 12 13	Application of MATLAB to analyse problems in basic engineering mechanics, mechanical vibrations, control system, statistics and dynamics of different circuits. **MATLAB Simulink:** Introduction to MATLAB Simulink, Simulink libraries, development of basic models in Simscape Power Systems

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- Able to implement loops, branching, control instruction and functions in MATLAB programming environment.
- Able to program curve fitting, numerical differentiation and integration, solution of linear equations in MATLAB and solve electrical engineering problems.
- Able to understand implementation of ODE using ode 45 and execute Solutions of nonlinear equations and DFT in MATLAB.
- Able to simulate MATLAB Simulink examples

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Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination(SEE).

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

Text Books:

1. Agam Kumar Tyagi, **"MATLAB and Simulink for Engineers"**, OXFORD Higher Education.

2. Dr. Shailendra Jain, **"Modeling& Simulation using MATLAB – Simulink"**, Wiley – India.

Reference Books:

1. Won Y.Tang, Wemun Cao, Tae-Sang Ching and John Morris, **"Applied Numerical Methods Using MATLAB"**, A John Wiley & Sons.

2. Steven T. Karris, **"Introduction to Simulink with Engineering Applications"**, Orchard Publications.

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Semester 05

DIGITAL MARKETING			
Course Code	21ME582	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:2:0:0	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	100
Credits	01	Exam Hours	01

Course objectives:

- To provide with the knowledge about business advantages of the digital marketing and its importance for marketing success;
- To develop a digital marketing plan;
- To make SWOT analysis;
- To define a target group;
- To get introduced to various digital channels, their advantages and ways of integration;
- To integrate different digital media and create marketing content;
- To optimize a Website and SEO optimization;
- To create Google AdWords campaigns; social media planning;
- To get basic knowledge of Google Analytics for measuring effects of digital marketing and getting insight of future trends that will affect the future development of the digital marketing.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

15. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
16. Chalk and Talk method for Problem Solving.
17. Adopt flipped classroom teaching method.
18. Adopt collaborative (Group Learning) learning in the class.
19. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1	
Introduction to the Course and Work plan, Introduction of the digital marketing, Digital vs. Real Marketing, Digital Marketing Channels Creating initial digital marketing plan, Content management, SWOT analysis, Target group analysis, Web design, Optimization of Web sites, MS Expression Web	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk

Module-2	
SEO Optimization, Writing the SEO content Google AdWords- creating accounts, Google AdWords- types Introduction to CRM, CRM platform, CRM models	
Teaching-Learning Process	. 1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk

Module-3	
Introduction to Web analytics, Web analytics – levels, Introduction of Social Media Marketing Creating a Facebook page, Visual identity of a Facebook page, Types of publications Business opportunities and Instagram options, Optimization of Instagram profiles, Integrating Instagram with a Web Site and other social networks, keeping up with posts	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk

Module-4

Business tools on LinkedIn,Creating campaigns on LinkedIn, Analyzing visitation on LinkedIn Creating business accounts on YouTube, YouTube Advertising, YouTube Analytics Facebook Ads, Creating Facebook Ads, Ads Visibility	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk
Module-5	
E-mail marketing, E-mail marketing plan, E-mail marketing campaign analysis, Keeping up with conversions Digital Marketing Budgeting- resource planning, cost estimating, cost budgeting, cost control	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk
Course outcome (Course Skill Set) At the end of the course the student will be able to: • toidentifytheimportance of the digital marketing for marketing success, • to manage customer relationships across all digital channels and build better customer relationships, • to create a digital marketing plan, starting from the SWOT analysis and defining a target group, then identifying digital channels, their advantages and limitations, • to perceive ways of the integration taking into consideration the available budget.	

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Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

Three Tests (preferably in MCQ pattern with 20 questions) each of **20 Marks (duration 01 hour)**

13. First test at the end of 5th week of the semester
14. Second test at the end of the 10th week of the semester
15. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

9. First assignment at the end of 4th week of the semester
10. Second assignment at the end of 9th week of the semester

Quiz/Group discussion/Seminar, any two of three suitably planned to attain the COs and POs for **20 Marks (duration 01 hours)**

The sum of total marks of three tests, two assignments, and quiz /seminar/ group discussion will be out of 100 marks and shall be **scaled down to 50 marks**

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

1. Ryan, D. (2014). Understanding Digital Marketing
2. Marketing Strategies for Engaging the Digital Generation, Kogan Page Limited
3. The Beginner's Guide to Digital Marketing (2015). Digital Marketer
4. Pulizzi,J.(2014) Epic Content Marketing, Mc-graw Hill Education.

Web links and Video Lectures (e-Resources):

- .

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

DefineaTargetGroup;CreatingWebSites;WritingtheSEOcontent;SEOOptimizacija;GoogleAdWords;CRM Platform; Social Media Marketing Plan; Making a Facebook page; Budgeting; Final presentation.

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Semester

VFX: VISUAL EFFECTS			
Course Code	21ME583	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:2:0:0	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	100
Credits	01	Exam Hours	01

Course objectives:

To expose the students to the following:

1. To learn the Basics of compositing using layer based compositing software.
2. To understand the tools and techniques of compositing.
3. To practice the categories in compositing process.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

20. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
21. Chalk and Talk method for Problem Solving.
22. Adopt flipped classroom teaching method.
23. Adopt collaborative (Group Learning) learning in the class.
24. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1

Visual Effects: Set Up Your VFX Content Development Workstation, The Foundation of Raster for VFX: Pixels, Color, and Alpha; The Foundation of Motion for VFX: Frames and Codecs; The Foundation of Audio for VFX: MIDI, Wave, and Sample.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk

Module-2

The Foundation of 2D Vector for VFX: Point, Path, and SVG; The Foundation of 3D Vector for VFX: Models and OpenGL; Professional VFX Software: Black magic Design Fusion; VFX Pipeline Composition: Using the Flow Node Editor.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk

Module-3

VFX Pipeline Animation: Using the Timeline Editor; VFX Pipeline Motion Control: Using the Spline Editor; VFX Pipeline Pixel Isolation: Animated Polyline Masking; VFX Pipeline Automated Masking: Matte Generators.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk

Module-4

VFX Pipeline Pixel Tracking: Using Motion Tracking; VFX Pipeline 3D Production: Compositing 3D Assets; VFX Pipeline 3D Rendering: Shader, Material, and Texture; VFX Pipeline 3D Modeling: 3D Text-Title Creation.

Teaching-Learning	1. Power-point Presentation, 2. Video demonstration or Simulations,

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Process	3. Chalk and Talk

Module-5
VFX Pipeline 3D Animation: 3D Text-Titling Modifiers; Advanced VFX Pipeline Effects: 3D Particle Systems; Advanced VFX Pipeline Physics: 3D Particle Physics; Advanced Interactive VFX: i3D Content Publishing.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

- Gain good understanding about compositing process.
- Identify major applications of compositing process used in industry.
- Develop a visual effects pipeline.
- Demonstrate an in-depth knowledge of grading and VFX principles, practice and system capabilities.
- Create customized tools through software or scripting to allow for more creative application of visual effects techniques.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

Three Tests (preferably in MCQ pattern with 20 questions) each of **20 Marks (duration 01 hour)**

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Quiz/Group discussion/Seminar, any two of three suitably planned to attain the COs and POs for **20 Marks (duration 01 hours)**

The sum of total marks of three tests, two assignments, and quiz /seminar/ group discussion will be out of 100 marks and shall be **scaled down to 50 marks**

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

1. Karen E. Goulekas Visual effects in a digital world

2. Wallace Jackson Vfx fundamentals: visual special effects using fusion 8.0

3. Martin Watt and Erwin Coumans [Digital] Visual Effects and Compositing

Web links and Video Lectures (e-Resources):

1. http://chrisoatley.com/upcoming2015/
2. https://thewaltdisneycompany.com/employee-profile-spotlight-on-a-visualdevelopment-artist-2/
3. http://www.artofvfx.com/escape-plan-chris-wells-vfx-supervisor-hydraulx/
4. http://conceptartworld.com/artists/interview-with-visual-development-artistlandis-fields/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning
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Semester - VI

PRODUCTION AND OPERATIONS MANAGEMENT			
Course Code	21ME61	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3-0-0-0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

Students will be able to

- Use of decision making tools such as break even analysis, linear programming, statistical analysis, simulation, etc. demands a strong knowledge of mathematics, science and engineering fundamentals.
- Forecasting models are basically mathematical equations. Formulating these models and solving them requires skill and a strong knowledge of mathematics, science, engineering & management fundamentals.
- Facility location and Capacity planning can be made by the use various mathematical models. Use of these models and solving them subsequently for arriving at a decision demands skill and knowledge on mathematics, science, engineering & management fundamentals.
- Preparation of aggregate plans and master schedule in an organization requires a strong background of mathematics, science, engineering & management fundamentals.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1

Introduction, Production of Goods Versus Providing Services, the operation management function, The Scope of Operations Management, Types and Characteristics of Manufacturing and Service Systems, Productivity, its improvement and factors affecting productivity and topic related numerical.

