VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI.

Scheme of Teaching and Examinations and Syllabus
M.Tech., Automative Engineering (MAU)
(Effective from the Academic year 2022-23)

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VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2022
M.Tech., Automative Engineering (MAU)
Choice Based Credit System (CBCS) and Outcome-Based Education(OBE)

I SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours per Week			Examination				Credits
				Theory	Practical/Seminar	Tutorial/ Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	T/SDA					
1	BSC	22MAU/MPU11	Applied Mathematics	03	00	00	03	50	50	100	3
2	IPCC	22MAU12	Automoive Engine And Systems	03	02	00	03	50	50	100	4
3	PCC	22MAU13	Noise, Vibration and Harshness	03	00	02	03	50	50	100	4
4	PCC	22MAU14	Vehicle Maintenance and Fleet Management	02	00	02	03	50	50	100	3
5	PCC	22MAU15	Advanced Machine Design	02	00	02	03	50	50	100	3
6	MCC	22RMI16	Research Methodology and IPR	03	00	00	03	50	50	100	3
7	PCCL	22MAUL17	Automotive Engineering Laboratory -I	01	02	00	03	50	50	100	2
8	AUD/AEC	22AUD18/ 22AEC18	BOS recommended ONLINE courses	Classes and evaluation procedures are as per the policy of the online course providers.							PP
			TOTAL	**17**	**04**	**06**	**21**	**350**	**350**	**700**	**22**

Note: BSC-Basic Science Courses, PCC: Professional core. IPCC-Integrated Professional Core Courses, MCC- Mandatory Credit Course,
AUD/AEC –Audit Course / Ability Enhancement Course(A pass in AUD/AEC is mandatory for the award of the degree), PCCL-Professional Core Course lab, **L-Lecture, P-Practical, T/SDA-Tutorial / Skill Development Activities**(Hours are for Interaction between faculty and students)

Integrated Professional Core Course (IPCC): **Integrated Professional Core Course (IPCC)**: Refers to Professional Theory Core Course Integrated with practical of the same course. The theory part of the IPCC shall be evaluated both by CIE and SEE. The practical part shall be evaluated by only CIE (no SEE). However, questions from the practical part of IPCC shall be included in the SEE question paper.

Audit Courses /Ability Enhancement Courses Suggested by BOS (ONLINE courses): Audit Courses: These are prerequisite courses suggested by the concerned Board of Studies. Ability Enhancement Courses will be suggested by the BoS if prerequisite courses are not required for the programs.

Ability Enhancement Courses:

- These courses are prescribed to help students to enhance their skills in in fields connected to the field of specialisation as well allied fields that leads toemployable skills. Involving in learning such courses are impetus to lifelong learning.
- The courses under this category are online courses published in advance and approved by the concerned Board of Studies.
- Registration to Audit /Ability Enhancement Course shall be done in consultation with the mentor and is compulsory during the concerned semester.
- In case a candidate fails to appear for the proctored examination or fails to pass the selected online course, he/she can register and appear for the same course if offered during the next session or register for a new course offered during that session, in consultation with the mentor.
- The Audit Ability Enhancement Course carries no credit and is not counted for vertical progression. However, a pass in such a course is mandatory for the award of the degree.

Skill development activities: Under Skill development activities in a concerning course, the students should

1. Interact with industry (small, medium, and large).
2. Involve in research/testing/projects to understand their problems and help creative and innovative methods to solve the problem.
3. Involve in case studies and field visits/ fieldwork.
4. Accustom to the use of standards/codes etc., to narrow the gap between academia and industry.
5. Handle advanced instruments to enhance technical talent.
6. Gain confidence in modelling of systems and algorithms for transient and steady-state operations, thermal study, etc.
7. Work on different software/s (tools) to simulate, analyze and authenticate the output to interpret and conclude.

All activities should enhance student's abilities to employment and/or self-employment opportunities, management skills, Statistical analysis, fiscal expertise, etc.

Students and the course instructor/s to involve either individually or in groups to interact together to enhance the learning and application skills of the study they have undertaken. The students with the help of the course teacher can take up relevant technical –activities which will enhance their skill. The prepared report shall be evaluated for CIE marks.

Semester- I

Semester- I

Applied Mathematics Common to MAU/ MPU			
Course Code	22MAU11	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To have an insight into solving Linear Algebraic Equations.
- Learn to use the roots of equations.
- To develop proficiency in solving ordinary and partial differential equations arising in engineering applications, using numerical methods.
- To Learn concepts of ANOVA

Module-1

Approximations and round off errors: Significant figures, accuracy and precision, error definitions, round off errors and truncation errors. Mathematical modeling and engineering problem solving: Simple mathematical model, Conservation laws of engineering. Roots of polynomial-polynomials in engineering and science, Muller's method, Bairstow's Method Graeffe's root squaring method. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Roots of Equations: False position method, Newton- Raphson method. Multiple roots by Newton-Raphson method. Simple fixed point iteration method- Acceleration of convergence- Δ^2 - Aitken's method. Numerical Differentiation and Numerical Integration: Newton –Cotes and Guassian Quadrature Integration formulae, Integration of Equations, Romberg integration, Numerical Differentiation Applied to Engineering problems, High Accuracy differentiation formulae. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Numerical Solution for Partial Differential Equations: Classification of second order partial differential equations. Solution of one dimensional heat equation by explicit method and Crank-Nicolson method. Solution one dimensional wave equation and two-dimensional Laplace equation by explicit method. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

System of linear algebraic equations and eigen value problems: Introduction, Direct methods, Gauss elimination method, triangularization method, Cholesky method, Partition method, Error analysis for direct methods. Eigen values and eigen vectors: bounds on eigen values, Jacobi method for symmetric matrices, Givens and Householder's method for symmetric matrices. Power method and Inverse power method 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Linear Transformation: Introduction to linear transformation. The matrix of linear transformation, linear models in science and engineering. Orthogonality and least squares: inner product, length and orthogonality, orthogonal sets, orthogonal projections. Gram-Schmidt process, least-square problems, inner product spaces.08 Hrs

Teaching-Learning	Chalk and talk method / PowerPoint Presentation

Process	

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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

1. S.S.Sastry: Introductory Methods of Numerical Analysis, Prentice Hall of India, 4th Edition, 2006. 2. Steven C. Chapra: Applied Numerical Methods with MATLAB for Engineers and Scientists, Tata Mcgraw Hill, 3rd Ed, 2011.
3. David C.Lay, Steven R.Lay and J.J.McDonald: LinearAlgebra and its Applications, 5th Edition, Pearson Education Ltd., 2015.

Reference Books:

1. B.S.Grewal: Numerical methods in Engineering and Science (with C,C++,&MATLAB), Khanna Publishers, 2014.
2. M. K. Jain, S.R.K. Iyengar and R. K. Jain, "Numerical Methods for Scientific and Engineering Computation", New Age International Publishers, 9th Edition, 2014.
3. PervizMoin, Fundamentals of Engineering Numerical Analysis, Cambridge University Press, 2010.

Web links and Video Lectures (e-Resources):

- http://.ac.in/courses.php?disciplineID=111
- http://www.class-central.com/subject/math(MOOCs)
- http://academicearth.org/
- http://www.bookstreet.in.
- VTU e-ShikshanaProgram
- VTU EDUSATProgram

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Acquire the idea of significant figures, types of errors during numerical computation.	5
CO2	Learn various numerical methods to solve system of linear equations	5
CO3	Analyze and solve PDE‟s related to wave equation arising in vibration analysis.	4
CO4	Understand sampling theory	3
CO5	Acquire knowledge of algebraic equations and analyze	4

Program Outcome of this course

Sl. No.	Description	Pos
PO1	An ability to independently carry out research /investigation and development work to solve practical problems pertaining to production engineering.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	An ability to demonstrate a degree of mastery over production engineering, a level higher than the requirements in the undergraduate program of mechanical engineering	
PO4	An ability to identify, critically analyze, formulate and solve manufacturing technology and automation problems to obtain optimal feasible solution considering safety, environment and other realistic constraints.	
PO5	An ability to demonstrate skills in latest engineering tools, software and equipments to analyze and solve complex production engineering problems.	
PO6	An ability to work as an individual and in a team with an understanding of the profession in ethical manner.	
PO7	Apply advanced level knowledge, techniques, skills and modern tools of production engineering.	

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**2**	**2**	**2**	**2**	**1**	**2**
CO2	**3**	**3**	**3**	**3**	**3**	**2**	**2**
CO3	**2**	**3**	**3**	**3**	**2**	**2**	**1**
CO4	**2**	**2**	**2**	**3**	**3**	**2**	**2**
CO5	**3**	**3**	**2**	**1**	**2**	**2**	**3**

Semester- I

AUTOMOIVE ENGINE AND SYSTEMS			
Course Code	**22MAU12**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 10-12 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

Course objectives:

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

1The course provides students with fundamental knowledge and principles in material removal processes.

2. In this course, the students apply the fundamentals and principles of metal cutting to practical applications through multiple labs using lathes, milling machines, grinding machines, and drill presses, Computer Numerical Control etc.

3. To demonstrate the fundamentals of machining processes and machine tools.

4. To develop knowledge and importance of metal cutting parameters.

5. To develop fundamental knowledge on tool materials, cutting fluids and tool wear mechanisms.

6. To apply knowledge of basic mathematics to calculate the machining parameters for different machining processes.

Module-1

Introduction:

Definition of a heat engine; external and internal combustion engine; basic engine components and nomenclature; the working principles of engines; classification of IC engines; application of IC engines.

Fuel Supply Systems:

SI Engine: Principle of elementary carburettor, Mixture requirements for steady state and transient operation, Gasoline Fuel Injection.

C.I. Engines:

Fuel injection pump systems- Types, constructional features and operation, Factors influencing fuel spray atomization, penetration and dispersion of diesel, Fuel Injection Pumps (inline, rotary), Filters, Governors – Types of Governors - fuel feed pumps and Types, injectors and nozzles – types, functions and necessities, injection lag, pressure waves in fuel lines

Teaching-Learning Process	**Teaching-Learning Process**

Module-2

Combustion in SI engines:

Essential features of ignition timing and ignition voltage, MBT timing, knock detection and control strategies, thermodynamic analysis of SI engine combustion, analysis of cylinder pressure data.

Combustion in CI engines:

Essential features of injection timing and delay period, correlations for ignition delay in engines, effect of fuel properties, types of combustion chambers and merits of the different types, analysis of cylinder pressure **data, fuel spray behavior.**

Teaching-Learning Process	**Teaching-Learning Process**

Module-3

Cooling and Lubrication System :

Cooling System:

Necessity, variation of gas temperature, Areas oh heat flow, heat transfer, piston and cylinder temperature,. Heat rejected to coolant, quantity of water required, cooling system, air cooling, water cooling, thermodynamics of forced circulation, thermostats, pressurized water cooling, regenerative cooling, comparison of air and water cooling, radiators types, cooling fan – power requirement, antifreeze solution.

Lubrication System:

Lubricants, lubricating systems, Lubrication of piston rings, bearings, oil consumption, Oil cooling. Heat transfer coefficients, liquid and air cooled engines, coolants, additives and lubricity improvers, oil filters, pumps, and crankcase ventilation – types

Teaching-Learning Process	Teaching-Learning Process

Module-4

Engine Management System:
Combined ignition and fuel management systems., Digital control techniques. Complete vehicle control systems, Artificial intelligence and engine management, Exhaust emission control in SI and CI engines, Techniques
Recent Developments in Automotive Engines:
Supercharger, Working Principle, Effect of Super charging, Types and Methods of Super charging, Turbo Charger, Working Principle , Turbo lag, VVT, V-TEC i-VTEC and IDTEC. ATFT, CRDI system – working Principle, Advantages and Effect of CRDI on emission reductions, Hybrid vehicles and fuel cells.

Teaching-Learning Process	Teaching-Learning Process

Module-5

Engine Performance Testing:
Engine performance parameters; Methods of determination of BP, IP, FP, volumetric, thermal, mechanical, scavenging efficiencies, etc., types of dynamometers, Morse Test, Numerical Problems in Engine Testing , Engine Performance and heat balance sheet.

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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

Sl.NO	Experiments
1	Assembling and Disassembling of Engine
2	Modeling of engine using appropriate material.
3	Study of lubrication systems in the proprotypes
4	Study on Fuel Supply Systems and modeling
5	Study on coolant
6	Study and performance of the engine and measuring the performance of engine

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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 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

1. Two Tests each of **20 Marks**
2. Two assignments each of **10 Marks/One Skill Development Activity of 20 marks**

3. Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60 marks, marks scored will be proportionally scaled down to **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 at the end /after completion of all the experiments 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)

1. The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.
2. The question paper will have ten questions. Each question is set for 20 marks.
3. 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.
4. 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 15 (50% of maximum marks-30) in the theory component and 10 (50% 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 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course(CIE+SEE)

Suggested Learning Resources:

Books

(1) Metal Cutting Principles - M.C. Shaw - Oxford Publication – 1985.
(2) Fundamentals of metal cutting & Machine Tools-by B.L.Juneja& G.S–Sekhar -Wiley Eastern.

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

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

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand all the concepts of Metal Cutting	5
CO2	Understand and analyse tool wear and Tool life	4
CO3	Each concept of Metal Cutting	5

Program Outcome of this course

Sl. No.	Description	Pos
PO1	An ability to independently carry out research /investigation and development work to solve practical problems pertaining to production engineering.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	An ability to demonstrate a degree of mastery over production engineering, a level higher than the requirements in the undergraduate program of mechanical engineering	
PO4	An ability to identify, critically analyze, formulate and solve manufacturing technology and automation problems to obtain optimal feasible solution considering safety, environment and other realistic constraints.	
PO5	An ability to demonstrate skills in latest engineering tools, software and equipments to analyze and solve complex production engineering problems.	
PO6	An ability to work as an individual and in a team with an understanding of the profession in ethical manner.	
PO7	Apply advanced level knowledge, techniques, skills and modern tools of production engineering.	

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**3**	**3**	**3**	**2**	**3**	**3**
CO2	**3**	**3**	**2**	**1**	**2**	**2**	**3**
CO3	**3**	**3**	**3**	**2**	**2**	**2**	**2**

Semester- I

NOISE, VIBRATION AND HARSHNESS			
Course Code	22MAU13	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	40Hrs +10-12 Activity Sessions	Total Marks	100
Credits	04	Exam Hours	03

Course Learning objectives:

1. Knowledge of the special casting techniques and principles of gating system.
2. Identify the defects in castings and familiarize with steel and Aluminium alloy foundry practices.

Module-1

Fundamentals of sound: Definition of NVH, Vehicle noise - Direct sound generation mechanism: airborne sound; Indirect sound generation mechanism: structure borne sound; Subjective response sound, Acoustic variables, basic attributes of sound such as wavelength, period, frequency; speed of sound, Decibel scale, Wave equation, types of sound fields, Measures of sound: Sound pressure, sound intensity and sound power, Combining sources: dB arithmetic, Standing wave, Beating, Impedance, Human hearing: frequency Versus sound pressure level, Loudness: phons and sones as noise descriptors; Weighting networks, Leqand various noise metrics for road noises. 08Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Noise measurements and instrumentation:, Measuring microphones, Sound level meter, time and frequency weighting, Sound spectra – Octave band analysis, Order analysis and waterfall plot, Various types of acoustic testing chambers, Sound power measurement from Sound pressure: Free field method, Reverberant field method, Semi- Reverberant field method and Comparison method (using calibrated Sources) Two- microphone probe for measuring; Sound power measurement from Sound Intensity 08Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Sound fields and Room Acoustics: Characterizing sound sources; Directivity; Sound Fields; Various approaches to modeling sound sources; Transmission loss (TL) and Insertion loss (IL); Reverberation time and Acoustic Absorption Coefficient; Effects of leaks on barrier and TL of composite barriers; measurement Absorption Coefficient and Transmission loss (TL). Vehicle Interior and Exterior noise: Internal noise sources in vehicles such as engine noise; road noise; aerodynamic (wind) noise; brake noise; squeak, rattle and tizz noises; sound package solution to reduce the interior noise: acoustic isolation, acoustic absorption and damping material solutions; Exterior noise sources in vehicles such as air intake systems and exhaust systems; Tyre noise**.** 08Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Sources of Vehicle vibration: Power train and Engine vibrations; driveline vibrations; chassis and suspension vibrations; Control strategies; Human response to vehicle vibrations, concept of harshness; subjective and objective evaluation of vehicle harshness. Vibration Isolation and Control: Introduction; damping of vibrations; vibration isolation and absorption; design of a Vibration Absorbers, unconstrained and constrained layer damping treatment, add on dampers and stiffeners, Introduction to Active Vibration Control. 08Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Vibration Measurement and Instrumentation: Definition of Modal Properties, Modal analysis theory, FE & Experimental modal analysis, Transducers and accelerometers Excitation sources Impact Excitation, Shaker excitation, Excitation signals, applications of Modal Analysis, laser based vibration measurements; analysis and presentation of vibration data. 08Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

3. Three Unit Tests each of **20 Marks**
4. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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:

6. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
7. The question paper will have ten full questions carrying equal marks.
8. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
9. Each full question will have a sub-question covering all the topics under a module.
10. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

1. Bies D A and Hansen C H,Engineering Noise Control: Theory and Practice, Spon Press, Taylor &Francis, NYUSA, 2003.

2. Vehicle Noise & Vibration Refinement, edited by Xu Wang, Elsevier Publishing Limited, 2010.

3. Mathew HarrisonVehicle Refinement – Controlling Noise & Vibration in Road Vehicles, Elsevier Publication (2004)

Web links and Video Lectures (e-Resources):

- .VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Industry Visit and Mini projects

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand the Solidification process, Gates and Risers types and design	5
CO2	Design simple casting design and learn casting defects	5
CO3	Understand constructional features and working of different foundry furnaces	5
Co4	Understand Ferrous and Aluminum metals and alloys	5
C05	Understand Foundry Mechanization and Modernization	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	An ability to independently carry out research /investigation and development work to solve practical problems pertaining to production engineering.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	An ability to demonstrate a degree of mastery over production engineering, a level higher than the requirements in the undergraduate program of mechanical engineering	
PO4	An ability to identify, critically analyze, formulate and solve manufacturing technology and automation problems to obtain optimal feasible solution considering safety, environment and other realistic constraints.	
PO5	An ability to demonstrate skills in latest engineering tools, software and equipments to analyze and solve complex production engineering problems.	
PO6	An ability to work as an individual and in a team with an understanding of the profession in ethical manner.	
PO7	Apply advanced level knowledge, techniques, skills and modern tools of production engineering.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**2**	**2**	**2**	**3**	**3**	**2**
CO2	**3**	**3**	**3**	**3**	**2**	**3**	**3**
CO3	**3**	**3**	**2**	**2**	**2**	**2**	**3**
CO4	**3**	**3**	**2**	**2**	**1**	**2**	**2**
CO5	**3**	**3**	**3**	**2**	**2**	**3**	**3**

Semester- I

Vehicle Maintenance and Fleet Management			
Course Code	22MAU14	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+ 10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:
To provide the students with the necessary fundamentals for understanding the material properties given by the available heat treatment processes.

