AC- 29/06/2021
Item No.- 6.10

UNIVERSITY OF MUMBAI

Bachelor of Engineering

in

Automobile Engineering

Third Year with Effect from AY 2021-22

(REV- 2019 'C' Scheme) from Academic Year 2019 – 20

Under

FACULTY OF SCIENCE & TECHNOLOGY

(As per AICTE guidelines with effect from the academic year 2019–2020)

Syllabus for Approval

Sr. No.	Heading	Particulars
1	Title of the Course	**Third Year B.E. in Automobile Engineering**
2	Eligibility for Admission	**After Passing Second Year Engineering as per the Ordinance 0.6243**
3	Passing Marks	**40%**
4	Ordinances / Regulations (if any)	**Ordinance 0.6243**
5	No. of Years / Semesters	**8 semesters**
6	Level	~~P.G.~~ **/ U.G./** ~~Diploma / Certificate~~ (Strike out which is not applicable)
7	Pattern	~~Yearly~~ **/ Semester** (Strike out which is not applicable)
8	Status	~~New~~ **/ Revised** (Strike out which is not applicable)
9	To be implemented from Academic Year	**2021-2022**

Date

Dr. S. K. Ukarande
Associate Dean
Faculty of Science and Technology
University of Mumbai

Dr Anuradha Muzumdar
Dean
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University of Mumbai

Preamble

To meet the challenge of ensuring excellence in engineering education, the issue of quality needs to be addressed, debated and taken forward in a systematic manner. Accreditation is the principal means of quality assurance in higher education. The major emphasis of accreditation process is to measure the outcomes of the program that is being accredited. In line with this Faculty of Science and Technology (in particular Engineering) of University of Mumbai has taken a lead in incorporating philosophy of outcome based education in the process of curriculum development.

Faculty resolved that course objectives and course outcomes are to be clearly defined for each course, so that all faculty members in affiliated institutes understand the depth and approach of course to be taught, which will enhance learner's learning process. Choice based Credit and grading system enables a much-required shift in focus from teacher-centric to learner-centric education since the workload estimated is based on the investment of time in learning and not in teaching. It also focuses on continuous evaluation which will enhance the quality of education. Credit assignment for courses is based on 15 weeks teaching learning process, however content of courses is to be taught in 12-13 weeks and remaining 2-3 weeks to be utilized for revision, guest lectures, coverage of content beyond syllabus etc.

There was a concern that the earlier revised curriculum more focused on providing information and knowledge across various domains of the said program, which led to heavily loading of students in terms of direct contact hours. In this regard, faculty of science and technology resolved that to minimize the burden of contact hours, total credits of entire program will be of 171, wherein focus is not only on providing knowledge but also on building skills, attitude and self learning. Therefore in the present curriculum skill based laboratories and mini projects are made mandatory across all disciplines of engineering in second and third year of programs, which will definitely facilitate self learning of students. The overall credits and approach of curriculum proposed in the present revision is in line with AICTE model curriculum.

The present curriculum will be implemented for Second Year of Engineering from the academic year 2020-21. Subsequently this will be carried forward for Third Year and Final Year Engineering in the academic years 2021-22, 2022-23, respectively.

Dr. S. K. Ukarande	Dr Anuradha Muzumdar
Associate Dean	Dean
Faculty of Science and Technology	Faculty of Science and Technology
University of Mumbai	University of Mumbai

Incorporation and implementation of Online Contents from NPTEL/ Swayam Platform

The curriculum revision is mainly focused on knowledge component, skill based activities and project based activities. Self learning opportunities are provided to learners. In the revision process this time in particular Revised syllabus of ‘C ‘ scheme wherever possible additional resource links of platforms such as NPTEL, Swayam are appropriately provided. In an earlier revision of curriculum in the year 2012 and 2016 in Revised scheme ‘A' and ‘B' respectively, efforts were made to use online contents more appropriately as additional learning materials to enhance learning of students.

In the current revision based on the recommendation of AICTE model curriculum overall credits are reduced to 171, to provide opportunity of self learning to learner. Learners are now getting sufficient time for self learning either through online courses or additional projects for enhancing their knowledge and skill sets.

The Principals/ HoD’s/ Faculties of all the institute are required to motivate and encourage learners to use additional online resources available on platforms such as NPTEL/ Swayam. Learners can be advised to take up online courses, on successful completion they are required to submit certification for the same. This will definitely help learners to facilitate their enhanced learning based on their interest.

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Preface

Engineering education in India, in general, is being revamped so as to impart the theoretical knowledge along with industrial exposure. It is our attempt, when we are introducing a new curriculum; to bridge the industry-academia gap. To enable this, we have introduced components such as skill-based laboratories and project-based learning. We trust that this will allow the learner to apply knowledge gained in previous and current semesters to solve problems for gaining better understanding. What once were pure mechanical systems have now been transformed into multidisciplinary systems of mechatronics, electronics and computer science. Interdisciplinary knowledge is gaining importance as we are moving towards automated world as technology advances. Keeping this in mind the curriculum has been designed in a way so that learner shall be acquainted with many Interdisciplinary subjects.