Operations Decision Making: Characteristics of Decisions, Framework for Decision Making, Decision Methodology, decision making environments, Economic Models and Statistical Models. Breakeven- analysis and trade-offs. (Topic related numerical)

Tutorial Components:

1. *Why manufacturing matters?*
2. *Productivity improvement* ***Case Studies.***

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-2

Forecasting: Introduction, Features Common to All Forecasts, Elements of a Good Forecast, Steps in the Forecasting Process, Approaches to Forecasting, choosing a Forecasting Technique, Accuracy and Control of Forecasts, Using Forecast Information, Operations Strategy and related numerical on various approaches.

Product and Service Design: Introduction, Sources of Ideas for New or Redesigned Products and Services, Legal, Ethical, and Environmental Issues, Designing for Manufacturing, and services.

Tutorial Components:

1. *High level forecasts can be bad news* ***-Case Studies***
2. *Managing poor forecast.*

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board.

Module-3

Capacity & Location Planning: Introduction, Importance of Capacity Decisions, Defining and Measuring Capacity, Determinants of Effective Capacity, Determining Capacity Requirements, Developing Capacity Strategies, Evaluating Alternatives, Planning Service Capacity and related numerical.

Location Planning and Analysis: The Need for Location Decisions, The Nature of Location Decisions, General Procedure for Making Location Decisions, Identifying a Country, Region, Community, site and related numerical.

Facility Layout: Designing Product Layouts: Line Balancing, Designing Process Layouts.

Tutorial Components: Case studies

1. *Managing higher capacities or thinking of OUTSOURCING*
2. *Any increase in efficiency also increases utilization. Although the upper limit on efficiency is 100 percent, what can be done to achieve still higher levels of utilization?*

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-4

Aggregate Planning: Introduction, The Purpose and Scope of Aggregate Planning, Basic Strategies for Meeting Uneven Demand, Techniques for Aggregate Planning, Aggregate Planning in Services, Disaggregating the Aggregate Plan and related numerical on the techniques.

Master Scheduling: The Master Scheduling Process, Planning Horizons, Master Scheduling Format, Available-to-Promise Quantities and related numerical

Tutorial Components: Case Studies

1. *Duplicate orders can lead to excess capacity*
2. *Service operations often face more difficulty in planning than their manufacturing counterparts. However, service does have certain advantages that manufacturing often does not.*

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-5

MRP and ERP: Introduction, MRP Inputs, processing, outputs, MRP in Services, Benefits and Requirements of MRP, numerical, Capacity Requirements Planning, MRP II and ERP.

Purchasing and Supply Chain Management (SCM): Introduction, Importance of purchasing and SCM, the procurement process, Concept of tenders, Approaches to SCM, Vendor development.

Tutorial Components:

1. *The ABCs of ERP.*
2. *How can ERP Improve a Company's Business Performance? - **Case Studies***

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

- Apply the necessary tools for decision making in operations management.
- Examinevariousapproachesforforecastingthesalesdemandforanorganization.
- Listvariouscapacityandlocationplanstodeterminethesuitablecapacityrequiredformeetingtheforecastdemandofan organization.
- Analyse the aggregate plan and master production schedule for an organization, given its periodic demand.
- Apply MRP, purchasing and SCM techniques into practice.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour)**

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks (duration 01 hours)**

- At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours**)

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Books

Sl. No.	Author/s	Title	Publisher	Edition & Year
1.	William J stevenson	Production and Operations management	Tata McGraw Hill.	13th edition, 2018
2.	Joseph G. Monks	Operations Management	Tata McGraw Hill.	2nd Edition, 2020
3.	B. Mahadevan	Operations Management: Theory and Practice	Pearson	3rd Edition, 2015
4.	Gregory Frazier and Norman Gaither	Operations Management: Concepts, Techniques & Applications	Cengage Learning India	9th edition, 2015

Web links and Video Lectures (e-Resources):

- NOC: Production and Operation Management, IIT Roorkee: https://nptel.ac.in/courses/110107141
- Case studies in operations management: https://www.tandfonline.com/doi/full/10.1080/09537287.2011.554736?scroll=top&needAccess=true
- OPERATIONS MANAGEMENT course by MIT Open Courseware: https://ocw.mit.edu/courses/15-760a-operations-management-spring-2002/pages/syllabus/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

Operations Management Outside of the Classroom

- Video 1. Introduction to inventory management by Professor Srikanth Jagabathula (New York University, 2014b). The video is available at: https://www.youtube.com/watch?v=kGPr9oeN0MQ
- Video 2. Problem-solution demonstration by Professor Jagabathula (New York University, 2014c). The video is available at: https://www.youtube.com/watch?v=JCt1IVSjsuM

Video 3. Introduction by Professor Jagabathula to a practice exercise for students to solve based on the video referenced in Figure 2. (New York University, 2014a). The video is available at: http://youtu.be/plOzdftXsXc

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Semester - VI

HEAT TRANSFER (IPCC)			
Course Code	21ME62	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2*:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 12 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

* ***Additional one hour may be considered for instructions if required***

Course objectives:

Student will be able to learn

- Principles of heat transfer.
- Steady and transient heat transfer, obtain the differential equation of heat conduction in various coordinate system.
- Physical mechanism of convection and visualize the development of velocity and thermal boundary layers during flow over a surface.
- Radiation heat transfer mechanism
- The mechanisms of boiling and condensation and understand performance parameters of heat exchangers.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1	**8 HOURS**
Introductory Concepts and definition: Review of basics of Modes of Heat Transfer **Conduction-Basic Equations:** General form of one-dimensional heat conduction equation. Boundary conditions of first, second and third kinds; **One dimensional Steady state conduction with and without heat generation**: Steady state conduction in slab, cylinder and sphere with engineering applications. **Steady state conduction:** Overall heat transfer coefficient for a composite medium; thermal contact resistance; critical thickness of insulation, Discussion on engineering applications.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
MODULE-2	**8 HOURS**
Extended surfaces; Steady state conduction in fins of uniform cross section long fin, fin with insulated tip and fin with convection at the tip; fin efficiency & effectiveness, Discussion on engineering applications. **One dimensional Transient conduction:** Conduction in solids with negligible internal temperature gradients (lumped system analysis) Use of transient temperature charts (Heisler's charts) for Transient conduction in slab, long cylinder and sphere; concept of semi-infinite solids, Discussion on engineering applications.	
Teaching-Learning Process	. 1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
MODULE-3	**8 HOURS**

Numerical Analysis of Heat Conduction: Introduction, one-dimensional steady conduction and one Dimensional unsteady conduction, boundary conditions, and solution methods. **Radiation Heat transfer:** (Review of basic laws of thermal radiation) Intensity of radiation and solid angle; Concept of thermal radiation resistance, Radiation network, view factor, Radiation heat exchange between two parallel infinite black surfaces, between two parallel infinite gray surfaces; Effect of radiation shield; Discussion on engineering applications.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
MODULE-4	**8 HOURS**
Concepts and Basic Relations in Boundary layers: Flow over a flat plate -Velocity boundary layer, Thermal boundary layer; Prandtl number; general expression for local heat transfer coefficient; Average heat transfer coefficient. **Forced Convection**: Physical significance of Dimensionless numbers. Use of various Correlations for hydro dynamically and thermally developed flows; Use of correlations for flow over a flat plate, cylinder, sphere and flow inside the duct. **Free or Natural Convection**: Physical significance of dimensionless numbers. Use of correlations for free convection from or to vertical, horizontal and inclined flat plates, vertical and inclined cylinder.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
MODULE 5	**8 HOURS**
Boiling and Condensation; Film, dropwise condensation theory, Pool boiling regimes, Use of correlations for film and dropwise condensation on tubes. **Heat Exchangers:** Classification of heat exchangers; Overall heat transfer coefficient, Fouling, Scaling factors; LMTD and NTU methods of analysis of heat exchangers, Compact heat exchangers.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

PRACTICAL COMPONENT OF IPCC *(May cover all / major modules)*

Modern computing tools are preferred to be used for analysis wherever possible.