Module-1	
Maintenance Tool, Shop, Schedule, Records: Standard tool set, torque wrenches, compression and vacuum gauges, engine analyzer and scanner, computerized wheel alignment and balancing, gauges for engine tune up and pollution measurement, spark plug cleaner, cylinder re boring machine, fuel injection calibration machine. 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-2	
Importance of maintenance: Schedule and unscheduled maintenance. Scope of maintenance. Equipment downtime. Vehicle inspection. Reports. Log books. Trip sheet. Lay out and requirements of maintenance shop. 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-3	
Power Plant Repair and Overhauling: Dismantling of power plant and its components. Cleaning methods. Inspection and checking. Repair and reconditioning methods for all engine components. Maintenance of ignition system, fuel injection system, cooling system,- lubrication system. Power plant trouble shooting chart. 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-4	
The Concept of Transport: The means of transport, classifications, and road transport - advantages of road transport, advantages of motor transport, and motor transport in India - types of road and their features. Transit Operation: Route planning - route location, stop location, route schedules, vehicle and labor scheduling, traffic control - traffic signals, signal timing, freeway control systems. . 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-5	
Legal Aspects: Motor vehicle act- registration, necessity of permits, insurance, test of competence to drive, mistake / offences for which a driver can be punished, adult workers - hours of work, running time, split duty, journey time, round journey time, layover, frequency**.** 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Reference Books:

1. A.W.Judge, Motor Vehicle Servicing, 3rd Edition, Pitman Paperpack, London , 1969.
2. W.Crouse, Everyday Automobile repair, Intl.student edition, TMH, New Delhi, 1986.
3. John Dolu, Manage "Fleet management ", McGraw-Hill Co., 1984.
4. Government of India Publication, "The Motor vehicle Act ", 1989.
5. Kitchin L D, "Bus operation ", llliffe and Sons Ltd., London, III Edition, 1992.
6. Frazee, fledell, Spicer,-Automobile collision Work, American technical publications, Chicago, 1953.
7. A,W.Judge, Maintenance of high speed diesel engines, Chapman Hall Ltd., London, 1956.
8. V.L.Maleev, Diesel Engine operation and maintenance, McGraw Hill Book CO., New york, 1995.
9. Vehicle servicing manuals.

Web links and Video Lectures (e-Resources):

- .VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Mini projects
- Industrial Visit

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	To understand the principles of operations, tests to evaluate mechanical and tribological properties.	5
CO2	To understand the principles of failure analysis and examination of failed components.	5
CO3	To understand the strain rate testing, test machine requirements and specimens measurements.	5
C04	To understand and describe the different types of coating and working principles.	5
C05	To learn and understand different heat treatment processes and their effect on finishing	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	An ability to independently carry out research /investigation and development work to solve practical problems pertaining to production engineering.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	An ability to demonstrate a degree of mastery over production engineering, a level higher than the requirements in the undergraduate program of mechanical engineering	
PO4	An ability to identify, critically analyze, formulate and solve manufacturing technology and automation problems to obtain optimal feasible solution considering safety, environment and other realistic constraints.	
PO5	An ability to demonstrate skills in latest engineering tools, software and equipments to analyze and solve complex production engineering problems.	
PO6	An ability to work as an individual and in a team with an understanding of the profession in ethical manner.	
PO7	Apply advanced level knowledge, techniques, skills and modern tools of production engineering.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**3**	**3**	**3**	**3**	**2**	**3**
CO2	**3**	**2**	**2**	**3**	**2**	**2**	**2**
CO3	**3**	**3**	**2**	**1**	**2**	**2**	**1**
CO4	**2**	**2**	**3**	**2**	**2**	**1**	**2**
CO5	**2**	**2**	**3**	**3**	**2**	**2**	**1**

Semester- I

ADVANCED MACHINE DESIGN			
Course Code	22MAU15	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+ 10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:
Students will be S_N curves and Damages in the Machines

Module-1

Introduction: Role of failure prevention analysis in mechanical design, Modes of mechanical failure, Review of failure theories for ductile and brittle materials including Mohr's theory and modified Mohr's theory, Numerical examples. Fatigue of Materials: Introductory concepts, High cycle and low cycle fatigue, 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Stess-Life (S-N) Approach: S-N curves, Statistical nature of fatigue test data, General S-N behavior, Mean stress effects, Different factors influencing S-N behaviour, S-N curve representation and approximations, Constant life diagrams, Fatigue life estimation using SN approach. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

LEFM Approach: LEFM concepts, Crack tip plastic zone, Fracture toughness, Fatigue crack growth, Mean stress effects, Crack growth life estimation. Notches and their effects: Concentrations and gradients in stress and strain, S-N approach for notched membranes, mean stress effects and Haigh diagrams, 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Fatigue from Variable Amplitude Loading: Spectrum loads and cumulative damage, Damage quantification and the concepts of damage fraction and accumulation, Cumulative damage theories, Load interaction and sequence effects, Cycle counting methods, Life estimation using stress life approach. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Surface Failure: Introduction, Surface geometry, Mating surface, Friction, Adhesive wear, Abrasive wear, Corrosion wear, Surface fatigue spherical contact, Cylindrical contact, General contact, Dynamic contact stresses, Surface fatigue strength. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

1. Ralph I. Stephens, Ali Fatemi, Robert, Henry o. Fuchs, "Metal Fatigue in engineering", John wileyNewyork, Second edition. 2001.
2. Failure of Materials in Mechanical Design, Jack. A. Collins, John Wiley, Newyork 1992.
3. Robert L. Norton , "Machine Design", Pearson Education India, 2000

Reference Books

1. S.Suresh , "Fatigue of Materials", Cambridge University Press, -1998
2. Julie.A.Benantine , "Fundamentals of Metal Fatigue Analysis", Prentice Hall,1990
3. Fatigue and Fracture, ASM Hand Book, Vol. 19, 2002.

Web links and Video Lectures (e-Resources):

- .VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Industrial Visit.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand the effect of manufacturing automation strategies.	5
CO2	Analyze computer aided quality control methods and techniques.	3
CO3	Analyse CIM planning system and computer network for manufacturing.	4
C04	Understand and analyse the flow lines and transfer mechanisms.	4
Co5	Understand and analyse Automated material Handling Storage system.	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	An ability to independently carry out research /investigation and development work to solve practical problems pertaining to production engineering.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	An ability to demonstrate a degree of mastery over production engineering, a level higher than the requirements in the undergraduate program of mechanical engineering	
PO4	An ability to identify, critically analyze, formulate and solve manufacturing technology and automation problems to obtain optimal feasible solution considering safety, environment and other realistic constraints.	
PO5	An ability to demonstrate skills in latest engineering tools, software and equipments to analyze and solve complex production engineering problems.	
PO6	An ability to work as an individual and in a team with an understanding of the profession in ethical manner.	
PO7	Apply advanced level knowledge, techniques, skills and modern tools of production engineering.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**3**	**3**	**3**	**2**	**2**	**2**
CO2	**3**	**3**	**3**	**3**	**2**	**2**	**2**
CO3	**3**	**3**	**2**	**2**	**1**	**2**	**2**
CO4	**3**	**3**	**2**	**2**	**2**	**3**	**2**
CO5	**3**	**3**	**2**	**2**	**2**	**3**	**2**

Semester- I

RESEARCH METHODOLOGY AND IPR			
Course Code	22RMI16	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

- To give an overview of the research methodology and explain the technique of defining a research problem
- To explain the functions of the literature review in research.
- To explain carrying out a literature search, its review, developing theoretical and conceptual frameworks and writing a review.
- To explain various research designs and their characteristics.
- To explain the details of sampling designs, and also different methods of data collections.
- To explain the art of interpretation and the art of writing research reports.
- To explain various forms of the intellectual property, its relevance and business impact in the changing global business environment.
- To discuss leading International Instruments concerning Intellectual Property Rights

Module-1

Research Methodology: Introduction, Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, and Problems Encountered by Researchers in India. Defining the Research Problem: Research Problem, Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Reviewing the literature: Place of the literature review in research, Bringing clarity and focus to your research problem, Improving research methodology, Broadening knowledge base in research area, Enabling contextual findings, How to review the literature, searching the existing literature, reviewing the selected literature, Developing a theoretical framework, Developing a conceptual framework, Writing about the literature reviewed. Research Design: Meaning of Research Design, Need for Research Design, Features of a Good Design, Important Concepts Relating to Research Design, Different Research Designs, Basic Principles of Experimental Designs, Important Experimental Designs. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Design of Sampling: Introduction, Sample Design, Sampling and Non-sampling Errors, Sample Survey versus Census Survey, Types of Sampling Designs.

Measurement and Scaling: Qualitative and Quantitative Data, Classifications of Measurement Scales, Goodness of Measurement Scales, Sources of Error in Measurement Tools, Scaling, Scale Classification Bases, Scaling Techniques, Multidimensional Scaling, Deciding the Scale.

Data Collection: Experimental and Surveys, Collection of Primary Data, Collection of Secondary Data, Selection of Appropriate Method for Data Collection, Case Study Method. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Testing of Hypotheses: Hypothesis, Basic Concepts Concerning Testing of Hypotheses, Testing of Hypothesis, Test Statistics and Critical Region, Critical Value and Decision Rule, Procedure for Hypothesis Testing, Hypothesis Testing for Mean, Proportion, Variance, for Difference of Two Mean, for Difference of Two Proportions, for Difference of Two Variances, P-Value approach, Power of Test, Limitations of the Tests of Hypothesis. Chi-square

Test: Test of Difference of more than Two Proportions, Test of Independence of Attributes, Test of Goodness of Fit, Cautions in Using ChiSquare Tests. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Interpretation and Report Writing: Meaning of Interpretation, Technique of Interpretation, Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports.

Intellectual Property: The Concept, Intellectual Property System in India, Development of TRIPS Complied Regime in India, Patents Act, 1970, Trade Mark Act, 1999,The Designs Act, 2000, The Geographical Indications of Goods (Registration and Protection) Act1999, Copyright Act,1957,The Protection of Plant Varieties and Farmers‟ Rights Act, 2001,The Semi-Conductor Integrated Circuits Layout Design Act, 2000, Trade Secrets, Utility Models, IPR and Biodiversity, The Convention on Biological Diversity (CBD) 1992. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

3. Three Unit Tests each of **20 Marks**
4. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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:

6. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
7. The question paper will have ten full questions carrying equal marks.
8. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
9. Each full question will have a sub-question covering all the topics under a module.
10. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

- Research Methodology: Methods and Techniques, C.R. Kothari, Gaurav Garg,New Age International,4th Edition, 2018.
- Research Methodology a step-by-step guide for beginners. (For the topic Reviewing the literature under module 2), Ranjit Kumar,SAGE Publications,3rd Edition, 2011.
- Study Material (For the topic Intellectual Property under module 5), Professional Programme Intellectual Property Rights, Law and Practice, The Institute of Company Secretaries of India, Statutory Body Under an Act of Parliament, September2013.
- Research Methods: the concise knowledge base, Trochim, Atomic Dog Publishing, 2005.
- Conducting Research Literature Reviews: From the Internet to Paper, Fink A, Sage Publications, 2009.

Web links and Video Lectures (e-Resources):

- .VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Discuss research methodology and the technique of defining a research problem	3
CO2	Explain the functions of the literature review in research, carrying out a literature search, developing theoretical and conceptual frameworks and writing a review	3
CO3	Explain various research designs, sampling designs, measurement and scaling techniques and also different methods of data collections.	3
CO4	Explain several parametric tests of hypotheses, Chi-square test, art of interpretation and writing research reports	4
CO5	Discuss various forms of the intellectual property, its relevance and business impact in the changing global business environment and leading International Instruments concerning IPR	3

Program Outcome of this course

Sl. No.	Description	POs
PO1	An ability to independently carry out research /investigation and development work to solve practical problems pertaining to production engineering.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	An ability to demonstrate a degree of mastery over production engineering, a level higher than the requirements in the undergraduate program of mechanical engineering	
PO4	An ability to identify, critically analyze, formulate and solve manufacturing technology and automation problems to obtain optimal feasible solution considering safety, environment and other realistic constraints.	
PO5	An ability to demonstrate skills in latest engineering tools, software and equipments to analyze and solve complex production engineering problems.	
PO6	An ability to work as an individual and in a team with an understanding of the profession in ethical manner.	
PO7	Apply advanced level knowledge, techniques, skills and modern tools of production engineering.	

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**3**	**3**	**3**	**2**	**2**	**2**
CO2	**2**	**2**	**3**	**3**	**3**	**1**	**2**
CO3	**3**	**3**	**3**	**2**	**2**	**3**	**3**
CO4	**2**	**2**	**2**	**3**	**3**	**3**	**2**
CO5	**3**	**3**	**3**	**2**	**2**	**3**	**3**

Semester- I

AUTOMOTIVE ENGINEERING LAB –I			
Course Code	22MAUL17	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:2:0	SEE Marks	50
Total Hours of Pedagogy	15 Hrs +10-12 Lab sessions	Total Marks	100
Credits	02	Exam Hours	100

Course objectives:
The course should enable the students to understand practical orientation of manufacturing processes.

Sl.NO	Experiments
1	Linear Static (Stress) Analysis of Automotive Engine Components such as Connecting Rod, Piston, Cylinder wall, Crank Shaft using FEA software Such as MSC Patran / MSC Nastran and etc
2	Modal Analysis of Automotive Engine Components using FEA software
3	Dynamics Analysis of Automotive Engine Components using FEA Software
4	Heat Transfer Analysis of Automotive Engine Components using FEA Software
5	Random Vibration analysis
6	Testing of Single Cylinder, Twin Cylinder and multi cylinder SI / CI engines for performance, Calculate BP, Thermal, volumetric efficiencies, and BSFC with emission testing.
7	Conduct Morse test for finding FP, IP, Indicated thermal efficiency and Mechanical efficiency and tuning the engine parameters
8	Performance test on computerized IC engine test rig using conventional fuels and Alternate Fuels.
9	Study and tuning of CRDI engine
10	Performance test on Variable Compression Ratio Engine

Course outcomes (Course Skill Set):

The course should enable the students to understand practical orientation of manufacturing processes.

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 50% of the maximum 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 40%of maximum marks in the semester-end examination(SEE). In total of CIE and SEE student has to secure 50% maximum marks of the course.

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.
- 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 10% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

Suggested Learning Resources:

REFRENCE BOOKS

1. Metal Cutting Principles - M.C. Shaw - Oxford Publication – 1985.
2. Fundamentals of metal cutting & Machine Tools - by B.L.Juneja & G.S – Sekhar - Wiley Eastern.
3. Metal Cutting - V.C.Venkatesh & S.Chandrasekhanan - Pantice Hall – 1991.
4. Metal Cutting - Dr. B.J.Ranganath -Vikas Publications

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI.

Scheme of Teaching and Examinations and Syllabus
M.Tech., Automative Engineering (MAU)
(Effective from the Academic year 2022-23)

Registrar,
Visvesvaraya Technological University
JnanaSangam, Machhe, Belagavi-590018
eMail: registrar@vtu.ac.in
contact: 0831-2498112

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2022
M.Tech., **Automotive Engineering** (MAU)
Choice Based Credit System (CBCS) and Outcome Based Education(OBE)

II SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical / Seminar	Tutorial/ Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	T/SDA					
1	PCC	22MAU/MPE21	Automotive Power trains	02	00	02	03	50	50	100	3
2	IPCC	22MAU/MPD/MPT/ MPY/MPE22	Industrial Design and Ergonomics	03	02	00	03	50	50	100	4
3	PEC	22MAU23x	Professional elective 1	02	00	02	03	50	50	100	3
4	PEC	22MAU24x	Professional	02	00	02	03	50	50	100	3
5	MPS	22MAU25	Mini Project with	00	04	02	--	100	--	100	3
6	PCCL	22MAUL26	Automotive Engineering Lab- II	01	02	00	03	50	50	100	02
7	AUD/ AEC	22MAU27	Suggested ONLINE courses	Classes and evaluation procedures are as per the policy of the online course providers.							PP
TOTAL				**10**	**08**	**08**	**15**	**350**	**250**	**600**	**18**

Note: PCC: Professional core courses, PEC: Professional Elective Courses, IPCC-Integrated Professional Core Courses. MPS-Mini Project With Seminar; AUD/AEC; Audit Courses / Ability Enhancement Courses (Mandatory), PCCL-Professional Core Course lab,
L-Lecture, P-Practical, T/SDA-Tutorial / Skill Development Activities(Hours are for Interaction between faculty and students)

Professional Elective 1		**Professional Elective 2**	
Course Code under 22MAU24X	**Course title**	**Course Code under 22MAU25X**	**Course title**
22MAU/MPE231	AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEMS	22MAU/MPE241	Simulation of I.C. Engine processes
22MAU/MPE232	VEHICLE DYNAMICS	22MAU/MPE242	Vehicle Performance
22MAU/MPE233	Automobile Chassis	22MAU/MSE/MTE243	Non-Traditional Machining
22MAU/MPE234	Manufacturing Techniques in Automotive Engineering	22MAU/MPE244	Off Road Vehicles
22MAU/MPE235	Design for Manufacturing and Assembly	22MPD/MAU/MDE/MEA/MMD/MTP/MPY/MIA/MAR/CAE/MPE/MPM/MCM245	Industry 4.0

Note:

1 Mini Project with Seminar: This may be hands-on practice**,** survey report, data collection and analysis, coding, mobile app development, field visit and report preparation, modelling of system, simulation, analysing and authenticating, case studies, etc.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide, if any, and a senior faculty of the department. Students can present the seminar based on the completed mini-project. Participation in the seminar by all postgraduate students of the program shall be mandatory.

The CIE marks awarded for Mini-Project work and Seminar, shall be based on the evaluation of Mini Project work and Report, Presentation skill and performance in Question and Answer session in the ratio 50:25:25. Mini-Project with Seminar shall be considered as a head of passing and shall be considered for vertical progression as well as for the award of degree. Those, who do not take-up/complete the Mini Project and Seminar shall be declared as fail in that course and have to complete the same during the subsequent semester. There is no SEE for this course.

2. Internship: All the students shall have to undergo a mandatory internship of **06 weeks** during the vacation of II and III semesters. A University examination shall be conducted during III semester and the prescribed internship credit shall be counted in the same semester. The internship shall be considered as a head of passing and shall be consideredfor vertical progression as well asfor the award of degree. Those, who do not take-up/complete the internship shall be declared as fail in the internship course and have to complete the same during the subsequent University examination after satisfying the internship requirements.

SEMESTER-II

Semester- II

Automotive Power Trains			
Course Code	22MAU/MPE21	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+ 10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:
To understand the basic concepts associated with the design and Functioning and applications of Robots
To study about the drives and sensors used in Robots

Module-1

Overview of Vehicle Power trains System:
Outlines of Power Trains, Power train functions, Power train layout and components, Main and Auxiliary functions, Requirements profile, Interrelations: Direction of rotation, Transmission Ratio and Torque, Road Profiles, Load Profiles, Typical Vehicle uses and Driver types, Performance features of Vehicle Transmissions. Design trends in Transmission, Kinematical relations of power trains, Numerical problems.

Matching engine and transmission:
Road loads and axle loads, Deriving condition diagram, Ideal transmission and engine-transmissions matching, Total ratio and overall gear ratio- Selecting the largest power- train ratio, Selecting the smallest power- train ratio, Selecting the intermediate gears- saw tooth profile, Geometrical gear steps, Progressive gear steps, Numerical problems. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Start-up Devices:
One -way clutch, Band clutch, Multi-disk clutch, Clutch Design and Analysis, Hydrodynamic Clutches and Torque Converters: Principles, Characteristic curves of Hydrodynamic Clutches, Construction and operation of Torque Converter, Input/output characteristics, Design Considerations, Trilok Converter, Torque Converter test diagram, Interaction of engine and Trilok Converter, Numerical problems.05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Manual Transmissions:
Manual Transmission Layouts and Components, Basic gear box construction, gear-sets with fixed axles, countershaft transmission and epicyclic gears, schemes for reverse gear. Transmission Power Flows, Numerical problems. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Gear shifting mechanisms, Layout and design of Synchronizers:
Internal shifting mechanisms and External shifting mechanisms, Classification of shifting elements, synchronizer functional requirements, synchronizing process, design of synchronizers, alternative transmission synchronizers 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Automatic Transmissions:
Level of automation, Gear shift mode, stepped and Continuously Variable Transmissions, synchronizer gear boxes, epicycloidal gear boxes, Car CVT'S: Van Doorne Continuously Variable Transmission (CVT) and Torotrak

Continuously Variable Transmission (CVT). Design and analysis of planetary gear trains, Gear ratios and clutch engagement schedule, Clutch torques in steady state condition, Torque analysis in shifting process, Numerical problems**.** 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Reference Books:

1. Automotive Transmissions: Fundamentals, Selection, Design and Application, Gisbert Lechner, Harald Naunheimer, Springer-Verlag Berlin Heidelberg, New York, ISBN 3-540-65903.

2. Design Practices: Passenger Car Automatic Transmissions, Many authors, Third Edition, AE-18, SAE, Warrendale, 1994.

3. Handbook of Automotive Powertrain and Chassis Design- J. Fenton, Professional Engineering Publishing, London 1998.

4. Gears and Transmissions, Vol. 4- J.G. Giles, Automotive Technology series, Butterworth, London 1969.

Web links and Video Lectures (e-Resources):

- .VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Industrial Visit

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Upon completion of this course, the students can able to apply the basic engineering.	5
CO2	To learn about knowledge for the design of robotics.	5
CO3	Will understand robot kinematics and robot programming.	4
CO4	Will understand application of Robots.	5
CO5	To learn about force and torque sensing.	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	An ability to independently carry out research /investigation and development work to solve practical problems pertaining to production engineering.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	An ability to demonstrate a degree of mastery over production engineering, a level higher than the requirements in the undergraduate program of mechanical engineering	
PO4	An ability to identify, critically analyze, formulate and solve manufacturing technology and automation problems to obtain optimal feasible solution considering safety, environment and other realistic constraints.	
PO5	An ability to demonstrate skills in latest engineering tools, software and equipments to analyze and solve complex production engineering problems.	
PO6	An ability to work as an individual and in a team with an understanding of the profession in ethical manner.	
PO7	Apply advanced level knowledge, techniques, skills and modern tools of production engineering.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**3**	**3**	**2**	**3**	**3**	**1**
CO2	**3**	**3**	**2**	**2**	**2**	**3**	**2**
CO3	**3**	**3**	**2**	**1**	**2**	**2**	**3**
CO4	**3**	**3**	**3**	**3**	**2**	**2**	**2**
CO5	**3**	**3**	**2**	**1**	**2**	**3**	**3**

Semester- II

Industrial Design and Ergonomics			
Course Code	**22MAU/MPD/MPT/MPY/MPE22**	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 10-12 Lab slots	Total Marks	100
Credits	04	Exam Hours	03

Course objectives:
Introduce the principles and techniques of Statistical Quality Control and their practical uses in product and/or process design and monitoring.

Module-1

Introduction: An approach to industrial design - elements of design structure for industrial design in engineering application in modem manufacturing systems. Ergonomics and Industrial Design: Introduction - general approach to the man-machine relationship workstation design-working position. 08 Hrs

Teaching-Learning Process	**Teaching-Learning Process**

Module-2

Control and Displays: shapes and sizes of various controls and displays-multiple displays and control situations - design of major controls in automobiles, machine tools etc., - design of furniture – design of instruments.. 08 Hrs

Teaching-Learning Process	**Teaching-Learning Process**

Module-3

Ergonomics and Production: Ergonomics and product design ergonomics in automated systems- expert systems for ergonomic design, Anthropomorphic data and its applications in ergonomic design limitations of anthropomorphic data - use of computerized database. 08 Hrs

Teaching-Learning Process	**Teaching-Learning Process**

Module-4

Visual Effects of Line and Form: The mechanics of seeing psychology of seeing, general influences of lined and form. Colour: colour and light - colour and objects - colour and the eye colour consistency - colour terms - reactions to colour and colour continuation - colour one engineering equipments. 08 Hrs

Teaching-Learning Process	**Teaching-Learning Process**

Module-5

Aesthetic Concepts: Concept of unity - concept of order with variety - concept of purpose style and environment - Aesthetic expressions. Style-components of style - house style, observations style in capital goods. Industrial Design in Practice: General design - specifying design equipments - rating the importance of industrial design – industrial design in the design process. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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

Sl.NO	Experiments
1	Development of Ergonomic Chair for various applications (office & Resting) , prepare a computer 3D model
2	Design the workspace area such that the work efficiency can be enhanced, prepare the sketches / Drawing
3	Design a product using athletics and ergonomics which is useful in day to today's life, do the sketches/drawings
4	Apply the ergonomics in improving the existing product and give min 5 improvement in it, provide sketches
5	Using House of style and giving an idea on the product development.
6	Implement various concepts and develop new product concepts and make a report on it.

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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 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

1. Two Tests each of **20 Marks**
2. Two assignments each of **10 Marks/One Skill Development Activity of 20 marks**
3. Total Marks of two tests and two assignments/one Skill Development Activity added will be CIE for 60 marks, marks scored will be proportionally scaled down to **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 at the end /after completion of all the experimentsshall 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)

1. The question paper will be set for 100 marks and marks scored will be scaled down proportionately to 50 marks.
2. The question paper will have ten questions. Each question is set for 20 marks.
3. 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.
4. 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 15 (50% of maximum marks-30) in the theory component and 10 (50% 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 40% of the maximum marks to qualify in the SEE. Marks secured will be scaled down to 50. (Student has to secure an aggregate of 50% of maximum marks of the course(CIE+SEE)

Suggested Learning Resources:

Books

- The Assurances Sciences - Halpern, Seigmund - Prentice Hall International, New Jersey, U.S.A - 1978.
- Quality Planning and Analysis - Juran, J.M and Gryna, F.M. - Tata McGraw Hill publishing Coimpany Ltd.,New Delhi, India – 1982.

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

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

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand the quality and basic probability concept.	3
CO2	Construct the control chart for variables.	4
CO3	Construct the control chart for attributes and analyse failure data.	4
CO4	Construct OC curve for determining the probability of lot acceptance.	4
CO5	Understand the basic concept of reliability and calculate maintainability and availability of resources.	3

Program Outcome of this course

Sl. No.	Description	POs
PO1	An ability to independently carry out research /investigation and development work to solve practical problems pertaining to production engineering.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	An ability to demonstrate a degree of mastery over production engineering, a level higher than the requirements in the undergraduate program of mechanical engineering	
PO4	An ability to identify, critically analyze, formulate and solve manufacturing technology and automation problems to obtain optimal feasible solution considering safety, environment and other realistic constraints.	
PO5	An ability to demonstrate skills in latest engineering tools, software and equipments to analyze and solve complex production engineering problems.	
PO6	An ability to work as an individual and in a team with an understanding of the profession in ethical manner.	
PO7	Apply advanced level knowledge, techniques, skills and modern tools of production engineering.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**3**	**3**	**3**	**3**	**3**	**2**
CO2	**3**	**3**	**2**	**3**	**2**	**2**	**3**
CO3	**3**	**3**	**3**	**2**	**2**	**3**	**3**
CO4	**3**	**2**	**2**	**2**	**2**	**3**	**2**
CO5	**3**	**2**	**2**	**2**	**3**	**3**	**2**

Semester- II

Professional Elective 1			
AUTOMOTIVE ELECTRICAL AND ELECTRONIC SYSTEMS			
Course Code	22MAU/MPE231	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:
This course aims to provide its trainees with the knowledge and the decision-making tools to face new challenges arising from current market demands, while remaining oriented towards a circular economy and keeping aware of environmental needs.

Module-1

Storage Battery:
Principle of lead acid cells, plates and their characteristics containers and separators, electrolyte and their preparation, effect of temperature on electrolyte, its specific gravity, capacity and efficiency, methods of charging from D.C. mains, defects and remedies of batteries, care of idle and new batteries. Recycling Process - Recent development in batteries
Charging :
D.C. Generators and Alternators their Characteristics. Control cutout, Electrical, Electro-mechanical and electronic regulators. Regulations for charging (For Discussion only) 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Lighting System
Wiring Requirements, Insulated and earth return system, details of head light and side light, LED lighting system, wiring colour code, Sealed beam head lamp construction, head light dazzling and preventive methods. Static and Dynamic Beaming of lights. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Starter Motor & Drives:
Battery motor starting system, condition at starting, behavior of starter during starting, series motor and its characteristics, consideration affecting size of motor, types of drives, starting circuit**.** 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Ignition systems and Engine Management Systems:
Ignition fundamentals, Types of solid state ignition systems, components, construction and operating parameters, high energy ignition distributors, Electronic spark timing, Ignition Advance, Types DIS, MBT and control.
05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Combined ignition and fuel management systems. Exhaust emission control, Digital control techniques – Dwell angle calculation, Ignition timing calculation and Injection duration calculation. Complete vehicle
control systems, Artificial intelligence and engine management 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

1. Modern Electrical Equipment of Automobiles - Judge A.W., Chapman and Hall, London ,1992

2. Understanding Automotive Electronics - William B. Ribbens, 5th edition- Butter worth Heinemann, 1998

3. Automobile Electrical Equipment - Young. A. P.,& Griffiths. L., English Language Book Society & New Press, 1990.

Reference Books:

1. Automotive Hand Book -Bosch, SAE, 8th Edn.

2. Storage Batteries - Vinal. G.W., John Wiley & Sons inc., New York, 1985.

3. Automobile Electrical Equipment – Crouse W. H., McGraw Hill Book Co Inc., New York, 1980.

4. Electrical Ignition Equipment – Spread bury F. G., Constable & Co Ltd., London, 1962.

5. Automotive Computers and Digital Instrumentation - Robert N Brady, Prentice Hall, Eagle Wood Cliffs, New Jersey, 1988.

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Introduce the various advanced welding techniques which make them interested to choose a career in the field of welding.	5
CO2	Understand the advanced welding practices in Industries and their comparative merits and demerits.	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	An ability to independently carry out research /investigation and development work to solve practical problems pertaining to production engineering.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	An ability to demonstrate a degree of mastery over production engineering, a level higher than the requirements in the undergraduate program of mechanical engineering	
PO4	An ability to identify, critically analyze, formulate and solve manufacturing technology and automation problems to obtain optimal feasible solution considering safety, environment and other realistic constraints.	
PO5	An ability to demonstrate skills in latest engineering tools, software and equipments to analyze and solve complex production engineering problems.	
PO6	An ability to work as an individual and in a team with an understanding of the profession in ethical manner.	
PO7	Apply advanced level knowledge, techniques, skills and modern tools of production engineering.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**3**	**3**	**2**	**2**	**1**	**2**
CO2	**2**	**2**	**2**	**3**	**3**	**2**	**2**

Semester- II

Professional Elective 1			
VEHICLE DYNAMICS			
Course Code	22MAU/MPE232	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:
To introduce the concept of non-destructive testing among the students and make them understand various types of non-traditional practices available for manufacturing industry.

Module-1

Basics of Vibration: Definitions, Modeling and Simulation, Global and Vehicle Coordinate System, Free, Forced, Un-damped and Damped Vibration, Response Analysis of Single DOF, Two DOF, Multi DOF, Magnification factor, Transmissibility, Vibration absorber, Vibration measuring instruments, Torsional vibration, Critical speed. Modal analysis. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Tyres: Tyre forces and moments, Tyre structure, Longitudinal and Lateral force at various slip angles, rolling resistance, Tractive and cornering property of tyre. Performance of tyre on wet surface. Ride property of tyres. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Magic formulae tyre model, Estimation of tyre road friction. Test on Various road surfaces. Tyre vibration.. Braking Performance: Basic equations, Braking forces, Brakes, Brake Proportioning, Antilock Brake system, Braking efficiency, Rear wheel lockup, Standards and Legislations, Numerical Examples.. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Vertical Dynamics: Human response to vibration, Sources of Vibration. Design, analysis and computer simulation of Passive, Semi-active and Active suspension using Quarter car, half car and full car model. Influence of suspension stiffness, suspension damping, and tyre stiffness. Control law for LQR, H-Infinite, Skyhook damping. Air suspension system and their properties. Vehicle Aerodynamics: Aerodynamic, Aerodynamic forces lift and drag components, Pitching, yawing, rolling moments, and Total road loads, Numerical Examples. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Steady State Handling Characteristics of Road Vehicles; Steering Geometry, Derivation of fundamental equation governing the steady-state handling behavior of a road vehicle, Neutral Steer, Understeer and Oversteer characteristics, characteristic and critical speeds, Neutral Steer Point, Static margin, Steady-State Response to Steering Input-Yaw Velocity Response, Lateral Acceleration Response, Sideslip Response and Curvature Response; Numerical Problems05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module .