Sl.NO	Experiments
1	Determination of Thermal Conductivity of a Metal Rod.
2	Determination of Overall Heat Transfer Coefficient of a Composite wall.
3	Determination of Effectiveness on a Metallic fin.
4	Determination of Heat Transfer Coefficient in free Convection
5	Determination of Heat Transfer Coefficient in a Forced Convention
6	Determination of Emissivity of a Surface and Determination of Stefan Boltzmann Constant.
7	Determination of LMDT and Effectiveness in a Parallel Flow and Counter Flow Heat Exchangers.
8	Experiments on Boiling of Liquid and Condensation of Vapour.

9	Experiment on Transient Conduction Heat Transfer.
10 11	Use of CFD for demonstrating heat transfer mechanism considering practical applications , Minimum two exercises
12	Using one dimensional transient conduction, experimentally demonstrate estimation of thermal conductivity and thermal diffusivity

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- Solve steady state heat transfer problems in conduction.
- Solve transient heat transfer problems
- solve convection heat transfer problems using correlations
- Solve radiation heat transfer problems
- Explain the mechanisms of boiling and condensation. And Determine performance parameters of heat exchangers.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks (duration 01 hour)**

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester
- Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks.**

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test **(duration 03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks.
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

- The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be reduced proportionally to 50 marks
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included. The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

1 Principals of heat transfer Frank Kreith, Raj M. Manglik, Mark S. Bohn Cengage learning Seventh Edition 2011.

2 Heat transfer, a practical approach Yunus A. Cengel Tata Mc Graw Hill Fifth edition

Reference Books

1 Heat and mass transfer Kurt C, Rolle Cengage learning second edition

2 Heat Transfer A Basic Approach M. NecatiOzisik McGraw Hill, New York 2005

3 Fundamentals of Heat and Mass Transfer Incropera, F. P. and De Witt, D. P John Wiley and Sons, New York 5th Edition 2006

4 Heat Transfer Holman, J. P. Tata McGraw Hill, New York 9th Edition 2008

Web links and Video Lectures (e-Resources):

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- **Course seminar**
- **Term project**

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Semester - VI

MACHINE DESIGN			
Course Code	21ME63	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2-2-0-0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

The student will be able:

- To explain the principles involved in design of machine elements, subjected to different kinds of forces, from the considerations of strength, rigidity.
- To understand and interpret different failure modes and application of appropriate criteria for design of machine elements.
- Develop the capability to design elements like shafts, couplings and springs, welded joints, screwed joints.
- To learn transmission elements like gears, belts, pulleys, bearings from the manufacturers' catalogue.
- To produce assembly and working drawings of various mechanical systems involving machine elements like clutches and brakes.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1	
Introduction and Review: Review of engineering materials and their properties and manufacturing processes; use of codes and standards, selection of preferred sizes. Review of axial, bending, shear and torsion loading on machine components, combined loading, two- and three dimensional stresses, principal stresses, stress tensors, Mohr's circles. **Design for static strength**: Factor of safety and service factor. Failure mode: definition and types. , Failure of brittle and ductile materials; even and uneven materials; Theories of failure: maximum normal stress theory, maximum shear stress theory, distortion energy theory, strain energy theory, Columba –Mohr theory and modified Mohr's theory. Stress concentration, stress concentration factor **Impact Strength**: Introduction, Impact stresses due to axial, bending and torsion loads. **Fatigue loading**: Introduction to fatigue failure, Mechanism of fatigue failure, types of fatigue loading, S-N Diagram, Low cycle fatigue, High cycle fatigue, Endurance limit.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Module-2	

Design of shafts: Torsion of shafts, solid and hollow shaft design with steady loading based on strength and rigidity, ASME and BIS codes for power transmission shafting, design of shafts subjected to combined bending, torsion and axial loading, Discussion on engineering applications. **Design of couplings**: Design of Flange coupling, and Bush and Pin type coupling. **Springs**: Types of springs, spring materials, stresses in helical coil springs of circular and non-circular cross sections. Tension and compression springs, concentric springs; springs under fluctuating loads. Leaf Springs: Stresses in leaf springs, equalized stresses, and nipping of leaf springs, Discussion on engineering applications.	
Teaching-Learning Process	. 1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Module-3	
Riveted joints: Types of rivets, rivet materials, Caulking and fullering, analysis of riveted joints, joint efficiency, failures of riveted joints, boiler joints, riveted brackets, Discussion on engineering applications. **Welded joints**: Types, strength of butt and fillet welds, eccentrically loaded welded joints, Discussion on engineering applications. **Threaded Fasteners**: Stresses in threaded fasteners, effect of initial tension, design of threaded fasteners under static, dynamic and impact loads, design of eccentrically loaded bolted joints, Discussion on engineering applications.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Module-4	
Spur Gears: Definitions, stresses in gear tooth: Lewis equation and form factor, design for strength, dynamic load and wear. **Helical Gears**: Definitions, transverse and normal module, formative number of teeth, design based on strength, dynamic load and wear. **Bevel Gears**: Definitions, formative number of teeth, design based on strength, dynamic load and wear. **Worm Gears**: Definitions, types of worm and worm gears, and materials for worm and worm wheel. Design based on strength, dynamic, wear loads and efficiency of worm gear drives.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Module-5	
Design of Clutches and Brakes: Design of single plate, multi-plate and cone clutches based on uniform pressure and uniform wear theories. Design of band brakes, block brakes and internal expanding brakes **Lubrication and Bearings**: Lubricants and their properties, bearing materials and properties; mechanisms of lubrication, hydrodynamic lubrication, pressure development in oil film, bearing modulus, coefficient of friction, minimum oil film thickness, heat generated, and heat dissipated. **Antifriction bearings**: Types of rolling contact bearings and their applications, static and dynamic load carrying capacities, equivalent bearing load, load life relationship, Discussion on engineering applications.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Course outcome (Course Skill Set) At the end of the course the student will be able to : • Apply codes and standards in the design of machine elements and select an element based on the Manufacturer's catalogue. • Analyse the performance and failure modes of mechanical components subjected to combined loading and fatigue loading using the concepts of theories of failure.	

- Demonstrate the application of engineering design tools to the design of machine components like shafts, springs, couplings, fasteners, welded and riveted joints, brakes and clutches
- Design different types of gears and simple gear boxes for relevant applications.
- Apply design concepts of hydrodynamic bearings for different applications and select Anti friction bearings for different applications using the manufacturers, catalogue.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour)**

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester
- Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks (duration 01 hours)**
- At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject **(duration 03 hours)**

- The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be reduced proportionally to 50 marks
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books

1 Shigley's Mechanical Engineering Design Richard G. Budynas,and J. Keith Nisbett McGraw-Hill Education 10th Edition, 2015

2 Fundamentals of Machine Component Design Juvinall R.C, and Marshek K.M John Wiley & Sons Third Edition 2007 Wiley student edition

3 Design of Machine Elements V. B. Bhandari Tata Mcgraw Hill 4th Ed 2016.

Reference Books:

1 Machine Design- an Integrated approach Robert L. Norton Pearson Education 2nd edition

2 Design and Machine Elements Spotts M.F., ShoupT.E Pearson Education 8th edition, 2006

3 Machine design Hall, Holowenko, Laughlin (Schaum's Outline Series adapted by S.K.Somani Tata McGraw Hill

Publishing Company Ltd Special Indian Edition, 2008
4 Elements of Machine Design H.G.Patil, S.C.Pilli, R.R.Malagi, M.S.Patil IK International First edition,2019
6 Hand book of Mechanical Design G. M. Maithra and L.V.Prasad Tata McGraw Hill 2nd edition, 2004

Design Data Books:

Design Data Hand Book, K.Lingaiah, McGraw Hill, 2nd edition, 2003.
Design Data Hand Book, K.Mahadevan and Balaveera Reddy, CBS publication.
Design Data Hand Book, H.G.Patil, I.K.International Publisher, 2010
PSG Design Data Hand Book, PSG College of technology, Coimbatore

Web links and Video Lectures (e-Resources):

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Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Term Projects
- Course seminar

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SUPPLY CHAIN MANAGEMENT & INTRODUCTION TO SAP			
Course Code	21ME641	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	50	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

- To acquaint with key drivers of supply chain performance and their inter-relationships with strategy.
- To impart analytical and problem-solving skills necessary to develop solutions for a variety of supply chain management & design problems.
- To study the complexity of inter-firm and intra-firm coordination in implementing programs such as e-collaboration, quick response, jointly managed inventories and strategic alliances.
- To understand the usage of SAP material management system

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

1. Adopt different type of teaching methods to develop the outcomes through Power-Point Presentation and Video demonstration or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Discuss the case studies and how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
4. Adopt collaborative (Group Learning) Learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information.