Suggested Learning Resources:

Books

- Non Destructive Testing - Mc Gonnagle JJ – Garden and reach New York.
- Non Destructive Evolution and Quality Control - volume 17 of metals hand book 9edition Asia internal 1989.
- The Testing instruction of Engineering materials - Davis H.E Troxel G.E wiskovilC.T - McGraw hill

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Distinguish the destructive and non-destructive testing and find effectiveness.	5
CO2	Find the surface defect using liquid penetrant and magnetic particle test and eddy current test.	5
CO3	Learn the mechanism of flaw detection using ultrasonic wave system.	5
CO4	Understand the operations of microwave and radiography inspection system.	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	An ability to independently carry out research /investigation and development work to solve practical problems pertaining to production engineering.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	An ability to demonstrate a degree of mastery over production engineering, a level higher than the requirements in the undergraduate program of mechanical engineering	
PO4	An ability to identify, critically analyze, formulate and solve manufacturing technology and automation problems to obtain optimal feasible solution considering safety, environment and other realistic constraints.	
PO5	An ability to demonstrate skills in latest engineering tools, software and equipments to analyze and solve complex production engineering problems.	
PO6	An ability to work as an individual and in a team with an understanding of the profession in ethical manner.	
PO7	Apply advanced level knowledge, techniques, skills and modern tools of production engineering.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**3**	**3**	**2**	**2**	**3**	**3**
CO2	**3**	**3**	**2**	**2**	**1**	**2**	**2**
CO3	**2**	**2**	**3**	**3**	**2**	**3**	**3**
CO4	**2**	**2**	**2**	**3**	**3**	**2**	**3**

Semester- II

Professional Elective 1			
AUTOMOTIVE CHASSIS			
Course Code	22MAU/MPE233	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:
Understand various smart material and its importance in engineering application.
To Know various processing techniques of smart materials.

Module-1	
Overview of Vehicle chassis System: General construction of chassis, Types of chassis layouts with respect to location of Power plant and drive arrangements and their comparison. Stability of vehicle on slope, weight distribution, numerical on above topics. 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2	
Frames: Types of frames, loads acting of frame, cross sections and materials for frames, loading points, sub frames, calculation of cross section of frame members, Testing of frames. 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3	
Front axle and steering systems: Types of front axles and stub axles, Axle parts and materials, loads and stresses, center sections, section near steering head, spring pads, Front wheel geometry- Camber, Castor, toe –in, toe out, King Pin Inclination, under steer and over steer conditions, etc. Condition for correct steering, types of steering gears, power steering, Types of linkages, Ackermann and Davis steering mechanisms, Reversible and Irreversible steering. 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4	
Suspension system: Need, functions and requirements of suspension system, types of suspension system, Constructional details of leaf spring, helper springs, coil springs, torsion bar, rubber springs, plastic springs, 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5	
air bellows or pneumatic suspension, hydraulic suspension, constructional details of telescopic shock absorbers, independent suspension, front wheel independent suspension, rear wheel independent suspension, types, stabilizer, trouble shooting, Numerical problems. 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

1. Automotive Chassis – P.M. Heldt, Chilton & Co.
2. Automotive Mechanics – N.K. Giri ,Khanna Publications, New Delhi,2004.

Reference Books

1. Automotive mechanics – Joseph I Heintner, Affiliate d East West Press, New Delhi/Madras,1967
2. Automobile Engineering Vol. I - Kirpal Singh, Standard publications, New Delhi
3. A Text Book of Automobile Engineering- Laxmi Publications Private Ltd, 2007.

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand various smart material and its importance in engineering application	5
CO2	Know various processing technics of smart materials	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	An ability to independently carry out research /investigation and development work to solve practical problems pertaining to production engineering.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	An ability to demonstrate a degree of mastery over production engineering, a level higher than the requirements in the undergraduate program of mechanical engineering	
PO4	An ability to identify, critically analyze, formulate and solve manufacturing technology and automation problems to obtain optimal feasible solution considering safety, environment and other realistic constraints.	
PO5	An ability to demonstrate skills in latest engineering tools, software and equipments to analyze and solve complex production engineering problems.	
PO6	An ability to work as an individual and in a team with an understanding of the profession in ethical manner.	
PO7	Apply advanced level knowledge, techniques, skills and modern tools of production engineering.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**3**	**2**	**2**	**2**	**3**	**2**
CO2	**3**	**3**	**3**	**2**	**2**	**2**	**3**

Semester- II

Professional Elective 1			
Manufacturing Techniques In Automotive Engineering			
Course Code	22MAU/MPE234	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:
On completion of this course, the students will be able to understand project characteristics and various stages of a project.

Module-1	
Sheet Metal Forming: Introduction, Forming methods, shearing and Blanking, Bending, stretch forming, Deep drawing, redrawing operations, Defects in formed products. High Energy Rate Forming: Explosive forming, Electro-hydraulic forming, Electro-magnetic forming, Super Plastic Forming – Process principles, Equipment, Process variables, Merits and Limitations 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2	
Forging: Classification, various stages during forging, Forging equipment, brief description, deformation in compression, forging defects. Residual stresses in forging. Special Casting processes: Gravity die-casting, Pressure die casting, Centrifugal casting, Squeeze Casting, Slush casting, Thixo-casting and Continuous Casting Processes. Different casting techniques for manufacturing of automotive components like cylinder block, piston, flywheel, bearing liners, etc. 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3	
Powder Metallurgy Processing: Process details and special characteristics of Powder Metallurgy process, Powder making methods, Characteristics of Powders, Process flow chart, Process steps and Process variables. Compaction techniques like CIP & HIP (Cold Iso-static and Hot Isostatic pressing), Product design considerations, Applications of Powder metallurgy 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4	
Joining methods- Fusion: MIG-CO2 welding, Flux Cored Arc Welding, Resistance Seam, Spot and Projection Welding-Process principles, Equipment, Process variables, Merits and Limitations. Solid State Welding: Friction Welding, Friction Stir Welding - Process principles, Equipment, 08 Hours Page 31 of 44 Process variables, Merits and Limitations. 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5	
Joining of Plastics: Heated tool welding or hot bar welding, Hot gas welding or pendulum welding, High frequency welding, Ultrasonic welding, Friction welding, Induction welding. 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

1. Fundamentals of Working of Metals- Sach G., Pergamon Press.
2. Engineering Materials & their applications, R. A. Flinn& P. K. Trojan, 4th edition, Jaico Publishing House.

Reference Books:

1. ASM Handbook on Powder Metallurgy, Volume 17, ASM publications
2. High speed combustion engines- P.M. Heldt, Oxford and IBH Publishing Co, New York, 1990.
3. AWS Hand Book on welding
4. Welding Technology- O.P. Khanna.
5. Welding for Engineers-Udin, funk &Wulf.
6. Welding and Welding Technology- R.L. Little.

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand the relation between investment opportunities, market, and demand analyses.	
CO2	Analyse the project cash flow, interest and tax factor.	
CO3	Understand the cost capital analysis of risk, financial project, social cost and benefit analysis.	
CO4	Understand the man power management and project team concept.	
CO5	Optimise the project management by PERT and CPM.	

Program Outcome of this course

Sl. No.	Description	POs
PO1	An ability to independently carry out research /investigation and development work to solve practical problems pertaining to production engineering.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	An ability to demonstrate a degree of mastery over production engineering, a level higher than the requirements in the undergraduate program of mechanical engineering	
PO4	An ability to identify, critically analyze, formulate and solve manufacturing technology and automation problems to obtain optimal feasible solution considering safety, environment and other realistic constraints.	
PO5	An ability to demonstrate skills in latest engineering tools, software and equipments to analyze and solve complex production engineering problems.	
PO6	An ability to work as an individual and in a team with an understanding of the profession in ethical manner.	
PO7	Apply advanced level knowledge, techniques, skills and modern tools of production engineering.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**3**	**3**	**2**	**2**	**2**	**3**
CO2	**3**	**3**	**2**	**2**	**2**	**3**	**3**
CO3	**2**	**2**	**3**	**3**	**3**	**2**	**2**
CO4	**3**	**3**	**2**	**3**	**3**	**2**	**3**
CO5	**3**	**3**	**2**	**1**	**2**	**3**	**2**

Semester- II

Professional Elective 1			
Design for Manufacturing and Assembly			
Course Code	22MAU/MPE235	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

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

1. Outline the appropriate design for economical production and select the materials.
2. Select between various machining and metal joining processes

Module-1	
INTRODUCTION: General design principles for manufacturability, Process Capability, Feature tolerance, Geometrical tolerance, Surface finish, Review of relationship between attainable Tolerance grades, and different machining processes, Economics of process selection, Principles of Design for Manufacture, Quality Manufacturability, Introduction to Tolerance Charting Technique. 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2	
DESIGN OF CASTINGS: Redesign of castings based on parting line considerations, Minimising core requirements, other design consideration, economic production quantities. 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3	
DESIGN OF WELDMENTS: Advantages of weldments, Design for economical and efficient welding, Redesigning cast members using weldments, use of welding symbols, Economic production quantities, Design recommendations, cost reduction. 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4	
DESIGN FOR ASSEMBLY: Applications of selective assembly, Design recommendations for different fastening arrangements, Automatic assembly, control of axial play in assemblies, Design for easy assembly, Design for easy disassembly. 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5	
TRUE POSITION THEORY AND DATUM SYSTEMS: Theoretically exact dimension, virtual size concept, assembly considerations as applied to True Position Tolerancing, examples, Grouped datum systems, different types examples. 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

- "Product Design for Manufacture and Assembly" Geoffrey Boothroyd, Peter Dewhurst and Winston A. Knight, Standardsmedia. ISBN-13: 978-1420089271,
- "Product Design and Development".Karl T. Ulrich and Steven D. EppingerMcGraw-Hill EducationISBN-13: 978-007340477

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand the principles of manufacturability and design for manufacture.	5
CO2	Design casting and weldment for economic production quantity	4
CO3	Understand the concept of assembly, its design and true position of datum system.	5
CO4	Design parts cut to length and screw machine parts of various processes, open and closed die forging.	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	An ability to independently carry out research /investigation and development work to solve practical problems pertaining to production engineering.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	An ability to demonstrate a degree of mastery over production engineering, a level higher than the requirements in the undergraduate program of mechanical engineering	
PO4	An ability to identify, critically analyze, formulate and solve manufacturing technology and automation problems to obtain optimal feasible solution considering safety, environment and other realistic constraints.	
PO5	An ability to demonstrate skills in latest engineering tools, software and equipments to analyze and solve complex production engineering problems.	
PO6	An ability to work as an individual and in a team with an understanding of the profession in ethical manner.	
PO7	Apply advanced level knowledge, techniques, skills and modern tools of production engineering.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**3**	**2**	**3**	**2**	**2**	**3**
CO2	**3**	**3**	**3**	**3**	**3**	**2**	**3**
CO3	**3**	**3**	**3**	**2**	**3**	**3**	**2**
CO4	**3**	**3**	**3**	**2**	**1**	**2**	**2**

Semester- II

Professional Elective-2			
Simulation I. C. Engine Processes			
Course Code	22MAU/MPE241	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

1. To develop an understanding of basic concepts and role of Logistics and supply chain management in business.
2. To understand how supply chain drivers play an important role in redefining value chain excellence of Firms.
3. To develop analytical

Module-1	
Principle Of Computer Modeling and Simulation: Monte Carlo simulation, Nature of computer modeling and simulation, advantages of simulation, limitations of simulation, and areas of application. System and Environment: Components of a system-iscrete and continuous systems. Models of a system-a variety of modeling approaches.05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2	
Design and Evaluation of Simulation Experiments: Variance reduction techniques-antithetic variables-variables verification and validation of simulation models. 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3	
S.I. Engine Simulation and Two Stroke Engine: Simulation of Otto cycle at full throttle, part throttle and supercharged conditions. Progressive combustion, Exhaust and intake process analysis. Two Stroke Engine Simulation-Engine and Porting Geometry, Gas Flow, Scavenging. 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4	
C.I. Engine Simulation: Simulation of ideal Diesel cycle and Diesel cycle at full throttle, part throttle and supercharged conditions. Zero dimensional combustion model, Progressive combustion, Exhaust and intake process analysis. 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5	
Simulation Exercises: Case studies of Simulation for 2 stoke and 4 stroke engine. Simulation exercises using computers – MATLAB/SimuLink, Pro-E / ICEM, CFD Analysis, FE Analysis procedures, Advantages of FEA, Simple Exercise using MSC Nastran. Multi-body Simulation Exercises: Simple Multi-body Suspension, Four Bar mechanisms, Handling Analysis of simple Bogie using MSC Adams.05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Reference Books:

1. Combustion Modeling in Reciprocating Engines - J. N. Mattavi and C. A. Amann, Plenum Press, 1980.
2. The Thermodynamics and Gas Dynamics of Internal Combustion Engines, Vol. I & II - Horlock and Winterbone, Clarendon Press, 1986.
3. The Basic Design of two-stroke engines - Gordon P. Blair, SAE Publication, 1990.
4. Internal Combustion Engine Modeling - J. I. Ramos, Hemisphere Publishing Corporation, 1989
5. MSC Nastran / Adams User Manual
6. MATLAB User manual
7. System Simulation with digital Computer - NARSINGH DEO, prentice Hall Of India,1979.

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Industrial Visit

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	To understand issues & challenges in implementing & developing lean manufacturing techniques from TPS & its contribution for improving organizational performance.	5
CO2	Apply lean techniques to bring competitive business culture for improving organization performance .	5
CO3	Analyze how lean techniques can be applied to manufacturing & service industry	4
CO4	Developing lean management strategy for Supply chain management.	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	An ability to independently carry out research /investigation and development work to solve practical problems pertaining to production engineering.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	An ability to demonstrate a degree of mastery over production engineering, a level higher than the requirements in the undergraduate program of mechanical engineering	
PO4	An ability to identify, critically analyze, formulate and solve manufacturing technology and automation problems to obtain optimal feasible solution considering safety, environment and other realistic constraints.	
PO5	An ability to demonstrate skills in latest engineering tools, software and equipments to analyze and solve complex production engineering problems.	
PO6	An ability to work as an individual and in a team with an understanding of the profession in ethical manner.	
PO7	Apply advanced level knowledge, techniques, skills and modern tools of production engineering.	

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**2**	**2**	**2**	**3**	**3**	**3**
CO2	**3**	**3**	**3**	**3**	**2**	**3**	**3**
CO3	**3**	**3**	**3**	**3**	**2**	**1**	**2**
CO4	**3**	**3**	**3**	**3**	**2**	**2**	**3**

Semester- II

Professional Elective-2			
VEHICLE PERFORMANCE			
Course Code	22MAU/MPE242	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

1. To understand the concept of Quality
2. To understand the Implication of Quality on Business
3. To Implement Quality Implementation Programs

Module-1	
Introduction to vehicle system: Morphology of vehicles, General layout of passenger cars and commercial vehicle, Type of power units, arrangement of power train, Vehicle controls 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2	
Friction and rolling resistance of pneumatic tyres: Aerodynamics forces and moments, Relationship between tractive effort and longitudinal slip of tyres, cornering properties of tyres, Equation of motion and maximum tractive effort. 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3	
Vehicle performance estimation and prediction: Power plant characteristic and transmission related requirements, Vehicle acceleration, and max. Speed, Gradability Drive systems comparison. 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4	
Vehicle transmissions: Characteristics and features friction clutches, mechanical geared transmission lay shaft and epicyclic gearbox, Synchronizers, Fluid coupling and torque converters. Drive lines, two wheel drive, four wheel drive, braking arrangement, safety in braking, weight transfer steering, and cornering power of tyres.05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5	
Handling characteristics of vehicles: Steering geometry, steady state handling characteristics, steady state response to steering input. Directional stability of vehicle. Effect of shock and vibration on human being, comfort criteria.05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Textbooks:

1. Theory and Practice of Mechanical Vibrations- Rao J.S. and Gupta. K., Wiley Eastern Ltd., 2ndEdition,2002.
2. Theory of ground vehicle- J. Y. Wong, John Wiley and Sons Inc., New York,1stEdition, 1978.
3. Automobile Mechanics- Dr. N. K. Giri, Seventh reprint, Khanna Publishers, Delhi, 3rdEdition,2005

Reference Books:

1. Mechanics of road vehicle- W. Steeds, Illiffe Books Ltd, London3rdEdition, 1992.
2. Steering, Suspension tyres- J. G. Giles, Illife Books Lid London1st Edition, 1975.
3. Automotive chassis- P. M .Heldt, Chilton Co,New York, 1st Edition,1982.
4. Vehicle Dynamics- J. R. Ellis, Business Books, London, 2ndEdition,1969.

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Learn the principles and practices of TQM.	3
CO2	Know the evolution and challenges made in industries byTQM.	4
CO3	Understand the models to solve the problems and improving the circumstances.	4
CO4	Learn the quality tools implemented in industries and itsperformances	3

Program Outcome of this course

Sl. No.	Description	POs
PO1	An ability to independently carry out research /investigation and development work to solve practical problems pertaining to production engineering.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	An ability to demonstrate a degree of mastery over production engineering, a level higher than the requirements in the undergraduate program of mechanical engineering	
PO4	An ability to identify, critically analyze, formulate and solve manufacturing technology and automation problems to obtain optimal feasible solution considering safety, environment and other realistic constraints.	
PO5	An ability to demonstrate skills in latest engineering tools, software and equipments to analyze and solve complex production engineering problems.	
PO6	An ability to work as an individual and in a team with an understanding of the profession in ethical manner.	
PO7	Apply advanced level knowledge, techniques, skills and modern tools of production engineering.	

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**3**	**3**	**3**	**2**	**2**	**3**
CO2	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CO3	**3**	**3**	**3**	**3**	**3**	**2**	**2**
CO4	**3**	**3**	**3**	**3**	**2**	**2**	**2**

Semester- II

NON-TRADITIONAL MACHINING PROCESSES			
Course Code	22MAU/MSE/MTE243	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	**2:0:2**	SEE Marks	50
Total Hours of Pedagogy	**25**	Total Marks	100
Credits	**03**	Exam Hours	03

Course Learning Objectives:

- Study the Comparison between conventional and non-conventional manufacturing process and understand the mechanism of USM and AJM.
- Understand EDM concept and operating characteristic.
- Learn how to distinguish ECM with other operations and various application and understand the usage of various chemical and maskants in CHM.
- Understand the generation of plasma, electron beam, laser and their machining characteristics.
- Understand the formation of ion beam and this application and various high velocity forming process.

Module-1 **(05 Hrs)**	
Introduction: Need for non-traditional machining processes. Processes selection classification on – comparative study of different processes. **Mechanical Process**: Ultrasonic Machining-Definition-Mechanism of metal elements of the process- Tool feed mechanism. Theories of mechanics of causing effect of parameter applications. **Abrasive Jet Machining**: Principles - parameters of the process applications-advantages and disadvantages.	
Teaching-Learning Process	Chalk and Talk / Use of ICT like Power Point Presentations etc

Module-2 **(05 Hrs)**	
Thermal Metal Removal Process: Electric discharge machining Principle of operation –mechanism of metal removal basic EDM circuitry-spark erosion get Analysis of relaxation type of circuit material removal rate in relaxation circuits-critical resistance parameters in RO Circuit-Die electric fluids-Electrodes for spark, surface finish, Applications. **Plasma arc Machining**: Introduction-Plasma-Generation of Plasma and equipment Mechanism of metals removal, PAN parameters- process characteristics - type of torches applications.	
Teaching-Learning Process	Chalk and Talk / Use of ICT like Power Point Presentations etc

Module-3 **(05 Hrs)**	
Electro Chemical and Chemical Processes: Electro chemical machining (ECM), Classification ECM process-principle of ECM Chemistry of the ECM parameters of the processes-determination of the metal removal rate - dynamics of ECM process- Hydrodynamics of ECM process-polarization-. Tool Design-advantages and disadvantages - applications. Electro Chemical Grinding-Electro Chemical holding, Electrochemical deburring. **Chemical Machining**: Introduction-fundamental principal types of chemical machining Maskants-Etchants Advantages and disadvantages-application.	
Teaching-Learning Process	Chalk and Talk / Use of ICT like Power Point Presentations etc

Module-4 **(05 Hrs)**	
Electron Beam Machining (EBM): Introduction-Equipment for production of Electron beam - Theory of electron beam machining Thermal & Non thermal type characteristics - applications. **Laser Beam Machining (LBM)**: Introduction-principle of generation of lasers Equipment and Machining Procedure-Types of Lasers-Process characteristics-advantages and limitations-applications **Ion Beam Machining**: Introduction-Mechanism of metal removal and associated equipment process characteristics applications.	
Teaching-Learning Process	Chalk and Talk / Use of ICT like Power Point Presentations etc

Module-5 **(05 Hrs)**	
High Velocity Forming Process: introduction - development of specific process selection comparison of conventional and high velocity forming methods - Types of high velocity forming methods- explosion forming process-elector hydraulics forming magnetic pulse forming.	
Teaching-Learning Process	Chalk and Talk / Use of ICT like Power Point Presentations etc

Tutorial/Activity Sessions:

- 10-12 tutorial/activity sessions need to be planned, which may be distributed among all the modules to cover entire portion of the syllabus within nearly 40 hours.

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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50 marks. The question paper will have ten full questions carrying equal marks.
2. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
3. Each full question will have a sub-question covering all the topics under a module.
4. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1 **Production Technology** - HMT - Tata McGraw Hill - ISBN-10; 0070964432

2 **Modern Machining Process** - P.C Pandy& H.S. Shan - Tata McGraw Hill - **ISBN:**0070965536 **-** Publishing Date: Feb-80

Web links and Video Lectures (e-Resources):

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Compare conventional and non-conventional manufacturing process and, the mechanism of USM and AJM.	L2
CO2	Explain the EDM concept and operating characteristic.	L2
CO3	Distinguish ECM with other operations and various application and understand the usage of various chemical and maskants in CHM.	L2
CO4	Describe the generation of plasma, electron beam, laser and their machining characteristics.	L2
CO5	Explain the formation of ion beam, its application and various high velocity forming process.	L2

Mapping of COS and POs

(Below table is only indicative and hence course teacher can revise it)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1										
CO2										
CO3										
CO4										
CO5										

Semester- II

Professional Elective-2			
OFF ROAD VEHICLES			
Course Code	22MAU244	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

1. To enable the students to understand the HR Management and system at various levels in general and in certain specific industries or organizations.
2. To help the students focus on and analyse the issues and strategies required to select and develop manpower resources

Module-1	
Equipment and operation: Different types, capacity, working principles and applications of bull Dozers, Loaders, Shovels, Excavators, Scrapers, Motor graders, Rollers, Compactors, Tractors and Attachments. 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2	
Engine, under carriage and Suspension systems: All systems of engine and special features like Automatic injection timer, turbochargers, after coolers etc., tyre and tracked vehicles, advantages and disadvantages under carriage components like, tracks, roller frames, drive sprockets, track rollers, track chains and track shoes. Rubber spring suspension and air spring suspension. 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3	
Transmissions and Final drives: Basic types of transmissions, auxiliary transmission, compound transmission, twin triple countershaft, transmissions and planetary, transmission, constructional and working principles, hydro shift automatic Transmission and retarders.. 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4	
FINAL DRIVES: types of reductions like, single reduction, double reduction final drives and planetary final drives PTO shaft 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5	
Hydraulics: Basic components of hydraulic systems like pumps (types of pumps), control valves like flow control valves, directional control valves and pressure control valves, hydraulic motors and hydraulic cylinders, depth & draft control systems. 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

1. Diesel equipment- volume I and II by Erich J.schulz
2. Construction equipment and its management - S. C. Sharma

Reference Books:

1. Farm machinery and mechanism - Donald R. hunt and L. W. Garner
2. Theory of ground vehicles - J. Y. Wong john Wiley and sons
3. Moving the earth - Herbert Nicholas
4. On and with the earth - Jagman Singh, W. Newman and Co. Kalkata

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand the basic concepts of HRM, Functions and role of HRM.	4
CO2	Know methodology of job selection process implemented in various sectors.	5
CO3	Analyse the effectiveness in training, evaluating and bench marking HR training.	4
CO4	Understand the career development concept and methods of personal appraisal	4
CO5	Understand International activities of HRM, Staffing, communication, appraisal training and interview system	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	An ability to independently carry out research /investigation and development work to solve practical problems pertaining to production engineering.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	An ability to demonstrate a degree of mastery over production engineering, a level higher than the requirements in the undergraduate program of mechanical engineering	
PO4	An ability to identify, critically analyze, formulate and solve manufacturing technology and automation problems to obtain optimal feasible solution considering safety, environment and other realistic constraints.	
PO5	An ability to demonstrate skills in latest engineering tools, software and equipments to analyze and solve complex production engineering problems.	
PO6	An ability to work as an individual and in a team with an understanding of the profession in ethical manner.	
PO7	Apply advanced level knowledge, techniques, skills and modern tools of production engineering.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**3**	**3**	**3**	**2**	**2**	**2**
CO2	**3**	**3**	**2**	**2**	**2**	**2**	**3**
CO3	**3**	**3**	**3**	**2**	**2**	**2**	**3**
CO4	**3**	**3**	**2**	**2**	**3**	**2**	**2**
CO5	**2**	**2**	**2**	**3**	**3**	**2**	**1**

Semester- II

Professional Elective-2			
Industry 4.0			
Course Code	22MPD/MAU/MDE/MEA/MMD/MTP /MPY/MIA/MAR/CAE/MPE/MPM/M CM245	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

1. Define the basics of simulation modeling and replicating the practical situations in organizations
2. Generate random numbers and random variates using different techniques.
3. Develop simulation model using heuristic methods.

Module-1	
Introduction to Industry 4.0: Introduction, core idea of Industry 4.0,origin concept of industry 4.0,Industry 4.0 production system, current state of industry 4.0, Technologies, How is India preparing for Industry 4.0 08Hrs	
Teaching-Learning Process	**Teaching-Learning Process**
Module-2	
A Conceptual Framework for Industry 4.0: Introduction, Main Concepts and Components of Industry 4.0, State of Art, Supportive Technologies, Proposed Framework for Industry 4.0. 08Hrs	
Teaching-Learning Process	**Teaching-Learning Process**
Module-3	
Technology Roadmap for Industry 4.0 : Introduction, Proposed Framework for Technology Roadmap, Strategy Phase, Strategy Phase, New Product and Process Development Phase. 08Hrs	
Teaching-Learning Process	**Teaching-Learning Process**
Module-4	
Advances in Robotics in the Era of Industry 4.0: Introduction, Recent Technological Components of Robots- Advanced Sensor Technologies, Internet of Robotic Things, Cloud Robotics, and Cognitive Architecture for Cyber-Physical Robotics, Industrial Robotic Applications- Manufacturing, Maintenance and Assembly. 08Hrs	
Teaching-Learning Process	**Teaching-Learning Process**
Module-5	
Obstacles and Framework Conditions for Industry 4.0 : Lack of A Digital Strategy alongside Resource Scarcity, Lack of standards and poor data security, Financing conditions, availability of skilled workers, comprehensive broadband infra- structure, 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks**to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

- Alp Ustundag and Emre Cevikcan,"Industry 4.0: Managing the Digital Transformation".
- Bartodziej, Christoph Jan,"The Concept Industry 4.0".
- Klaus Schwab,"The Fourth Industrial Revolution".
- Christian Schröder ,"The Challenges of Industry 4.0 for Small and Medium-sized Enterprises".

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Industrial visit

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Describe the role of important elements of discrete event simulation and modeling paradigm.	
CO2	Conceptualize real world situations related to systems development decisions, originating from source requirements and goals.	
CO3	Develop skills to apply simulation software to construct and execute goal-driven system models.	
CO4	Interpret the model and apply the results to resolve critical issues in a real world environment.	

Program Outcome of this course

Sl. No.	Description	POs
PO1	An ability to independently carry out research /investigation and development work to solve practical problems pertaining to production engineering.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	An ability to demonstrate a degree of mastery over production engineering, a level higher than the requirements in the undergraduate program of mechanical engineering	
PO4	An ability to identify, critically analyze, formulate and solve manufacturing technology and automation problems to obtain optimal feasible solution considering safety, environment and other realistic constraints.	
PO5	An ability to demonstrate skills in latest engineering tools, software and equipments to analyze and solve complex production engineering problems.	
PO6	An ability to work as an individual and in a team with an understanding of the profession in ethical manner.	
PO7	Apply advanced level knowledge, techniques, skills and modern tools of production engineering.	

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**3**	**3**	**3**	**3**	**3**	**3**
CO2	**3**	**3**	**3**	**2**	**2**	**2**	**2**
CO3	**3**	**3**	**3**	**3**	**2**	**2**	**2**
CO4	**2**	**2**	**2**	**2**	**2**	**3**	**3**

Semester- II

Mini Project with Seminar			
Course Code	22MAU25	CIE Marks	100
Teaching Hours/Week (L:P:SDA)	0:4:2	SEE Marks	--
Total Hours of Pedagogy	--	Total Marks	100
Credits	3	Exam Hours	03

Course objectives:

- To support independent learning.
- To guide to select and utilize adequate information from varied resources maintaining ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources) clearly.
- To develop interactive, communication, organisation, time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instil responsibilities to oneself and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Project Work Phase - II: Each student of the project batch shall involve in carrying out the project work jointly in constant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

Course outcomes:

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

- Present the project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.
- Learn on their own, reflect on their learning and take appropriate actions to improve it.

Continuous Internal Evaluation:

Project Report: 50 marks. The basis for awarding the marks shall be the involvement of the student in the project and in the preparation of project report. To be awarded by the internal guide in consultation with external guide if any.

Project Presentation: 30 marks.

The Project Presentation marks of the Project Work Phase -II shall be awarded by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

Question and Answer: 20 marks.

The student shall be evaluated based on the ability in the Question and Answer session.

Semester End Examination
SEE marks for the project report (50 marks), seminar (30 marks) and question and answer session (20 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University.

Automotive Engineering LAB-II			
Course Code	22MAUL26	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:2:0	SEE Marks	50
Credits	02	Exam Hours	100

Course objectives:
The main objective of this course is to emphasize the importance manufacturing sciences in the day-to-day life, and to study the basic manufacturing processes and tools used.

Sl.NO	Experiments
1	Study of Suspension systems used in low, medium and Heavy vehicle
2	Simulation of Suspension system using commercial software for LCV and HCV
3	Study of Drive line systems and Simulation using Commercial MBD software
4	Stress Analysis of Chassis components using FE Software
5	Testing Two Wheeled Vehicles on Chassis Dynamometer
6	Study and practice of wheel alignment (computerized) and wheel balancing
7	Head light focusing test and visibility test
8	Simulation of Static and Dynamic head light bending
9	Study of MPFI and CRDI
10	Impact Analysis of Automotive Vehicle System using FE Software

Course outcomes (Course Skill Set):
At the end of the course the student will be able to:
1. Learn about patterns and casting of metals.
2. Understand the concept of Arc, Spot, TIG welding and brazing process.
3. Understand the Process of simple, compound and progressive press and Hydraulic press

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 50% of the maximum 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 40%of maximum marks in the semester-end examination(SEE). In total of CIE and SEE student has to secure 50% maximum marks of the course.

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.
- 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 10% Marks allotted to the procedure part to be made zero.

The duration of SEE is 03 hours

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI.

Scheme of Teaching and Examinations and Syllabus
M.Tech., Automative Engineering (MAU)
(Effective from the Academic year 2022-23)

Registrar,
Visvesvaraya Technological University
JnanaSangam, Machhe, Belagavi-590018
eMail: registrar@vtu.ac.in
contact: 0831-2498112

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2022
M.Tech., Automative Engineering (MAU)
Choice Based Credit System (CBCS) and Outcome Based Education(OBE)

III SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week			Examination				Credits
				Theory	Practical / Mini – Project/ Internship	Tutorial / Skill Development Activities	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	P	SDA					
1	PCC	22MAU/ MPE31	Automotive Body Engineering and safety	03	00	02	03	50	50	100	4
2	PEC	22MAU32 X	Professional elective 3	03	00	00	03	50	50	100	3
3	OEC	22MAU33 X	**Professional Elective 4**	03	00	00	03	50	50	100	3
4	PROJ	22MAU34	Project Work phase -1	00	06	00	--	100	--	100	3
5	SP	22MAU35	Societal Project	00	06	00	--	100	--	100	3
6	INT	22MAUI36	Internship	(06 weeks Internship Completed during the intervening vacation of II and III semesters.)			03	50	50	100	6
TOTAL				**09**	**12**	**03**	**12**	**400**	**200**	**600**	**22**

Note: PCC: Professional core courses, PEC: Professional Elective Courses, IPCC-Integrated Professional Core Courses. MPS-Mini Project With Seminar; AUD/AEC; Audit Courses / Ability Enhancement Courses (Mandatory), PCCL-Professional Core Course lab, **L-Lecture, P-Practical, T/SDA-Tutorial / Skill Development Activities**(Hours are for Interaction between faculty and students)

Professional elective 3		**Professional Elective 4**	
Course Code under 22MPD31X	**Course title**	**Course Code under 22MPD32X**	**Course title**
22MAU/MPE321	Automotive Embedded Systems	22MAU/MPE/MPD331	Non Destructive Testing
22MAU/MDE/MEA/MMD/MPD/MPE/MSE/MTE/MPY/MPM322	Rapid Prototyping	22MAU/MPD/MPE/MST/MTE/MPE332	Hydraulics and Pneumatics
22MAU/MPE/MSE/MPY/MEM323	Composite Materials	22MAU/MPE333	Two and Three wheeler Technology
22MAU/MPE324	Organizational Behaviour	22MAU/MDE/MEA/MMD334	Introduction to hybrid and Electric Vehicles
22MAU/MPE325	Industrial Robots and Expert Systems	22MAU/MPE335	AUTOMOTIVE CONTROL SYSTEM

Note:

1. Project Work Phase-1: The project work shall be carried out individually. However, in case a disciplinary or interdisciplinary project requires more participants, then a group consisting of not more than three shall be permitted.