Module-1

Introduction: Supply Chain – Fundamentals –Evolution- Role in Economy - Importance - Decision Phases – Supplier Manufacturer-Customer chain. - Enablers/ Drivers of Supply Chain Performance. Supply chain strategy - Supply Chain Performance Measures.

Strategic Sourcing Outsourcing – Make Vs buy - Identifying core processes - Market Vs Hierarchy - Make Vs buy continuum -Sourcing strategy - Supplier Selection and Contract Negotiation. Creating a world class supply base-Supplier Development - World Wide Sourcing.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk Method

Module-2

Warehouse Management Stores management-stores systems and procedures-incoming materials control stores accounting and stock verification Obsolete, surplus and scrap-value analysis-material handling transportation and traffic management -operational efficiency-productivity-cost effectiveness-performance measurement.

Supply Chain Network Distribution Network Design – Role - Factors Influencing Options, Value Addition – Distribution Strategies - Models for Facility Location and Capacity allocation. Distribution Center Location Models.

Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk Method

Module-3

Supply Chain Network optimization models. Impact of uncertainty on Network Design - Network Design, decisions using Decision trees. Planning Demand, -multiple item -multiple location inventory management. Pricing and Revenue Management.

Teaching-Learning	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk Method

Process	
Module-4	
Current Trends: Supply Chain Integration - Building partnership and trust in Supply chain Value of Information: Bullwhip Effect - Effective forecasting - Coordinating the supply chain. Supply Chain restructuring, Supply Chain Mapping - Supply Chain process restructuring, Postpone the point of differentiation – IT in Supply Chain - Agile Supply Chains -Reverse Supply chain. Future of IT in supply chain- EBusiness in supply chain.	
Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk Method
Module-5	
Introduction to SAP, SAP Material Management, Procurement process, Organization structure, Enterprise structure, Master data management, purchase Info record, source list, procurement cycle, purchase requisition, request for quotation, purchase order, inventory management, invoice verification, service management, transaction code	
Teaching-Learning Process	Power-point Presentation, Video demonstration or Simulations, Chalk and Talk Method
Course outcome (Course Skill Set) At the end of the course the student will be able to : • Understand the framework and scope of supply chain management. • Build and manage a competitive supply chain using strategies, models, techniques and information technology. • Plan the demand, inventory and supply and optimize supply chain network. • Understand the emerging trends and impact of IT on Supply chain. • Understand the basics of SAP material management system	

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour)**

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester
- Two assignments each of **10 Marks**
- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester
- Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks (duration 01 hours)**
- At the end of the 13th week of the semester
- The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

- The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be reduced proportionally to 50 marks
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Janat Shah, Supply Chain Management– Text and Cases, Pearson Education, 2nd edition
2. Sunil Chopra and Peter Meindl, Supply Chain Management-Strategy Planning and Operation, PHI Learning / Pearson Education, 6th edition.
3. David Simchi-Levi, Philip Kaminsky, Edith Simchi-Levi, Designing and Managing the Supply Chain: Concepts, Strategies, and Cases, Tata McGraw-Hill.
4. Ballou Ronald H, Business Logistics and Supply Chain Management, Pearson Education
5. Ashfaque Ahmed, The SAP Materials Management Handbook, CRC Press Publication. 2014 edition.
6. Martin Murray & Jawad Akhtar, Materials Management with SAP ERP: Functionality and Technical Configuration, SAP Press; Fourth edition.
7. P. Gopalakrishanan, M. Sundaresan, Materials Management: An Integrated Approach, Prentice Hall India

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc21_mg45/preview
- https://nptel.ac.in/courses/110106045
- https://www.udemy.com/course/sap-mm-training/
- https://www.udemy.com/course/sap-s4hana-mm-sourcing-and-procurement/
- https://nptel.ac.in/courses/110105095

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Case study of companies example Amazon, Flipkart, Parle, DMart, Reliance etc can be discussed

VI SEMESTER

MECHATRONICS SYSTEM DESIGN			
Course Code	21ME642	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

1. Gain knowledge of basics of Mechatronics system design and sensors.
2. Understanding various techniques of Mechatronics system design for solving engineering problems.
3. Understanding Dynamic responses of systems and Fault detection techniques
4. Determination of optimization solutions, effective decision making, Convert the data in real time interfacing.
5. Understand real time mechatronic system design through case study

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Arrange visits to show the live working models other than laboratory topics.
4. Adopt collaborative (Group Learning) Learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1 **8 HOURS**

Introduction to mechatronics System Design: Mechatronics Definition, integrated design issues in Mechatronics, the Mechatronics design process, the key elements, Application of Mechatronics.

Sensors in Mechatronics: sensors for motion and position measurement. Force and pressure sensors. Sensors for temperature measurements.

Teaching-Learning Process	1. PowerPoint Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving (In-general).

Module-2 **8 HOURS**

Modeling and Simulation of Physical Elements: Operator notation and transfer functions, Block diagrams, manipulations and simulation, block diagram modeling- Direct method and analogy approach, Electrical systems, Mechanical systems **(Rotational and Translational),** electrical Mechanical Coupling, Fluid systems

Teaching-Learning Process	1. . PowerPoint Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving (In-general).

Module-3 **8 HOURS**

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Dynamic responses of systems and Fault Finding. Modelling of dynamic systems, Terminology, first order systems and second order systems. Fault detection techniques, Parity and error coding checks, Common hardware faults. Microprocessor systems. Emulation and simulation.	
Teaching-Learning Process	1. PowerPoint Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving (In-general).
Module-4	**8 HOURS**
Signal Conditioning and Real time Interfacing: Introduction, elements of Data Acquisition and Control System, Transducers and Signal Conditioning, Devices for data conversion, Data conversion process, Application software.	
Teaching-Learning Process	1. PowerPoint Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving (In-general).
Module-5	**8 HOURS**
Case Studies: Comprehensive and Data acquisition case studies, data acquisition and control case studies.	
Teaching-Learning Process	1. PowerPoint Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving (In-general).
Course outcome (Course Skill Set) At the end of the course the student will be able to: **CO1.** Discuss about Mechatronics design process and select the sensor and Actuator for a Mechatronics application **CO2.** Explain Modeling and Simulation of mechanical Elements, electrical Elements and fluid system the sensors in mechatronics systems and Fault detection techniques in Mechatronics. **CO3.** Understand the elements of Data Acquisition and Control System, Convert the data in real time interfacing **CO4.** Model the dynamic response of first order and second order systems.	

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous internal Examination (CIE)

Three Tests (preferably in MCQ pattern with 20 questions) each of **20 Marks (duration 01 hour)**

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Quiz/Group discussion/Seminar, any two of three suitably planned to attain the COs and POs for **20 Marks (duration 01 hours)**

The sum of total marks of three tests, two assignments, and quiz /seminar/ group discussion will be out of 100 marks and shall be **scaled down to 50 marks**

Semester End Examinations (SEE)

SEE paper shall be set for 50 questions, each of 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour.** The student has to secure minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Books

1. Mechatronics System Design by Devdas Shetty and Richard A Kolk, Second edition, Thomson Learning Publishing Company, Vikas publishing house, 2001.
2. W. Bolton, "Mechatronics" - Addison Wesley Longman Publication, 1999.
3. Shetty and Kolk "Mechatronics System Design"- Cengage Learning, 2010

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Quiz
- Presentations
- Group Activity

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VI Semester

AUTONOMOUS VEHICLES			
Course Code	21ME643	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3-0-0-0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

1. Introduce the fundamental aspects of Autonomous Vehicles.
2. Gain Knowledge about the Sensing Technology and Algorithms applied in Autonomous vehicles.
3. Understand the Connectivity Aspects and the issues involved in driverless cars.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Adopt flipped classroom teaching method.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information..