Students in consultation with the guide/co-guide (if any) in disciplinary project or guides/co-guides (if any) of all departments in case of multidisciplinary projects, shall pursue a literature survey and complete the preliminary requirements of the selected Project work. Each student shall prepare a relevant introductory project document, and present a seminar.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, all Guide/s and co-guide/s (if any) and a senior faculty of the concerned departments. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session in the ratio of 50:25:25.

2. Societal Project: Students in consultation with the internal guide as well as with external guide (much preferable) shall involve in applying technology toworkout/proposing viable solutions for societal problems.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session in the ratio of 50:25:25.

Those, who have not pursued /completed the Societal Project, shall be declared as fail in the course and have to complete the same during subsequent semester/s after satisfying the Societal Project requirements. There is no SEE (University examination) for this course.

3. Internship: Those, who have not pursued /completed the internship, shall be declared as fail in the internship course and have to complete the same during subsequent University examinations after satisfying the internship requirements. Internship SEE (University examination) shall be as per the University norms.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, Guide/co-guide if any, and a senior faculty of the department. The CIE marks awarded for project work phase -1, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session in the ratio of 50:25:25.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examinations – 2022
M.Tech.,Automative Engineering (MAU)
Choice Based Credit System (CBCS) and Outcome Based Education(OBE)

IV SEMESTER

Sl. No	Course	Course Code	Course Title	Teaching Hours /Week		Examination				Credits
				Theory	Practical/ Field work	Duration in hours	CIE Marks	SEE Marks Viva voce	Total Marks	
				L	P					
1	Project	22MAU41	Project work phase -2	--	08	03	100	100	200	18
			TOTAL	--	**08**	**03**	**100**	**100**	**200**	**18**

Note:

1. Project Work Phase-2:

Students in consultation with the guide/co-guide (if any) in disciplinary project or guides/co-guides (if any) of all departments in case of multidisciplinary projects, shall continue to work of Project Work phase -1to complete the Project work. Each student / batch of students shall prepare project document, and present a seminar.

CIE marks shall be awarded by a committee comprising of HoD as Chairman, all Guide/s and co-guide/s (if any) and a senior faculty of the concerned departments. The CIE marks awarded for project work phase -2, shall be based on the evaluation of Project Report, Project Presentation skill, and performance in the Question and Answer session in the ratio of 50:25:25.

SEE shall be at the end of IV semester. Project work evaluation and Viva-Voce examination (SEE), after satisfying the plagiarism check, shall be as per the University norms.

SEMESTER III

Semester- III

Automobile Body Engineering and Safety			
Course Code	22MAU/MPE31	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	40 Theory+ 10-12 Activities	Total Marks	100
Credits	04	Exam Hours	03

Course Learning objectives:
Illustrate capabilities and applications of metal forming processes.

Module-1

Introduction: Types of car bodies, bus bodies and commercial vehicle bodies. Interior Ergonomics: Introduction, Seating dimensions, Interior ergonomics, ergonomics system design, seat comfort, requirements of drivers and passenger seats, suspension seats, split frame seating, back passion reducers, dash board instruments, electronic displays, commercial vehicle cabin ergonomics, mechanical package layout, goods vehicle layout. Visibility, regulations, drivers visibility, methods of improving visibility, Window winding and seat adjustment mechanisms. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Aerodynamics: Basics, Vehicle drag and types, Various types of forces and moments, effects of forces and moments, various body optimization techniques for minimum drag, Principle of wind tunnel technology, flow visualization techniques, tests with scale models, aerodynamic study for heavy vehicles. Body Materials, Trim, Mechanisms: Steel sheet, timber, plastic, GRP, properties of materials - Corrosion - Anticorrosion methods – Selection of paint and painting process - Body trim items - Body mechanisms 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Noise and vibration: Noise characteristics, Sources of noise, sound measurement techniques: Sound level meter, time and frequency weighting, Sound spectra – Octave band analysis, Various types of acoustic testing chambers, Sound power measurement from Sound pressure: Free field method, Reverberant field method, Semi-Reverberant field method and Comparison method (using calibrated Sources) Two- microphone probe for measuring; Sound power measurement from Sound Intensity, Body structural vibrations, chassis bearing vibration, designing against fatigue, methods of noise suppression.08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Body Loads and Design of Vehicle Bodies: Idealized structure- structural surface, shear panel method, symmetric and asymmetrical vertical loads in car, longitudinal loads, different loading situations. Vehicle Layout design: preliminary design, Load distribution on vehicle structure, stress analysis of bus body structure under bending and torsion, stress analysis in integral bus body, Design of chassis frame, Rules and regulations for body, Recent safety measures, Testing of body. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Vehicle safety: Active and passive safety, Restraint systems used in automobiles: safety belts, Head restraints, Air bags, Knee bolsters, Importance of Bumpers and their design, Types of safety glass and their requirements, Importance of Ergonomics in Automotive safety- Locations of controls. Vehicle structures for crash worthiness: Types of crash / roll over Tests, Regulatory requirements for crash testing, Instrumentation, high speed photography, Image Analysis. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text books:

1. Vehicle Body Engineering-Pawloski J., Business Books Ltd.
2. The automotive chassis: Engineering principle - Reimpell J, 2nd Edition, 1983.
3. Low speed Automobile Accidents -Watts, A. J., et al Lawyers and Judges 1996
4. An Introduction to Modern Vehicle Design- JullianHappian-Smith SAE, 2002

Web links and Video Lectures (e-Resources):

- .VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand the basics of metal forming.	3
CO2	Recognize the importance of metal forging using different geometrical shapes and various defects.	4
CO3	Understanding the concept of rolling ,types of rolling mills and processes and its defects	5
CO4	To understand the concepts of extrusion and drawing and their applications.	5
CO5	To understand the types of sheet metal forming processes and HERF	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	An ability to independently carry out research /investigation and development work to solve practical problems pertaining to production engineering.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	An ability to demonstrate a degree of mastery over production engineering, a level higher than the requirements in the undergraduate program of mechanical engineering	
PO4	An ability to identify, critically analyze, formulate and solve manufacturing technology and automation problems to obtain optimal feasible solution considering safety, environment and other realistic constraints.	
PO5	An ability to demonstrate skills in latest engineering tools, software and equipments to analyze and solve complex production engineering problems.	
PO6	An ability to work as an individual and in a team with an understanding of the profession in ethical manner.	
PO7	Apply advanced level knowledge, techniques, skills and modern tools of production engineering.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**3**	**3**	**3**	**2**	**2**	**2**
CO2	**3**	**3**	**3**	**2**	**1**	**2**	**3**
CO3	**3**	**3**	**2**	**2**	**2**	**2**	**2**
CO4	**3**	**3**	**3**	**2**	**3**	**3**	**3**
CO5	**3**	**3**	**3**	**3**	**2**	**3**	**3**

Semester- III

Professional Elective-3			
Automotive Embedded Systems			
Course Code	22MAU/MPE321	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

1. Identify and describe different types of material processing techniques for advanced materials
2. Ability to select suitable material for specific applications

Module-1	
Electronics in Automotive: Introduction Body and convenience electronics: vehicle power supply controllers and lighting modules, door control modules, Safety electronics: active safety systems: ABS, ASR, ESP 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2	
passive safety systems: Restraint systems and their associated sensors in an automobile. Powertrain Electronics: Gasoline engine management, Infotainment electronics: Dashboard/instrument cluster, car audio, telematic systems, navigation systems, multimedia systems, cross application technologies. 42V vehicle power supply system.05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3	
Drive by Wire: Challenges and opportunities of X-by-wire: system & design requirements steer-by-wire, brake-by-wire, suspension-by-wire, gas-by wire, power-by-wire, shift by-wire. Future of Automotive Electronics. 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4	
HARDWARE MODULES: MC9S12XD family features -Modes of operation-functional block diagram overview-programming model. Memory Map Overview Pulse Width Modulator (PWM) –On-chip ADC Serial Communication Protocol: SCI, SPI,IIC, CAN05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5	
Software Development Tools: Introduction to HCS12XDT512 Student Learning Kit & PBMCU (Project Board) – Introduction to Code Warrior IDE-Editing-Debugging Simulating simple programs. Flashing code into HCS12XDT512 SLK board and testing 05 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text books:

1. Semiconductors-Technical Information, Technologies and characteristic data, PublicisCorporatePublishing 2nd revised and considerably enlarged edition, 2004,

2. Freescale MC9S12XDP512 data sheet

3. Automotive Electronics Handbook- Ronald K Jurgen , McGraw Hill , 2000.

4. Semiconductors: Technical Information, Technologies and Characteristic Data- Werner Klingenstein& Team, Publicis Corporate Publishing, 2nd edition, 2004

5. Intelligent Vehicle Technologies: Theory and Applications- LjuboVlacic, Michel Parent & FurnioHarshima, , Butterworth-Heinemann publications, 2001.

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Classify materials and physical characteristics.	5
CO2	Understand iron carbon equilibrium diagram, TTT diagram, heat treatment process of various steels.	5
CO3	Understand alloys of various nonferrous metals.	5
CO4	Understand polymers, ceramics and their mechanical – thermal properties.	4
CO5	Identify the composites and their structure and Understand applications of ceramics	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	An ability to independently carry out research /investigation and development work to solve practical problems pertaining to production engineering.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	An ability to demonstrate a degree of mastery over production engineering, a level higher than the requirements in the undergraduate program of mechanical engineering	
PO4	An ability to identify, critically analyze, formulate and solve manufacturing technology and automation problems to obtain optimal feasible solution considering safety, environment and other realistic constraints.	
PO5	An ability to demonstrate skills in latest engineering tools, software and equipments to analyze and solve complex production engineering problems.	
PO6	An ability to work as an individual and in a team with an understanding of the profession in ethical manner.	
PO7	Apply advanced level knowledge, techniques, skills and modern tools of production engineering.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**3**	**3**	**3**	**2**	**2**	**2**
CO2	**2**	**2**	**2**	**3**	**3**	**2**	**2**
CO3	**3**	**3**	**3**	**3**	**3**	**2**	**3**
CO4	**2**	**2**	**2**	**1**	**2**	**2**	**2**
CO5	**3**	**2**	**2**	**2**	**2**	**2**	**2**

Professional Elective-3			
Rapid Prototyping			
Course Code	22MAU/MDE/MEA/MMD/MPD/MPE /MSE/MTE/MPY/MPM322	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:
This course provides students with an opportunity to conceive, design and implement a product, using rapid prototyping methods and computer-aid tools.

Module-1	
Introduction: Need for the compression in product development, history of RP systems, Survey of applications, Growth of RP industry, and classification of RP systems. Stereo Lithography Systems: Principle, Process parameter, Process details, Data preparation, data files and machine details, Application. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2	
Selective Laser Sintering and Fusion Deposition Modeling: Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications, Principle of Fusion deposition modeling, Process parameter, Path generation, Applications. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3	
Solid Ground Curing: Principle of operation, Machine details, Applications. Laminated Object Manufacturing: Principle of operation, LOM materials. Process details, application 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4	
Rapid Tooling: Indirect Rapid tooling -Silicone rubber tooling – Aluminum filled epoxy tooling Spray metal tooling, Cast kirksite, 3Q keltool, Direct Rapid Tooling Direct. AIM, Quick cast process, Copper polyamide, Rapid Tool, DMILS, Prometal, Sand casting tooling, Laminate tooling soft Tooling vs. hard tooling. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5	
RP Process Optimization: factors influencing accuracy. Data preparation errors, Part building errors, Error in finishing, influence of build orientation. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

- Stereo lithography and other RP & M Technologies -Paul F. Jacobs - SME, NY1996
- Rapid Manufacturing - Flham D.T &Dinjoy S.S - Verlog London2001.
- Rapid automated - Lament wood - Indus press NewYork (
- Wohler's Report 2000 - Terry Wohlers - Wohler's Association -2000

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Describe product development, conceptual design and classify rapid prototyping systems; explain stereo lithography process and applications.	5
CO2	Explain direct metal laser sintering, LOM and fusion deposition modeling processes.	5
CO3	Demonstrate solid ground curing principle and process.	4
CO4	Discuss LENS, BPM processes; point out the application of RP system in medical field define virtual prototyping and identify simulation components.	3

Program Outcome of this course

Sl. No.	Description	POs
PO1	An ability to independently carry out research /investigation and development work to solve practical problems pertaining to production engineering.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	An ability to demonstrate a degree of mastery over production engineering, a level higher than the requirements in the undergraduate program of mechanical engineering	
PO4	An ability to identify, critically analyze, formulate and solve manufacturing technology and automation problems to obtain optimal feasible solution considering safety, environment and other realistic constraints.	
PO5	An ability to demonstrate skills in latest engineering tools, software and equipments to analyze and solve complex production engineering problems.	
PO6	An ability to work as an individual and in a team with an understanding of the profession in ethical manner.	
PO7	Apply advanced level knowledge, techniques, skills and modern tools of production engineering.	

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**3**	**3**	**2**	**2**	**2**	**1**
CO2	**2**	**2**	**2**	**2**	**3**	**3**	**3**
CO3	**3**	**2**	**3**	**2**	**1**	**2**	**3**
CO4	**3**	**3**	**2**	**2**	**1**	**2**	**3**

Semester- III

Professional Elective-3			
Composite Materials			
Course Code	22MAU/MPE/MSE/MPY/MEM323	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:
Equip students with knowledge on composite strengthening addition of components and their production routes

Module-1

Introduction to Composite Materials: Definition, Classification, Types of matrices & reinforcements, characteristics & selection, Fiber composites, laminated composites, particulate composites, prepegs, sandwich constructions 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Micro Mechanical Analysis of a Lamina: Introduction, Evaluation of the four elastic moduli – Rule of mixture, Macro mechanics of a lamina: Hooke's law for different types of materials, number of elastic constants, Laminate code, Failure criterion. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Manufacturing: Lay Up and Curing – open and closed mould processing – Hand lay up techniques Bag moulding and filament winding. Pultrusion, Pulforming, Thermoforming, Injection moulding, Cutting, Machining and joining, tooling, Quality assurance Introduction, material qualification, types of defects, NDT methods. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Fabrication of Composites: Cutting, machining, drilling, mechanical fasteners & addesive bonding joining computer aided design manufacturing tooling fabrication equipment. Design of Fibre Reinforced Composite Structures: Introduction, Composite structural design, Design criteria, Laminate design, Mathematical analysis of the laminate, Design of composite stiffeners 08 Hrs
10 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Application Developments – Aircrafts, missiles, space hardware, automobile, electrical and electronics, marine, recreational and sports equipment-future potential of composites. Metal Matrix Composites: Re-inforcement materials, types, Characteristics & Selection, base metals-selection, applications. Powder metullury technique, liquid metallurgy technique. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

- Composite Materials Handbook - Mein Schwartz - Mc Graw Hill Book Company - 1984.
- Mechanics of Composite Materials - Autar K.Kaw - CRC Press New York - 1st edi, 1997

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Identify, describe and evaluate the properties of fibre reinforcements, polymer matrix materials and commercial composites.	
CO2	Develop competency in one or more common composite manufacturing techniques, and be able to select the appropriate technique for manufacture of fibre-reinforced composite products	
CO3	Analyse the elastic properties and simulate the mechanical performance of composite laminates; and understand and predict the failure behaviour of fibre-reinforced composites	
CO4	Apply knowledge of composite mechanical performance and manufacturing methods to a composites design project	

Program Outcome of this course

Sl. No.	Description	POs
PO1	An ability to independently carry out research /investigation and development work to solve practical problems pertaining to production engineering.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	An ability to demonstrate a degree of mastery over production engineering, a level higher than the requirements in the undergraduate program of mechanical engineering	
PO4	An ability to identify, critically analyze, formulate and solve manufacturing technology and automation problems to obtain optimal feasible solution considering safety, environment and other realistic constraints.	
PO5	An ability to demonstrate skills in latest engineering tools, software and equipments to analyze and solve complex production engineering problems.	
PO6	An ability to work as an individual and in a team with an understanding of the profession in ethical manner.	
PO7	Apply advanced level knowledge, techniques, skills and modern tools of production engineering.	

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**3**	**3**	**3**	**2**	**2**	**2**
CO2	**3**	**3**	**3**	**2**	**2**	**2**	**1**
CO3	**2**	**2**	**2**	**2**	**2**	**2**	**2**
CO4	**3**	**3**	**3**	**3**	**3**	**3**	**3**

Semester- III

Professional Elective-3			
Organizational Behaviour			
Course Code	22MAU/MPE324	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:
To analyze and compare different models used to explain individual behaviour related to motivation and rewards.