Module-1	
Introduction : Evolution of Automotive Electronics -Basic Control System Theory applied to Automobiles -Overview of the Operation of ECUs -Infotainment, Body, Chassis, and Powertrain Electronics-Advanced Driver Assistance Systems-Autonomous Vehicles	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-2	
Sensor Technology for Autonomous Vehicles: Basics of Radar Technology and Systems -Ultrasonic Sonar Systems -LIDAR Sensor Technology and Systems -Camera Technology -Night Vision Technology -Use of Sensor Data Fusion -Kalman Filters	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-3	
Computer Vision and Deep Learning for Autonomous Vehicles: Computer Vision Fundamentals -Advanced Computer Vision -Neural Networks for Image Processing –Tensor Flow - Overview of Deep Neural Networks -Convolutional Neural Networks	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

Module-4

Connected Car Technology: Connectivity Fundamentals - DSRC (Direct Short Range Communication) - Vehicle-to-Vehicle Technology and Applications -Vehicle-to-Roadside and Vehicle-to-Infrastructure Applications -Security Issues.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Module-5	
Autonomous Vehicle Technology: Driverless Car Technology-Different Levels of Automation -Localization - Path Planning. Controllers to Actuate a Vehicle - PID Controllers -Model Predictive Controllers, ROS Framework	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Course outcome (Course Skill Set) At the end of the course the student will be able to : 1. Describe the evolution of Automotive Electronics and the operation of ECUs. 2. Compare the different type of sensing mechanisms involved in Autonomous Vehicles. 3. Discuss about the use of computer vision and learning algorithms in vehicles. 4. Summarize the aspects of connectivity fundamentals existing in a driverless car. 5. Identify the different levels of automation involved in an Autonomous Vehicle. 6. Outline the various controllers employed in vehicle actuation	

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour)**

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks (duration 01 hours)**

- At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

- The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be reduced proportionally to 50 marks
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Shaoshan Liu, Liyun Li, "Creating Autonomous Vehicle Systems", Morgan and Claypool Publishers, 2017.

2. Marcus Maurer, J.ChristianGerdes, "Autonomous Driving: Technical, Legal and Social Aspects" Springer, 2016.

3. Ronald.K.Jurgen, "Autonomous Vehicles for Safer Driving", SAE International, 2013.

4. James Anderson, KalraNidhi, Karlyn Stanly, "Autonomous Vehicle Technology: A Guide for Policymakers", Rand Co, 2014.

5. Lawrence. D. Burns, ChrostopherShulgan, "Autonomy – The quest to build the driverless car and how it will reshape our world", Harper Collins Publishers, 2018

Web links and Video Lectures (e-Resources):

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning
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Semester - 06

INTERNET OF THINGS (IOT)			
Course Code	21ME644	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:0:2:0	SEE Marks	50
Total Hours of Pedagogy	30 hours Theory + 12 Lab slots	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

- To introduce the fundamental concepts of IoT and physical computing
- To expose the student to a variety of embedded boards and IoT Platforms
- To create a basic understanding of the communication protocols in IoT communications.
- To familiarize the student with application program interfaces for IoT.
- To enable students to create simple IoT applications.

Teaching-Learning Process (General Instructions)

These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.

25. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
26. Chalk and Talk method for Problem Solving.
27. Adopt flipped classroom teaching method.
28. Adopt collaborative (Group Learning) learning in the class.
29. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

MODULE-1	**8 HOURS**
Overview of IoT:The Internet of Things: An Overview, The Flavor of the Internet of Things, The "Internet" of "Things", The Technology of the Internet of Things, Enchanted Objects, Who is Making the Internet of Things?, Design Principles for Connected Devices, Calm and Ambient Technology, Privacy, Keeping Secrets, Whose Data Is It Anyway?, Web Thinking for Connected Devices, Small Pieces, Loosely Joined, First-Class Citizens On The Internet, Graceful Degradation, Affordances.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-2	**8 HOURS**
Embedded Devices - I: Embedded Computing Basics, Microcontrollers, System-on-Chips, Choosing Your Platform, Arduino, Developing on the Arduino, Some Notes on the Hardware, Openness.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-3	**8 HOURS**
Embedded Devices - II: Raspberry Pi , Cases and Extension Boards, Developing on the Raspberry Pi, Some Notes on the Hardware, Openness, Other notable platforms, Mobile phones and tablets, Plug Computing: Always-on Internet of Things.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

MODULE-4	8 HOURS
Communication in the IoT:Internet Principles, Internet Communications: An Overview, IP, TCP, The IP Protocol Suite (TCP/IP), UDP, IP Addresses, DNS, Static IP Address Assignment, Dynamic IP Address Assignment, IPv6, MAC Addresses, TCP and UDP Ports, An Example: HTTP Ports, Other Common Ports, Application Layer Protocols- HTTP, HTTPS: Encrypted HTTP, Other Application Layer Protocols.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
MODULE 5	**8 HOURS**
Prototyping Online Components: Getting Started with an API, Mashing Up APIs, Scraping, Legalities, Writing a New API, Clockodillo, Security, Implementing the API, Using Curl to Test, Going Further, Real-Time Reactions, Polling, Comet, Other Protocols, MQ Telemetry Transport, Extensible Messaging and Presence Protocol, Constrained Application Protocol.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board

PRACTICAL COMPONENT OF IPCC *(May cover all / major modules)*

Sl.NO	Experiments
1	Select any one development board (Eg., Arduino or Raspberry Pi) and control LED using the board.
2	Using the same board as in (1), read data from a sensor. Experiment with both analog and digital sensors.
3	Control any two actuators connected to the development board using Bluetooth.
4	Read data from sensor and send it to a requesting client. (using socket communication) Note: The client and server should be connected to same local area network.
5	Create any cloud platform account, explore IoT services and register a thing on the platform.
6	Push sensor data to cloud.
7	Control an actuator through cloud.
8	Access the data pushed from sensor to cloud and apply any data analytics or visualization services.
9	Create a mobile app to control an actuator.
10	Identify a problem in your local area or college which can be solved by integrating the things you learned so far and create a prototype to solve it
11	
12	

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- explain IoT architecture, interpret the design principles that govern connected devices, summarize the roles of various organizations for IoT
- explain the basics of microcontrollers, outline the architecture of Arduino, develop simple applications using Arduino
- outline the architecture of Raspberry Pi, develop simple applications using Raspberry Pi, select a platform for a particular embedded computing application
- interpret different protocols and compare them, select which protocol can be used for a specific application,Utilize the Internet communication protocols for IoT applications
- select IoT APIs for an application, design and develop a solution for a given application using APIs, test for errors in the application

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

CIE for the theory component of IPCC

Two Tests each of **20 Marks (duration 01 hour)**

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Scaled-down marks of two tests and two assignments added will be CIE marks for the theory component of IPCC for **30 marks**.

CIE for the practical component of IPCC

- On completion of every experiment/program in the laboratory, the students shall be evaluated and marks shall be awarded on the same day. The**15 marks** are for conducting the experiment and preparation of the laboratory record, the other **05 marks shall be for the test** conducted at the end of the semester.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to 15 marks.
- The laboratory test **(duration 03 hours)** at the end of the 15th week of the semester /after completion of all the experiments (whichever is early) shall be conducted for 50 marks and scaled down to 05 marks.

Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **20 marks**.

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SEE for IPCC

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours)

11. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be reduced proportionally to 50 marks
12. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

13. The students have to answer 5 full questions, selecting one full question from each module.

The theory portion of the IPCC shall be for both CIE and SEE, whereas the practical portion will have a CIE component only. Questions mentioned in the SEE paper shall include questions from the practical component).

- The minimum marks to be secured in CIE to appear for SEE shall be the 12 (40% of maximum marks-30) in the theory component and 08 (40% of maximum marks -20) in the practical component. The laboratory component of the IPCC shall be for CIE only. However, in SEE, the questions from the laboratory component shall be included. The maximum of 04/05 questions to be set from the practical component of IPCC, the total marks of all questions should not be more than the 20 marks.
- SEE will be conducted for 100 marks and students shall secure 35% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50.

Suggested Learning Resources:

Books

- Adrian McEwen, Hakim Cassimally - Designing the Internet of Thing Wiley Publications, 2012.
- ArshdeepBahga, Vijay Madisetti - Internet of Things: A Hands-On Approach,Universities Press, 2014.
- Pethuru Raj, Anupama C. Raman, The Internet of Things, Enabling technologies and usecases –CRC Press 2017.

Web links and Video Lectures (e-Resources):

https://www.arduino.cc/

https://www.raspberrypi.org/

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

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VI Semester

PROJECT MANAGEMENT			
Course Code	21ME651	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3-0-0-0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

- To understand how to break down a complex project into manageable segments and use of effective project management tools and techniques to arrive at solution and ensure that the project meets its deliverables and is completed within budget and on schedule.
- To impart knowledge on various components, phases, and attributes of a project.
- To prepare students to plan, develop, lead, manage, and successfully implement and deliver projects within their chosen practice area.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Arrange visits to show the live working models other than laboratory topics.
- Adopt collaborative (Group Learning) Learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' Analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1

Introduction: Definition of project, characteristics of projects, understand projects, types of projects, scalability of project tools, project roles Project Selection and Prioritization – Strategic planning process, Strategic analysis, strategic objectives, portfolio alignment – identifying potential projects, methods of selecting projects, financial mode / scoring models to select projects, prioritizing projects, securing and negotiating projects.

Teaching-Learning Process	• PowerPoint Presentation, • Video demonstration or Simulations, • Chalk and Talk are used for Problem Solving (In-general).

Module-2

Planning Projects: Defining the project scope, Project scope checklist, Project priorities, Work Breakdown Structure (WBS), Integrating WBS with organisation, coding the WBS for the information system.

Scheduling Projects: Purpose of a project schedule, historical development, how project schedules are limited and created, develop project schedules, uncertainty in project schedules, Gantt chart.

Teaching-Learning Process	• . PowerPoint Presentation, • Video demonstration or Simulations, • Chalk and Talk are used for Problem Solving (In-general).

Module-3

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Resourcing Projects: Abilities needed when resourcing projects, estimate resource needs, creating staffing management plant, project team composition issues, Budgeting Projects: Cost planning, cost estimating, cost budgeting, establishing cost control. Project Risk Planning: Risk Management Planning, risk identification, risk analysis, risk response planning, Project Quality Planning and Project Kick off: Development of quality concepts, project quality management plan, project quality tools, kick off project, baseline and communicate project management plan, using Microsoft Project for project baselines.	
Teaching-Learning Process	• PowerPoint Presentation, • Video demonstration or Simulations, • Chalk and Talk are used for Problem Solving (In-general).
Module-4	
Performing Projects: Project supply chain management: - Plan purchasing and acquisitions, plan contracting, contact types, project partnering and collaborations, project supply chain management. Project Progress and Results: Project Balanced Scorecard Approach, Internal project, customer, financial issues, Finishing the project: Terminate project early, finish projects on time, secure customer feedback and approval, knowledge management, perform administrative and contract closure.	
Teaching-Learning Process	• PowerPoint Presentation, • Video demonstration or Simulations, • Chalk and Talk are used for Problem Solving (In-general).
Module-5	
Network Analysis: Introduction, network construction - rules, Fulkerson's rule for numbering the events, AON and AOA diagrams; Critical path method (CPM) to find the expected completion time of a project, floats; PERT for finding expected duration of an activity and project, determining the probability of completing a project, predicting the completion time of project; crashing of simple projects.	
Teaching-Learning Process	• PowerPoint Presentation, • Video demonstration or Simulations, • Chalk and Talk are used for Problem Solving (In-general).

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

- Understand the selection, prioritization and initiation of individual projects and strategic role of project management.
- Understand the work breakdown structure by integrating it with organization.
- Understand the scheduling and uncertainty in projects.
- Understand risk management planning using project quality tools.
- Understand the activities like purchasing, acquisitions, contracting, partnering and collaborations related to performing projects.
- Determine project progress and results through balanced scorecard approach
- Draw the network diagram to calculate the duration of the project and reduce it using crashing.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour)**

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks (duration 01 hours)**

- At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject **(duration 03 hours)**

- The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be reduced proportionally to 50 marks
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1 Project Management Timothy J Kloppenborg Cengage Learning Edition 2009

2 Project Management -A systems approach to planning scheduling and controlling Harold kerzner CBS publication

3 Project Management S Choudhury McGraw Hill Education (India) Pvt. Ltd. New Delhi 2016

Reference Books

1 Project Management Pennington Lawrence Mc Graw Hill

2 Project Management A Moder Joseph and Phillips New Yark Van Nostrand Reinhold

3 Project Management, Bhavesh M. Patel Vikas publishing House

Web links and Video Lectures (e-Resources):

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Activity Based Learning (Suggested Activities in Class)/ Practical Based learning
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Semester VI

RENEWABLE ENERGY POWER PLANTS (OPEN ELECTIVE)			
Course Code	21ME652	**CIE Marks**	50
Teaching Hours/Week (L:T:P: S)	3-0-0-0	**SEE Marks**	50
Total Hours of Pedagogy	40	**Total Marks**	100
Credits	03	**Exam Hours**	03

Course objectives:

- To introduce the concepts and principles of solar energy, its radiation, collection, storage and application.
- To understand application aspects of Wind, Biomass, Geothermal, hydroelectric and Ocean energy.
- To examine energy sources and systems, including fossil fuels and nuclear energy, and then focus on other forms of alternate energy sources.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Adopt flipped classroom teaching method.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analyzing information.

Module-1

Introduction: Energy sources (including fossil fuels and nuclear energy), India's production and reserves of commercial energy sources, need for nonconventional energy sources, energy alternatives, Indian and global energy scenario.

Solar Radiation & Measurement: Extra-Terrestrial radiation, spectral distribution of extra-terrestrial radiation, solar constant, solar radiation at the earth's surface, beam, diffuse and global radiation, solar radiation data. Pyrometer, shading ring Pyrheliometer, sunshine recorder, schematic diagrams, and principle of working, actinometer and bolometer.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving. /White board

Module-2

Solar Radiation Geometry: Flux on a plane surface, latitude, declination angle, surface azimuth angle, hour angle, zenith angle, solar altitude angle, expressions for the angle between the incident beam and the normal to a plane surface (No derivation) local apparent time, apparent motion of sun, day length, numerical problems.

Solar Thermal Systems: Flat plate collector, Evacuated Tubular Collector, Solar air collector, Solar concentrator, Solar distillation, Solar cooker, Thermal energy storage systems, Solar Pond, Solar Chimney (Tower).

Solar Photovoltaic Systems: Introduction, Solar cell Fundamentals, Characteristics and classification, Solar cell: Module, panel and array construction.

Teaching-Learning	1. Power-point Presentation, 2. Video demonstration or Simulations,

Process	3. Chalk and Talk are used for Problem Solving. /White board
Module-3	
Wind Energy: Properties of wind, availability of wind energy in India, wind velocity and power from wind; major problems associated with wind power, wind machines; Types of wind machines and their characteristics, horizontal and vertical axis windmills, elementary design principles; coefficient of performance of a windmill rotor, design aspects, numerical examples. **Energy from Biomass**: Energy plantation, biogas production from organic wastes by anaerobic fermentation, description of bio-gas plants, transportation of biogas, problems associated with bio-gas production, application of biogas, application of biogas in engines, cogeneration plant, advantages & disadvantages.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving. /White board
Module-4	
Hydroelectric plants: Advantages & disadvantages of waterpower, Hydrographs and flow duration curves-numericals, Storage and pondage, General layout of hydel power plants- components such as Penstock, surge tanks, spill way and draft tube and their applications, pumped storage plants, Detailed classification of hydroelectric plants. **Tidal Power:** Tides and waves as energy suppliers and their mechanics, fundamental characteristics of tidal power, harnessing tidal energy, limitations of tidal energy. **Energy from ocean waves:** Wave energy conversion, Wave energy technologies, advantages, and disadvantages.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving. /White board
Module-5	
Ocean Thermal Energy Conversion: Principle of working, Rankine cycle, OTEC power stations in the world, problems associated with OTEC, case studies. **Geothermal energy:** Introduction, Principle of working, types of geothermal stations with schematic diagram Estimates of Geothermal Power, Nature of geothermal fields, Geothermal resources, Hydrothermal, Resources Geo pressured resources, Hot dry rock resources of petro-thermal systems, Magma Resources-Interconnection of geothermal fossil systems, Advantages, and disadvantages of geothermal energy over other energy forms, Geothermal stations in the world	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving. /White board
Course outcome (Course Skill Set) At the end of the course the student will be able to : • Describe the various forms of non-conventional energy resources. • Apply the fundamental knowledge of mechanical engineering to design various renewable energy systems • Analyze the implications of renewable energy forms for selecting an appropriate system for a specific application • Discuss on the environmental aspects and impact of non-conventional energy resources, in comparison with various conventional energy systems, their prospects and limitations.	

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation (CIE):

At the beginning of the semester, the instructor/faculty teaching the course must announce the methods of CIE for the course.