Module-1	
Orgnanizational Behavior – Definition, Need for studying Organizational Behavior, Disciplines involved in the study of Organizational Behavior, -Contributing disciplines and area like psychology, social psychology, economics, anthropology etc. Application of Organizational Behavior in Business. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-2	
Basic Behavioural Process, Cognitive Functions – Intelligence Creativity, Learning and its Process – Attitude and Values, Personality – Concepts counselling – importance and relevance 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-3	
Group Dynamics – Formal and Informal Group, Group Norms, Group Cohesiveness, Group Behaviour and Group Decision – making. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-4	
Motivation and morale, leadership-nature, styles and approaches, development of leadership including laboratory training. Power and Authority – Definition of Power – Types of Power. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation
Module-5	
Management of change- Conflict Management- Organisation Health, Development and Effectiveness. Management of culture, Cross Cultural Management. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

- Organizational Behaviour, Nelson & Quick, Cengage learning.
- Organizational Behaviour, S. Fayyaz Ahamed and others, Atlantic publisher

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Define organisational behaviour, analyse discipline and area of application in business.	5
CO2	Understand personality, interpersonal and intergroup behaviour.	4
CO3	Understand group types, norms and decision making.	5
CO4	Understand nature and development of leadership and types of power.	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	An ability to independently carry out research /investigation and development work to solve practical problems pertaining to production engineering.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	An ability to demonstrate a degree of mastery over production engineering, a level higher than the requirements in the undergraduate program of mechanical engineering	
PO4	An ability to identify, critically analyze, formulate and solve manufacturing technology and automation problems to obtain optimal feasible solution considering safety, environment and other realistic constraints.	
PO5	An ability to demonstrate skills in latest engineering tools, software and equipments to analyze and solve complex production engineering problems.	
PO6	An ability to work as an individual and in a team with an understanding of the profession in ethical manner.	
PO7	Apply advanced level knowledge, techniques, skills and modern tools of production engineering.	

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**3**	**3**	**2**	**2**	**2**	**1**
CO2	**2**	**2**	**2**	**2**	**3**	**3**	**3**
CO3	**2**	**2**	**2**	**2**	**2**	**3**	**3**
CO4	**3**	**3**	**3**	**2**	**2**	**2**	**3**

Semester- III

Professional Elective-3			
INDUSTRIAL ROBOTICS AND EXPERT SYSTEMS			
Course Code	22MAU/MPE325	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:
The goal of this course is for students to understand the methodologies and application of change management and relational 3D CAD product design within the confines of a Product Data Management (PDM) system in PLM environments.

Module-1	
Introduction and Robot Kinematics Definition need and scope of Industrial robots – Robot anatomy – Work volume – Precision movement – End effectors – Sensors. Robot Kinematics – Direct and inverse kinematics – Robot trajectories – Control of robot manipulators – Robot dynamics – Methods for orientation and location of objects. 08Hrs	
Teaching-Learning Process	**Teaching-Learning Process**
Module-2	
Robot sensors Transducers and Sensors – Tactile sensor – Proximity and range sensors – Sensing joint forces – Robotic vision system – Image Representation - Image Grabbing –Image processing and analysis – Edge Enhancement – Contrast Stretching – Band Rationing - Image segmentation – Pattern recognition – Training of	
Teaching-Learning Process	**Teaching-Learning Process**
Module-3	
Robot drives and control Controlling the Robot motion – Position and velocity sensing devices – Design of drive systems – Hydraulic and Pneumatic drives – Linear and rotary actuators and control valves – Electro hydraulic servo valves, electric drives – Motors – Designing of end effectors – Vacuum, magnetic and air operated grippers. Robot Cell Design and Application Robot work cell design and control – Safety in Robotics. 08Hrs	
Teaching-Learning Process	**Teaching-Learning Process**
Module-4	
Methods of Robot Programming Robot Programming, Artificial Intelligence and Expert Systems - Characteristics of task level languages lead through programming methods – Motion interpolation. 08 Hrs	
Teaching-Learning Process	**Teaching-Learning Process**
Module-5	
Artificial intelligence Artificial intelligence – Basics – Goals of artificial intelligence – AI techniques – problem representation in AI – Problem reduction and solution techniques - Application of AI and KBES in Robots 08Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

3. Three Unit Tests each of **20 Marks**
4. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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:

6. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
7. The question paper will have ten full questions carrying equal marks.
8. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
9. Each full question will have a sub-question covering all the topics under a module.
10. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Books

- (1)Computer Integrated Design and Manufacturing - David Bed worth. Mark Henderson &. Philips Wolfe - McGraw Hill Inc
- (2)Visual Modeling with Rational Rose and UML - Terry Quatrain - Addison Wesley

Reference Books

- (1)Wind-chill - RS.O Reference manuals - 2000.

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Explain the concepts, tools and techniques for managing product data.	5
CO2	Analyze various processes in the product data management frameworks.	5
CO3	Evaluate risks in large and complex workflow management environments.	5
CO4	Develop product data management plans for various types of organizations.	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	An ability to independently carry out research /investigation and development work to solve practical problems pertaining to production engineering.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	An ability to demonstrate a degree of mastery over production engineering, a level higher than the requirements in the undergraduate program of mechanical engineering	
PO4	An ability to identify, critically analyze, formulate and solve manufacturing technology and automation problems to obtain optimal feasible solution considering safety, environment and other realistic constraints.	
PO5	An ability to demonstrate skills in latest engineering tools, software and equipments to analyze and solve complex production engineering problems.	
PO6	An ability to work as an individual and in a team with an understanding of the profession in ethical manner.	
PO7	Apply advanced level knowledge, techniques, skills and modern tools of production engineering.	

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**3**	**3**	**32**	**2**	**2**	**1**
CO2	**3**	**3**	**3**	**3**	**3**	**2**	**2**
CO3	**3**	**3**	**3**	**3**	**2**	**3**	**3**
CO4	**3**	**3**	**3**	**3**	**2**	**2**	**1**

Semester- III

Professional Elective 4			
Non-Destructive Testing			
Course Code	22MAU/MPE/MPD331	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:
The student shall be able to find the internal flaws in the material by NDT and take measures to eliminate them.

Module-1	
Introduction: Definition, concept of NDT, comparison between destructive and non destructive testing, purposes of NDT, classification of NDT methods, advantages, disadvantages, application of NDT in industries, visual inspection, pressure and leak testing. Liquid Penetrant Inspection: Basic processing steps of LPI, penetrant testing materials, penetrant dwell time, developers, material smear and its removal, advantages, disadvantages &applications 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2	
Magnetic particle inspection: Basic principle of MPI, Processing steps of MPI, Methods of generating magnetic fields, types of magnetic particles and suspension liquids, advantages, disadvantages and applications. Eddy current inspection: Basic principle of eddy current inspection, operating variables, procedure, inspection coils, and detectable discontinuities by the method of eddy current inspection, advantages, disadvantages and applications. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3	
Ultrasonic inspection: Principle of ultrasonic inspection, basic equipment, characteristics of ultrasonic waves, variables in inspection, inspection methods - scanning systems, pulse echo A-scan, B-scan, and C-scans, contact and immersion methods, transducer elements, couplants, search units, reference blocks, applications.. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4	
Microwave inspection: Principle of microwave inspection, basic equipment & inspection procedure, advantages, disadvantages and applications. Radiography inspection: Principle of radiographic inspection, radiation sources, X-rays and Gamma-rays, X-ray tubes, Radiographic films, screens and filters, image intensifiers, penetrameters, image quality, radiographic sensitivity, neutron radiography, safety aspects related totesting, applications 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5	
Holographic Inspection: Basic principle of optical holography, The basic hologram, recording and reconstruction, interferrometric holography, methods of storing for interferrometric holography, basic principle of acoustic holography, systems and techniques, advantages, disadvantages, and applications of holography. 08 Hrs	
Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module
6.

Suggested Learning Resources:

Books

- Non Destructive Testing - Mc Gonnagle J J – Garden and Reach, New York.
- Non Destructive Inspection and Quality Control – Metals Hand Book Vol.11 American Society of Metals

Reference Books

- The Testing and Inspection of Engineering materials - Davis H.E, Troxel G.E, Wiskovil C.T - McGraw Hill.
- Non Destructive Evaluation and Quality Control - volume 17 of metals hand book 9 edition Asia internal 1989.
- The Testing instruction of Engineering materials - Davis H.E Troxel G.E wiskovil C.T - McGraw hill

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Distinguish the destructive and non-destructive testing and find effectiveness	5
CO2	Find the surface defect using liquid penetrant and magnetic particle test and eddy currenttest	5
CO3	Learn the mechanism of flaw detection using ultrasonic wave system.	4
CO4	Understand the operations of microwave and radiography inspection system	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	An ability to independently carry out research /investigation and development work to solve practical problems pertaining to production engineering.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	An ability to demonstrate a degree of mastery over production engineering, a level higher than the requirements in the undergraduate program of mechanical engineering	
PO4	An ability to identify, critically analyze, formulate and solve manufacturing technology and automation problems to obtain optimal feasible solution considering safety, environment and other realistic constraints.	
PO5	An ability to demonstrate skills in latest engineering tools, software and equipments to analyze and solve complex production engineering problems.	
PO6	An ability to work as an individual and in a team with an understanding of the profession in ethical manner.	
PO7	Apply advanced level knowledge, techniques, skills and modern tools of production engineering.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**3**	**3**	**3**	**3**	**2**	**2**
CO2	**3**	**3**	**3**	**3**	**2**	**2**	**2**
CO3	**3**	**3**	**3**	**2**	**2**	**2**	**1**
CO4	**3**	**3**	**3**	**2**	**2**	**2**	**2**

Semester- III

Professional Elective 4			
Hydraulics and Pneumatics			
Course Code	22MAU/MPD/MPE/MST/MTE/MPE332	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

1. To increase awareness of the need for and role of ergonomics in occupational health.
2. To obtain knowledge in the application of ergonomic principles to design of industrial workplaces and the prevention of occupational injuries
3. To understand the breadth and scope of occupational ergonomics.

Module-1

Introduction to Hydraulic Power and Pumps: review of fluid mechanics, Pascal's Law, structure of hydraulic control system. pumps: pumping theory, pump classification, gear pumps- external and internal type, vane pumps- simple, balanced, pressure compensated types, piston pumps- radial and axial (both swash plate and bent axis type), pump performance. Hydraulic Actuators and Motors: Linear hydraulic actuators - single acting, double acting, tandem cylinder, telescopic rod cylinder, mechanics of hydraulic cylinder loading, cylinder cushioning, hydraulic rotary actuators, hydrostatic transmission – open and close circuit, performance of hydraulic motor. 10Hrs

Teaching-Learning Process	**Teaching-Learning Process**

Module-2
Control Components in Hydraulic Systems: directional control valves (DCV), constructional features, 2/2,3/2,4/2,4/3 DCV, centre configuration in 4/3 DC open, closed, tandem, regenerative, floating centre configuration, actuation of DCVs- manual, mechanical, solenoid, and indirect actuation, relays for the solenoid

Teaching-Learning Process	**Teaching-Learning Process**

Module-3
Hydraulic Circuit Design and Analysis: control of single and double acting hydraulic cylinder, regenerative circuit, counter balance valve application, cylinder sequencing circuits, cylinder synchronizing circuits, speed control of hydraulic cylinder – meter in and meter out, speed control of hydraulic motors, relay circuit design for the operation of solenoid directional control valve- single and double solenoid relay circuit 10Hrs

Teaching-Learning Process	**Teaching-Learning Process**

Module-4
Introduction To Pneumatic Control: choice of working medium, characteristics of compressed air, structure of pneumatic control system , supply, signal generators, signal processor, final control elements , actuators, production of compressed air – compressors - reciprocating and rotary type, preparation of compressed air – driers, filters, regulators, lubricators, distribution of compressed air – piping layout. 10 Hrs

Teaching-Learning Process	**Teaching-Learning Process**

Module-5
Pneumatic Actuators , Valves: linear cylinder – types, conventional type of cylinder – working, directional control valve, shuttle valve, quick exhaust value, twin pressure valve, direct and indirect actuation of pneumatic cylinder, memory valve, time delay valve. Pneumatic circuits and logic circuits: supply air and exhaust air throttling, will dependent circuits, travel dependent controls – types – construction – practical applications, cylinder sequencing circuits, travel step diagrams, practical examples involving two or three cylinders, use of logic functions – OR, AND, NOR, NAND,YES, NOT functions in pneumatic applications, practical examples involving the use of logic functions. 10Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks**or**oneSkill Development Activity of 40 marks**to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module
6.

Suggested Learning Resources:

Books

- S.R.Majumdar-Pnematic System, TMH, 1995
- Antony Esposito, Fluid Power Systems and Control, Prentice Hall,1998
- R.Srinivasan, Hydraulic and Pneumatics control published by Vijay Nicole Imprints Private Ltd.
- Andrew Parr, Hydraulic and Pneumatics, Butterworth-Heinemann
- Herbert R Merritt, Hydraulic control systems, John Wiely& Sons, Newyork,1967.
- Dudbey A Peace, Basic fluid power, Prentice hall Inc,1967.
- Peter Rohner, Fluid power logic circuit design, Macmillan press Ltd, London,1979.
- Peter Rohner, Fluid Power logic circuit design, Mcmelan prem,1994.
- Servo Pneumatics D Schilz A Zimmermann

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understanding the concepts of Industrial design and man-machine relationship.	5
CO2	Design of optimistic display and control devices for various applications	5
CO3	Applying the anthropomorphic data in ergonomic design.	3
CO4	Understanding the visual effects of lines, form and color on engineering equipments.	4

Program Outcome of this course

Sl. No.	Description	POs
PO1	An ability to independently carry out research /investigation and development work to solve practical problems pertaining to production engineering.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	An ability to demonstrate a degree of mastery over production engineering, a level higher than the requirements in the undergraduate program of mechanical engineering	
PO4	An ability to identify, critically analyze, formulate and solve manufacturing technology and automation problems to obtain optimal feasible solution considering safety, environment and other realistic constraints.	
PO5	An ability to demonstrate skills in latest engineering tools, software and equipments to analyze and solve complex production engineering problems.	
PO6	An ability to work as an individual and in a team with an understanding of the profession in ethical manner.	
PO7	Apply advanced level knowledge, techniques, skills and modern tools of production engineering.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**3**	**2**	**2**	**2**	**2**	**3**
CO2	**3**	**3**	**3**	**3**	**3**	**2**	**3**
CO3	**3**	**3**	**2**	**2**	**3**	**1**	**3**
CO4	**3**	**3**	**2**	**2**	**2**	**3**	**1**

Semester- III

Professional Elective 4			
TWO AND THREE WHEELER TECHNOLOGY			
Course Code	22MAU/MPE333	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:
The objective of the Heat treatment and surface finishing engineering course is to provide the students with the necessary fundamentals for understanding the material properties given by the available heat treatment processes.

Module-1

The Power Unit:
Types of engines for two wheelers, advantages and disadvantages of two stroke and four stroke engines, engine components, constructional details, materials, symmetrical and unsymmetrical port timing diagrams, valve Actuating mechanisms, valve timing diagrams. Rotary valve engine, Advantages and disadvantages of diesel engines for two wheelers, power plant for electric bikes, exhaust systems. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Fuel, Lubrication and Cooling system: Layout of fuel supply system, fuel tank construction, carburetor types, construction, working and adjustments. Types of cooling systems, advantages of air cooling system. Lubrication types, Lubrication of parts, grades of lubricating oils. Electrical system: Types of ignition system, their working principles, wiring diagram for Indian vehicles, spark plug construction, indicators and gauges used in two wheelers, lighting systems. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Transmission system: Primary drive and Clutch: Motor cycle power train, Primary drives, Types of primary drives, Chain drive, Gear drive, Construction and operation of motorcycle clutches, Clutch release mechanism. Gear boxes. Transmission: Introduction to motorcycle transmission, Sprockets and chain, Gears and Dogs in motor cycle transmission, Gear and Gear ratios, Sliding gear transmissions, Shifting fork mechanisms, Constant mesh transmissions and lubrication. Final drive: Introduction to motorcycle final drives, Fundamentals of chain drive, Chain lubrication and lubricators, Shaft drives, Drive shaft couplings, Final drive gear case. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Frames and suspension:
Types and constructional details of frames, advantages and limitations, frame materials, frame stresses, frame building problems, frame components, Front and Rear suspension systems, shock absorber construction and working, Panel meters and controls on handle bar, body manufacture and painting.
Brakes and Wheels:
Front and rear braking systems, disc and drum brakes, merits and demerits, Types of wheels, loads on wheels, construction and materials for wheels, wheels designation, tyre designation, inflation, types of tyres, construction details. 08 Hrs

Teaching-	Chalk and talk method / PowerPoint Presentation

Learning Process	

Module-5

Two wheelers and Three wheelers:

Case study of major Indian models of major motor cycles, scooters, scooteretts and mopeds. Case study of Indian models of three wheelers, Front mounted engine and rear mounted engine types, Auto rickshaws, pick up van, delivery van and trailer.