Three Unit Tests each of **20 Marks (duration 01 hour)**

1. First test at the end of 5th week of the semester
2. Second test at the end of the 10th week of the semester
3. Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

4. First assignment at the end of 4th week of the semester
5. Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks (duration 01 hours)**

6. At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject **(duration 03 hours)**

1. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be reduced proportionally to 50 marks
2. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
3. The students must answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Books

1. Solar Energy Principles, Thermal Collection &Storage, S.P.Sukhatme: Tata McGraw Hill Pub., NewDelhi.
2. Non-Conventional Energy Sources, G.D.Rai, NewDelhi.
3. Renewable Energy, power for a sustainable future, Godfrey Boyle,2004,
4. The Generation of electricity by wind, E.W.Golding.
5. Non-Conventional Energy Resources by B.H. Khan, Tata McGraw Hill Pub.,2009.

Reference Books

1. Fundamentals of Renewable Energy Resources by G.N.Tiwari, M.K.Ghosal, Narosa Pub., 2007.
2.Non-Conventional Energy Resources by B.H. Khan, Tata McGraw Hill Pub., 2009.
3. Non-Conventional Energy Resources by Shobh Nath Singh, Pearson India., 2016
4. Environmental Justice in India: The National Green Tribunal, By Gitanjali Nain Gill, Routledge (2016).
5. Ref: The Oxford Handbook of Comparative Environmental Law, edited by Emma Lees, Jorge E. ViÒuales, Oxford University Press (2019).

Web links and Video Lectures (e-Resources):

• https://www.youtube.com/watch?v=iZyzvDj6Y3c&list=PLwdnzlV3ogoXUifhvYB65lLJCZ74o_fAk&index=2 • https://www.youtube.com/watch?v=Og4LEc7SpdQ&list=PLwdnzlV3ogoXUifhvYB65lLJCZ74o_fAk&index=3 • https://www.youtube.com/watch?v=L3AEXdvtIkk&list=PLwdnzlV3ogoXUifhvYB65lLJCZ74o_fAk&index=19 • https://www.youtube.com/watch?v=TUu40kDqcEc&list=PLwdnzlV3ogoXUifhvYB65lLJCZ74o_fAk&index=24 • https://www.youtube.com/watch?v=k7LX0a67V8A&list=PLwdnzlV3ogoXUifhvYB65lLJCZ74o_fAk&index=37
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning • Case studies • Quiz • Topic Seminar presentation • Assignments

VI Semester

MECHATRONICS			
Course Code	21ME653	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3-0-0-0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course objectives:

- To acquire a strong foundation in science and focus in mechanical, electronics, control, software, and computer engineering, and a solid command of the newest technologies.
- To understand the evolution and development of Mechatronics as a discipline.
- To substantiate the need for interdisciplinary study in technology education
- To understand the applications of microprocessors in various systems and to know the functions of each element.
- To demonstrate the integration philosophy in view of Mechatronics technology
- To be able to work efficiently in multidisciplinary teams.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

- Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
- Chalk and Talk method for Problem Solving.
- Adopt flipped classroom teaching method.
- Adopt collaborative (Group Learning) learning in the class.
- Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analyzing information.

Module-1

Introduction: Scope and elements of mechatronics, mechatronics design process, measurement system, requirements and types of control systems, feedback principle, Basic elements of feedback control systems, Classification of control system. Examples of Mechatronics Systems such as Automatic Car Park system, Engine management system, Antilock braking system (ABS) control, Automatic washing machine.

Transducers and sensors: Definition and classification of transducers, Difference between transducer and sensor, Definition and classification of sensors, Principle of working and applications of light sensors,Potentiometers, LVDT, Capacitance sensors, force and pressure sensors, Strain gauges, temperature sensors, proximity switches and Hall Effect sensors.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving. /White board
Module-2	
Signal Conditioning: Introduction – Hardware – Digital I/O, Analog to digital conversions, resolution, Filtering Noise using passive components – Registers, capacitors, amplifying signals using OP amps. Digital Signal Processing – Digital to Analog conversion, Low pass, high pass, notch filtering. Data acquisition systems (DAQS), data loggers, Supervisory control and data acquisition (SCADA), Communication methods. Electro Mechanical Drives: Relays and Solenoids – Stepper Motors – DC brushed motors – DC brushless motors – DC servo motors – 4-quadrant servo drives, PWM's – Pulse Width Modulation.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving. /White board
Module-3	
Microprocessor & Microcontrollers: Introduction, Microprocessor systems, Basic elements of control systems, Microcontrollers, Difference between Microprocessor and Microcontrollers. Microprocessor Architecture: Microprocessor architecture and terminology-CPU, memory and address, I/O and Peripheral devices, ALU, Instruction and Program, Assembler, Data Registers, Program Counter, Flags, Fetch cycle, write cycle, state, bus interrupts. Intel 's 8085A Microprocessor.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving. /White board
Module-4	
Programmable Logic Controller: Introduction to PLCs, Basic structure of PLC, Principle of operation, input and output processing, PLC programming language, ladder diagram, ladder diagrams circuits, timer counters, internal relays, master control, jump control, shift registers, data handling, and manipulations, analogue input and output, selection of PLC for application. Application of PLC control: Extending and retracting a pneumatic piston using latches, control of two pneumatic pistons, control of process motor, control of vibrating machine, control of process tank, control of conveyer motor etc.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving. /White board
Module-5	
Mechatronics in Computer Numerical Control (CNC) machines: Design of modern CNC machines – Machine Elements: Different types of guide ways, Linear Motion guideways. Bearings: anti-friction bearings, hydrostatic bearing and hydrodynamic bearing. Re-circulating ball screws. Typical elements of open and closed loop control systems. Adaptive controllers for machine tools. Mechatronics Design process: Stages of design process – Traditional and Mechatronics design concepts – Case studies of Mechatronics systems – Pick and place Robot – Automatic car park barrier.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving. /White board

Course outcome (Course Skill Set)

At the end of the course the student will be able to :

- Illustrate various components of Mechatronics systems.
- Assess various control systems used in automation.
- Design and conduct experiments to evaluate the performance of a mechatronics system or component with respect to specifications, as well as to analyse and interpret data.
- Apply the principles of Mechatronics design to product design.
- Function effectively as members of multidisciplinary teams.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour)**

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks (duration 01 hours)**

- At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours**)

14. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be reduced proportionally to 50 marks
15. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1 Mechatronics-Principles Concepts and Applications Nitaigour Premchand Mahalik Tata McGraw Hill 1stEdition, 2003

2 Mechatronics–Electronic Control Systems in Mechanical and Electrical Engineering, W.Bolton Pearson Education 1stEdition, 2005

Reference Books

1 Mechatronics HMT Ltd Tata Mc Graw Hill 1st Edition, 2000 ISBN:978007 4636435

2 Mechatronics: Integrated Mechanical Electronic Systems K.P. Ramachandran, G.K. Vijayaraghavan, M.S. Balasundaram. Wiley India Pvt. Ltd. New Delhi 2008

3 Introduction to Mechatronics and Measurement Systems David G. Aldatore, Michael B. Histand McGraw-Hill Inc USA

2003 4 Introduction to Robotics: Analysis, Systems, Applications. Saeed B. Niku, Person Education 2006 5 Mechatronics System Design Devdas Shetty, Richard A. kolk Cengage publishers. Second edition
Web links and Video Lectures (e-Resources):
• .
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning • Case studies • Quiz • Topic Seminar presentation • Assignments

H. O. D.
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VI Semester

MODERN MOBILITY			
Course Code	21ME654	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To understand the different chassis design & main components of automobile
- To understand the working of transmission and control system employed in automobiles
- To understand the automotive pollution and alternative automotive technologies under trail
- To understand the upcoming electric vehicle technology

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

6. Explain clearly through Power Point presentations
7. showing live Videos for working of components
8. Demonstration of live working of components through cut section models
9. Inspecting live vehicles
10. Visiting nearby service centres
11. Expert Talks

Module-1	**Mobility Systems**
History of Automobile, Classification of Automobile w.r.t Usage, Chassis, Body, Power Sources, capacity, main components of Internal Combustion Engines and their Functions, Modern Fuel supply system, Cooling System, Lubrication System & Ignition System, Engine Management System	
Teaching-Learning Process	Power Point presentations Live Videos for working of components Explaining through live components in class room
Module-2	**Power Transmission**
Clutches; Plate Clutches, Cone Clutch, Centrifugal Clutch, Fluid Flywheel **Gear Box;** Gear Shifting mechanism, synchromesh Gear box, Torque converter, Automatic Manual Transmission (AMT), Automatic Transmission (AT), Continuously Variable Transmission (CVT), Infinitely Variable Transmission (IVT)& IMT, Working of Differential.. **Types Of Tyres-** Radial & Conventional, Tubeless Tyres, Tubed Tyres- Puncture patching	
Teaching-Learning Process	Power Point presentations Live Videos for working of components Explaining through live components in class room
Module-3	**Direction Control & Braking**
Steering system- mechanisms & Linkages, Steering gear boxes- Rack & pinion, worm & wheel construction & working,, power Steering construction & working, steering geometry, Wheel balancing **Braking System-** Mechanism and Linkages; Mechanical Brakes, Hydraulic Brakes, Power Brakes, Parking brakes, ABS, **Suspension** – layout & working of Hydraulic& Air suspension, Independent suspension,	
Teaching-Learning Process	Power Point presentations Live Videos for working of components Explaining through live components in class room
Module-4	**Exhaust Emission & Alternate Sources**