Maintenance:

Importance of maintenance, Decarburizing procedure for engine and silencer, periodic inspection, maintenance schedules, trouble diagnosis charts, safety precautions, Lubrication charts. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

3. Three Unit Tests each of **20 Marks**
4. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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:

7. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
8. The question paper will have ten full questions carrying equal marks.
9. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
10. Each full question will have a sub-question covering all the topics under a module.
11. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

1. Motor cycle engines - P. E. Irving, Temple Press Book, London, 1992
2. Motor cycles -Michel M. Griffin
3. Motor cycle Mechanics - William H. Crouse and Donald L. Anglin, TMH

Reference Books:

1. The cycle Motor manual - Temple Press Ltd, 1990
2. Vespa maintenance and repair series - Bryaut R. V.
3. Encyclopedia of Motor Cycling 20 volumes - Marshall Cavendish, New York., 1989

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Understand the basic concept of coating, plating and metal spray methods inelectroplates.	5
CO2	Understand the mechanism of coating formation and theirproperties.	5
CO3	Test coated and spray metal surfaces using suitable heat treatment methods.	5
CO4	Heat treat gears, spindle and cuttingtools.	3

Program Outcome of this course

Sl. No.	Description	POs
PO1	An ability to independently carry out research /investigation and development work to solve practical problems pertaining to production engineering.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	An ability to demonstrate a degree of mastery over production engineering, a level higher than the requirements in the undergraduate program of mechanical engineering	
PO4	An ability to identify, critically analyze, formulate and solve manufacturing technology and automation problems to obtain optimal feasible solution considering safety, environment and other realistic constraints.	
PO5	An ability to demonstrate skills in latest engineering tools, software and equipments to analyze and solve complex production engineering problems.	
PO6	An ability to work as an individual and in a team with an understanding of the profession in ethical manner.	
PO7	Apply advanced level knowledge, techniques, skills and modern tools of production engineering.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**3**	**3**	**3**	**3**	**2**	**2**
CO2	**3**	**3**	**3**	**2**	**2**	**2**	**3**
CO3	**3**	**3**	**2**	**2**	**3**	**2**	**1**
CO4	**3**	**3**	**3**	**3**	**2**	**2**	**2**

Professional Elective-2			
HYBRID VEHICLE TECHNOLOGIES			
Course Code	22MAU/MDE/MEA/MMD334	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	2:0:2	SEE Marks	50
Total Hours of Pedagogy	25 Hrs+10-12 Activity Sessions	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:
Apply the basic elements of Lean thinking and Agile systems and be able to articulate when each of these approaches is more appropriate to enhance flow in production and supply chain systems.

Module-1

Hybrid Vehicles:
Introduction to HVs, Performance characteristics of road vehicles; calculation of road load, predicting fuel economy, grid -connected hybrids.
05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Hybrid architecture:
Series configuration- locomotive drives, series parallel switching, load tracking architecture. Pre transmission parallel and combined configurations-Mild hybrid, power assist, dual mode, power split, power split with shift,

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Propulsion methods: DC motors-series wound, shunt wound, compound wound and separately excited motors AC motors-Induction, synchronous, brushless DC motor, switched reluctance motors.. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Hybrid power plant specifications: Grade and cruise targets, launching and boosting, braking and energy recuperation, drive cycle implications, engine fraction-engine downsizing and range and performance, usage requirements. Sizing the drive system: Matching electric drive and ICE, sizing the propulsion motor; sizing power electronics05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Energy storage technology: Battery basics; lead-acid battery; different types of batteries; battery parameters, Battery Recycling Fuel cells. 05 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Suggested Learning Resources:

Text Books:

1. The Electric Car: Development & Future of Battery, Hybrid & Fuel-Cell Cars - Mike Westbrook, M H Westbrook, British library Cataloguing in Publication Data.
2. Electric and Hybrid Vehicles- Robin Hardy, Iqbal Husain, CRC Press.
3. Propulsion Systems for Hybrid Vehicles- John M. Miller, Institute of Electrical Engineers, London.

Reference Books:

1. Energy Technology Analysis Prospects for Hydrogen and Fuel Cells, International Energy Agency, France.
2. Handbook of Electric Motors- Hamid A Toliyat, Gerald B Kliman, Marcel Decker Inc.

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars
- Industry or workshop Visit.

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Earn the concepts of Lean, Flexibility, and Agility as applied in automotive manufacturing and supply chain management ·	5
CO2	Learn Strategies/Methodologies relating to such topics as Production Planning and Control, Factory Dynamics·	5
CO3	Learn Best Business Practices in automotive manufacturing and supply chain management ·	5

Program Outcome of this course

Sl. No.	Description	POs
PO1	An ability to independently carry out research /investigation and development work to solve practical problems pertaining to production engineering.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	An ability to demonstrate a degree of mastery over production engineering, a level higher than the requirements in the undergraduate program of mechanical engineering	
PO4	An ability to identify, critically analyze, formulate and solve manufacturing technology and automation problems to obtain optimal feasible solution considering safety, environment and other realistic constraints.	
PO5	An ability to demonstrate skills in latest engineering tools, software and equipments to analyze and solve complex production engineering problems.	
PO6	An ability to work as an individual and in a team with an understanding of the profession in ethical manner.	
PO7	Apply advanced level knowledge, techniques, skills and modern tools of production engineering.	

Mapping of COS and Pos

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**3**	**3**	**3**	**1**	**2**	**3**
CO2	**3**	**3**	**3**	**2**	**2**	**1**	**2**
CO3	**3**	**3**	**3**	**2**	**2**	**2**	**2**

Semester- III

AUTOMOTIVE CONTROL SYSTEM			
Course Code	22MAU/MPE335	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:
To introduce the basic principles and methods of statistical design of experiments.

Module-1

Chassis and Drive Line Control: Components of chassis management system – role of various sensors and actuators pertaining to chassis system – construction – working principle of wheel speed sensor, steering position, tyre pressure, brake pressure, steering torque, fuel level, Engine and vehicle design data Drive Line Control: Speed control – cylinder cut - off technology, Gear shifting control – Traction / braking control, brake by wire – Adaptive cruise control, throttle by wire. Steering - power steering, collapsible and tiltable steering column – steer by wire 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-2

Engine Management System: Basic Engine Operations – Fuel Control, Ignition control, Lambda Control, Idle Speed Control, Knock Control , Open Loop and Closed Loop Control Sensors: Basic sensor arrangement; Types of sensors such as oxygen sensors, Crank angle position sensors, fuel metering/vehicle speed sensors and detonation sensors, altitude sensors, flow sensors, throttle position sensors, solenoids, 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-3

Safety and Security Systems: Airbags, seat belt tightening system, collision warning systems, child Lock, anti-lock braking systems, Vision enhancement – Static and dynamic bending of Head light, road recognition system, Anti-theft technologies, smart card system, number plate coding, central locking system. 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-4

Comfort and Vehicle Control System: Active suspension systems, requirement and characteristics, different types, Vehicle Handling and Ride characteristics of road vehicle, pitch, yaw, bounce control, power windows, adaptive noise control. ABS Control System – Torque Balance at Wheels road contact – Control cycle of ABS System – Advantages – Traction control system Combination of ABS with Traction control system08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

Module-5

Intelligent Transportation System: Traffic routing system - Automated highway systems - Lane warning system – Driver Information System, driver assistance systems - Data communication within the car, Driver conditioning warning - Route Guidance and Navigation Systems – vision enhancement system - In Vehicle Computing – Vehicle Diagnostics system. VANET usage in Automobiles 08 Hrs

Teaching-Learning Process	Chalk and talk method / PowerPoint Presentation

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 50% of the maximum marks. Minimum passing marks in SEE is 40% of the maximum marks of SEE. 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 50% (50 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

1. Three Unit Tests each of **20 Marks**
2. Two assignments each of **20 Marks** or **one Skill Development Activity of 40 marks** to attain the COs and POs

The sum of three tests, two assignments/skill Development Activities, will be **scaled down to 50 marks**

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:

1. The SEE question paper will be set for 100 marks and the marks scored will be proportionately reduced to 50.
2. The question paper will have ten full questions carrying equal marks.
3. Each full question is for 20 marks. There will be two full questions (with a maximum of four sub-questions) from each module.
4. Each full question will have a sub-question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module
6.

Suggested Learning Resources:

Text books:

1. Automotive Control Systems- U. Kiencke, and L. Nielsen, SAE and Springer-Verlag, 2000.
2. Intelligent Vehicle Technologies- LjuboVlacic, Michel Parent, Fumio Harashima, Butterworth- Heinemann publications,Oxford, 2001.

Reference Books:

1. Automotive Mechanics- Crouse, W.H. &Anglin, D.L., Intl. Student edition, 9th edition, TMH, New Delhi, 2002.
2. Understanding Automotive Electronics- William B.Ribbens -5th edition, Butter worth Heinemann Woburn,1998.
3. Automotive HandBook- Bosch, 8th edition, SAE, 2007.

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program

Skill Development Activities Suggested

- Quizzes
- Assignments
- Seminars

Course outcome (Course Skill Set)

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

Sl. No.	Description	Blooms Level
CO1	Plan data collection, to turn data into information and tomake decisions that lead appropriate action.	5
CO2	Apply the methods taught to real lifesituations.	5
CO3	Plan, analyze, and interpret the results ofexperiments	5
CO4	To understand the Orthogonal arrays.	4

Program Outcome of this course

Sl. No.	Description	POs
PO1	An ability to independently carry out research /investigation and development work to solve practical problems pertaining to production engineering.	
PO2	An ability to write and present a substantial technical report/document.	
PO3	An ability to demonstrate a degree of mastery over production engineering, a level higher than the requirements in the undergraduate program of mechanical engineering	
PO4	An ability to identify, critically analyze, formulate and solve manufacturing technology and automation problems to obtain optimal feasible solution considering safety, environment and other realistic constraints.	
PO5	An ability to demonstrate skills in latest engineering tools, software and equipments to analyze and solve complex production engineering problems.	
PO6	An ability to work as an individual and in a team with an understanding of the profession in ethical manner.	
PO7	Apply advanced level knowledge, techniques, skills and modern tools of production engineering.	

Mapping of COS and POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	**3**	**3**	**3**	**2**	**2**	**2**	**1**
CO2	**3**	**3**	**3**	**2**	**2**	**2**	**2**
CO3	**2**	**2**	**2**	**2**	**3**	**3**	**3**
CO4	**3**	**3**	**3**	**3**	**2**	**2**	**2**

Semester- III

PROJECTWORK PHASE–1			
Course Code	22MAU34	CIE Marks	100
Teaching Hours/Week (L:P:SDA)	0:6:0	SEE Marks	--
Total Hours of Pedagogy	--	Total Marks	100
Credits	03	Exam Hours	--

Course Learning objectives:

- Support independent learning.
- Guide to select and utilize adequate information from varied resources maintaining ethics.
- Guide to organize the work in the appropriate manner and present information(acknowledgingthesources)clearly.
- Develop interactive,communication,organisation,timemanagement,andpresentationskills.
- Impart flexibility and adaptability.
- Inspire independent and team working.
- Expand intellectual capacity,credibility,judgement,intuition.
- Adhere to punctuality,setting and meeting deadlines.
- Instil responsibilities to one self and others.
- Train students to present the topic of project work in a seminar without any fear,face audience confidently,enhance communication skill,involve in group discussion to present and exchange ideas.

Project Phase-1 Students in consultation with the guide/s shall carry out literature survey/ visit industries to finalize the topic of the Project. Subsequently, the students shall collect the material required for the selected project, prepare synopsis and narrate the methodology to carry out the project work.

Seminar: Each student,under the guidance of a Faculty,is required to

- Present the seminar on the selected projectorally and/or through power points lides.
- Answer the queries and involve in debate/discussion.
- Submit two copies of the typed report with a list of references.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach highs tandards and become self-confident.

Courseout comes:

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

- Demonstrate a sound technical knowledge of their selected project topic.
- Undertake problem identification,formulation,and solution.
- Design engineering solutions to complex problems utilizing a systems approach.
- Communicate with engineers and the community at large in written an oral forms.
- Demonstrate the knowledge, skills and attitudes of a professional engineer.

Continuous Internal Evaluation

CIE marks for the project report (50 marks), seminar (30 marks) and question and answer (20 marks) shall be awarded(based on the quality of report and presentation skill,participation in the question and answer session by the student)by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

Semester- III

SOCIETAL PROJECT			
Course Code	22MAU35	CIE Marks	100
Teaching Hours/Week (L:P:SDA)	0:6:0	SEE Marks	--
Total Hours of Pedagogy	--	Total Marks	100
Credits	03	Exam Hours	--

Course Learning objectives:

- To support independent learning and innovative attitude.
- To guide to select and utilize adequate information from varied resources upholding ethics.
- To guide to organize the work in the appropriate manner and present information(acknowledging the sources)clearly.
- To develop interactive,communication,organisation,time management, and presentation skills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility, judgement, intuition.
- To adhere to punctuality, setting and meeting deadlines.
- To instill responsibilities to one self and others.
- To train students to present the topic of project work in a seminar without any fear, face audience confidently, enhance communication skill, involve in group discussion to present and exchange ideas.

Societal-Project: Eachstudentoftheprojectbatchshallinvolveincarryingouttheprojectworkjointlyinconstantconsultationwithinternalguide,co-guide,andexternalguideandpreparetheprojectreportasperthenormsavoidingplagiarism.

Course outcomes:

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

- Present the societal –project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving skills.
- Communicate effectively and to present ideas clearly and coherently in both the written and oral forms.
- Work in a team to achieve common goal.

Learn on their own,reflecton their learning and take appropriate actions to improve it.

CIE procedure for Societal - Project:

The CIE marks awarded for Mini-Project, shall be based on the evaluation of Societal- Project Report, Project Presentation skill and Question and Answer session in the ratio 50:25:25.The marks awarded for Societal - Project report shall be the same for all the batch mates.

Semester- III

INTERNSHIP			
Course Code	22MAUI36	CIE Marks	50
Teaching Hours/Week (L:P:SDA)	(06 weeks Internship,To be Completed during the intervening vacation of II and III semesters.)	SEE Marks	50
Total Hours of Pedagogy	--	Total Marks	100
Credits	06	Exam Hours	03

Course Learning objectives:

Internship/Professional practice provide students the opportunity of hands-on experience that include personal training, time and stress management, interactive skills, presentations, budgeting, marketing, liability and risk management, paperwork, equipment ordering, maintenance, responding to emergencies etc. The objective are further,

1. To put theory into practice.
2. To expand thinking and broaden the knowledge and skills acquired through coursework in the field.
3. To relate to, interact with ,and learn from current professionals in the field.
4. To gain a greater understanding of the duties and responsibilities of a professional.
5. To understand and adhere to professional standards in the field.
6. To gain insight to professional communication including meetings,memos,reading,writing,publicspeaking,research,clientinteraction,inputofideas, and confidentiality.
7. To identify personal strengths and weaknesses.
8. To develop the initiative and motivation to be a self-starter and work independently..

Internship/Professionalpractice: Students under the guidance of internal guide/sand externalguide shall take part in all the activities regularly to acquire as much knowledgeaspossiblewithoutcausinganyinconvenienceattheplaceofinternship.

Seminar: Each student, is required to

- Present the seminar on the internship orally and/or through powerpoint slides.
- Answer the queries and involve in debate/discussion.
- Submit the report duly certified by the external guide.

The participants shall take part in discussion to foster friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Course outcomes:

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

- Gain practical experience within industry in which the internship is done.
- Acquire knowledge of the industry in which the internship is done.
- Apply knowledge and skills learned to classroom work.
- Develop a greater understanding about career options while more clearly defining personal career goals.
- Experience the activities and functions of professionals.
- Develop and refine oral and written communication skills.
- Identify areas for future knowledge and skill development.
- Expand intellectual capacity,credibility,judgment,intuition.

Continuous Internal Evaluation

CIE marks for the Internship/Professional practice report (20 marks), seminar (20 marks) and question and answer session (10marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session by the student) by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

Semester End Examination

SEE marks for the internship report (20 marks), seminar (20 marks) and question and answer session (10 marks) shall be awarded(based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University.

4th Semester

PROJECTWORKPHASE-2			
Course Code	22MAU41	CIE Marks	100
Teaching Hours/Week (L:P:SDA)	0:0:8	SEE Marks	100
Total Hours of Pedagogy	--	Total Marks	200
Credits	18	Exam Hours	03

Courseobjectives:

- To support independent learning.
- To guide to select and utilize adequate information from varied resources maintaining ethics.
- To guide to organize the work in the appropriate manner and present information (acknowledging the sources)clearly.
- To develop interactive,communication,organisation,timemanagement,andpresentationskills.
- To impart flexibility and adaptability.
- To inspire independent and team working.
- To expand intellectual capacity, credibility,judgement,intuition.
- To adhere to punctuality,setting and meeting deadlines.
- To in still responsibilities to one self and others.
- To train students to present the topic of project work in a seminar without anyfear,face audience confidently,enhance communication skill,involve ingroup discussion to present and exchange ideas.

Project Work Phase - II: Each student of the project batch shall involve in carrying out the project work jointly inconstant consultation with internal guide, co-guide, and external guide and prepare the project report as per the norms avoiding plagiarism.

Course outcomes:

At the end of the course the student will be ablet o:

- Present the project and be able to defend it.
- Make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
- Habituated to critical thinking and use problem solving kills
- Communicateeffectivelyandtopresentideasclearlyandcoherentlyinboththewrittenandoralforms.
- Work in a team to achieve common goal.
- Learn on their own,reflecton their learning and take appropriate actions to improve it

Continuous Internal Evaluation:

Project Report: 50 marks. The basis for awarding the marks shall be the involvement of the student in the project and in the preparation of project report. To be awarded by the internal guide in consultation with external guide if any.

Project Presentation:30marks.

The Project Presentation marks of the Project Work Phase -II shall be awarded by the committee constituted for the purpose by the Head of the Department. The committee shall consist of three faculty from the department with the senior most acting as the Chairperson.

Question and Answer: 20marks.

The student shall be evaluated based on the ability in the Question and Answer session

Semester End Examination

SEE marks for the project report (50 marks), seminar (30 marks) and question and answer session (20 marks) shall be awarded (based on the quality of report and presentation skill, participation in the question and answer session) by the examiners appointed by the University.