Exhaust gas pollutants and their effects on environment, Emission norms, IC engine fuels types, extraction& availability, BIO Fuels – Production and impact. Ethanol engines, CNG vehicles- operation, advantages& disadvantages, over view of Hydrogen - fuel cell vehicles, advantages & disadvantages, IC engine/ electric hybrid vehicles over view, layout, transmission & control system, solar powered vehicles- wind powered vehicles, super capacitors, supply rails	
Teaching-Learning Process	Power Point presentations Live Videos for working of components
Module-5	**Electrical Vehicles**
Electric vehicles principle and components- layout of two & 4 wheeler, Motors used in Electric vehicles –types- over view of construction and working, power transmission & control system system in Electric vehicles. Batteries – construction & working principle of Lead acid, nickel based, sodium based, Lithium & Metal Air batteries. Battery charging types and requirements	
Teaching-Learning Process	Power Point presentations Live Videos for working of components
Course outcome (Course Skill Set) At the end of the course the student will be able to : 9. Understand the working of different systems employed in automobile 10. Analyse the limitation of present day automobiles 11. Evaluate the energy sources suitability 12. Apply the knowledge for selection of automobiles based on their suitability	

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour)**

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks (duration 01 hours)**

- At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject **(duration 03 hours)**

16. The question paper will have ten questions. Each question is set for 20 marks. Marks scored shall be reduced proportionally to 50 marks
17. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Books

9. Electric Vehicle Technology Explained James Larminie Oxford Brookes University, Oxford, UK John Lowry Acenti Designs Ltd., UK
10. 1. Automobile engineering, Kirpal Singh, Vol I and II (12th Edition) Standard Publishers 2011 2
11. Automotive Mechanics, S. Srinivasan, (2nd Edition) Tata McGraw Hill 2003.
12. Automotive mechanics, William H Crouse & Donald L Anglin (10th Edition) Tata McGraw Hill Publishing Company Ltd., 2007.
13. Modren Electric, Hybrid Electric, and Fuel Cell Vehicles,MehrdadEhsani, YiminGao, CRC Press, Taylor & Francis Group
14. Automotive mechanics: Principles and Practices, Joseph Heitner, D Van Nostrand Company, Inc
15. . Fundamentals of Automobile Engineering, K.K.Ramalingam, Scitech Publications (India) Pvt. Ltd. 4.
16. Automobile Engineering, R. B. Gupta, SatyaPrakashan,(4th Edition) 1984.

Web links and Video Lectures (e-Resources):

https://archive.nptel.ac.in/courses/107/106/107106088/ https://onlinecourses.nptel.ac.in/noc20_de06/preview https://www.digimat.in/nptel/courses/video/107106088/L01.html https://nptel.ac.in/courses/107106088 https://www.youtube.com/watch?v=LZ82iANWBL0&list=PLbMVogVj5nJTW50jj9_gvJmdwFWHaqR5J
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning • Operate the cut section models of complete vehicle chassis and observe the working of all components • Dismantle & Assemble the Automotive Engine, Gear Box, Clutch, brakes • Prepare the posters of automobile chassis & display • Visit nearby automobile showrooms/ service station • Prepare a comparison statement of different automobiles using specification provided by respective manufacturers • Visit auto expo

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Semester -VI

CNC PROGRAMMING AND 3-D PRINTING LAB			
Course Code	21MEL66	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2*:0	SEE Marks	50
Credits	01	Exam Hours	03

Additional one hour may be considered for Instructions if required

Course objectives:

- To expose the students to the techniques of CNC programming and cutting tool path generation through CNC simulation software by using G-Codes and M-codes.
- To educate the students on the usage of CAM packages.
- To expose the students on the usage of 3D Printing Technology
- To make the students understand the importance of automation in industries through exposure to FMS, Robotics, and Hydraulics and Pneumatics.

Sl.NO	Experiments
1	Manual CNC part programming using ISO Format G/M codes for 2 turning and 2 milling parts. Selection and assignment of tools, correction of syntax and logical errors, and verification of tool path using CNC program verification software.
2	CNC part programming using CAM packages : Simulation of Turning simulations to be carried out using simulation packages like: CademCAMLab-Pro, Master-CAM.
3	CNC part programming using CAM packages : Simulation of Drilling simulations to be carried out using simulation packages like: CademCAMLab-Pro, Master-CAM.
4	CNC part programming using CAM packages : Simulation of Milling simulations to be carried out using simulation packages like: CademCAMLab-Pro, Master-CAM.
5	Internal and external threading : Write a CNC program to create internal and external threading on a cylindrical block.s
6	Simple 3D Printing Model : Creating Simple 3D model (example cube, gear, prism etc) in CAD software and printing the model using any 3D Printer (FDM/SLA/SLS printer)
7	Assembly Model-1: Creating an 3D CAD model of NUT and Bolt (example size M12x50), print the model using any 3D Printer and Check the assembly
8	Assembly Model-2: Creating an 3D CAD assembly model containing four or more parts (example Screw jack, plumber block etc) print the model using any 3D Printer and Check the assembly
	Demonstration Experiments (For CIE)
9	Robot programming: Using Teach Pendent & Offline programming to perform pick and place, stacking of objects (2 programs).
10	Pneumatics and Hydraulics, Electro-Pneumatics: 3 typical experiments on Basics of these topics to be conducted.
11	FMS (Flexible Manufacturing System): Programming of Automatic storage and Retrieval system (ASRS) and linear shuttle conveyor Interfacing CNC lathe, milling with loading unloading arm and ASRS to be carried out on simple components.
12	Simple strength testing of 3D Printed Parts

Course outcomes (Course Skill Set):

At the end of the course the student will be able to:

- Students will have knowledge of G-code and M-code for machining operations.
- Students will able to perform CNC programming for turning, drilling, milling and threading operation.
- Students will able to visualize the 3D models using CAD software's
- Students will able to use 3D printing technology
- Students are able to understand robotic programming and FMS

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each course. The student has to secure not less than 35% (18 Marks out of 50) in the semester-end examination(SEE).

Continuous Internal Evaluation (CIE):

CIE marks for the practical course is **50 Marks**.

The split-up of CIE marks for record/ journal and test are in the ratio **60:40**.

- Each experiment to be evaluated for conduction with observation sheet and record write-up. Rubrics for the evaluation of the journal/write-up for hardware/software experiments designed by the faculty who is handling the laboratory session and is made known to students at the beginning of the practical session.
- Record should contain all the specified experiments in the syllabus and each experiment write-up will be evaluated for 10 marks.
- Total marks scored by the students are scaled downed to 30 marks (60% of maximum marks).
- Weightage to be given for neatness and submission of record/write-up on time.
- Department shall conduct 02 tests for 100 marks, the first test shall be conducted after the 8th week of the semester and the second test shall be conducted after the 14th week of the semester.
- In each test, test write-up, conduction of experiment, acceptable result, and procedural knowledge will carry a weightage of 60% and the rest 40% for viva-voce.
- The suitable rubrics can be designed to evaluate each student's performance and learning ability. Rubrics suggested in Annexure-II of Regulation book
- The average of 02 tests is scaled down to **20 marks** (40% of the maximum marks).

The Sum of scaled-down marks scored in the report write-up/journal and average marks of two tests is the total CIE marks scored by the student.

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the University

All laboratory experiments are to be included for practical examination.

(Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

Students can pick one question (experiment) from the questions lot prepared by the internal /external examiners jointly.

Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Rubrics suggested in Annexure-II of Regulation book

Suggested Learning Resources:

- https://nptel.ac.in/courses/112102103
- https://onlinecourses.nptel.ac.in/noc19_me46/preview
- https://nptel.ac.in/courses/112103306
- https://archive.nptel.ac.in/courses/112/105/112105211/
- https://onlinecourses.nptel.ac.in/noc20_me50/preview

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