Automobile Engineering is one of the fastest growing sectors, with lots of inventions and innovations happening. The graduating Automobile Engineers can contribute in the areas such as engines, transmission, safety and stability, energy and alternate energy etc. The challenges for our budding engineers would be manifold, when electric vehicles are already gaining popularity and driverless cars becoming a reality.

Engineers develop new technological solutions. During the engineering design process, the responsibilities of the engineer may include defining problems, conducting and narrowing research, analyzing criteria, finding and analyzing solutions, and making decisions. The Program Educational Objectives proposed for the undergraduate program in Automobile Engineering are listed below;

1. To prepare the stake holder to exhibit leadership qualities with demonstrable attributes in lifelong learning to contribute to the societal needs.
2. To make ready the stake holder to pursue higher education for professional development
3. To help the stake holder to acquire the analytical and technical skills, knowledge, analytical ability attitude and behavior through the program
4. To prepare the stakeholders with a sound foundation in the mathematical, scientific and engineering fundamentals
5. To motivate the learner in the art of self-learning and to use modern tools for solving real life problems and also inculcate a professional and ethical attitude and good leadership qualities
6. To Prepare the stake holder to able to Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

We trust this revised version of syllabus come up to the expectations of all stakeholders. We wish to place on record our sincere thanks and appreciations to the various contributors from the academia and industry for their most learned inputs in framing this syllabus.

Board of Studies in Mechanical Engineering

Dr. Vivek K. Sunnapwar : Chairman
Dr. S. M. Khot : Member
Dr. V. M. Phalle : Member
Dr. Siddappa Bhusnoor : Member
Dr. S.S. Pawar : Member
Dr. Sanjay U. Bokade : Member
Dr. Dhanraj Tambuskar : Member

Semester VI

Course Code	Course Name	Teaching Scheme (Contact Hours)		Credits Assigned		
		Theory	Pract. Tut.	Theory	Pract.	Total
AEC601	Automotive System Design	4	--	4	--	4
AEC602	Mechanical Vibrations	3	--	3		3
AEC603	Vehicle Body Engineering and Safety	3	--	3	--	3
AEC604	Automation and Artificial Intelligence #	3	--	3	--	3
AEDLO602X	Department Optional Course – 2#	3	--	3	--	3
AEL601	Automotive System Design	--	2	--	1	1
AEL602	Mechanical Vibrations	--	2	--	1	1
AEL603	Vehicle Body Engineering and Safety	--	2	--	1	1
AESBL601	Measurements & Automation #	--	4	--	2	2
AEPBL601	Mini Project – 2 B	--	4$	--	2	2
Total		**16**	**14**	**16**	**07**	**23**

Course Code	Course Name	Examination Scheme							
		Theory					Term Work	Prac/oral	Total
		Internal Assessment			End Sem Exam	Exam. Duration (in Hrs)			
		Test 1	Test 2	Avg					
AEC601	Automotive System Design	20	20	20	80	3	--	--	100
AEC602	Mechanical Vibrations	20	20	20	80	3	--	--	100
AEC603	Vehicle Body Engineering and Safety	20	20	20	80	3	--	--	100
AEC604	Automation and Artificial Intelligence #	20	20	20	80	3	--	--	100
AEDLO602X	Department Level Optional Course – 2#	20	20	20	80	3	--	--	100
AEL601	Automotive System Design	--	--	--	--	--	25	25	50

AEL602	Mechanical Vibrations	--	--	--	--	--	25	--	25
AEL603	Vehicle Body Engineering and Safety	--	--	--	--	--	25	25	50
AESBL601	Measurements & Automation #	--	--	--	--	--	25	25	50
AEPBL601	Mini Project – 2 B	--	--	--	--	--	25	25	50
Total		**--**	**--**	**100**	**400**	--	**125**	**100**	**725**

Department Level Optional Course – 2

Course Code	**Department Level Optional Course – 2**
AEDLO6021	Press Tool Design#
AEDLO6022	Tool Engineering#
AEDLO6023	Metal Forming Technology#

$ indicates work load of Learner (Not Faculty), for Mini Project
 # indicates common with Mechanical Engineering

Note: Students are required to undergo Internship (Garage Training) of minimum 4 weeks in vacation of Semester VI.

Course Code	Course Name	Credits
AEC 601	**Automotive Systems & Design**	**04**

Objectives:

1. To study the basics of automotive systems and subsystems.
2. To study working of different automotive systems and subsystems.
3. To study different types of vehicle layout.
4. To have a basic idea about how automotive systems are designed.

Outcomes: Learner will be able to…

1. Identify different Automotive systems and components.
2. Compare different types of Automotive systems and components.
3. Understand the working of different types of Automotive systems and components
4. Apply knowledge of Engineering Mechanics and Strength of materials to design different Automotive systems and components.
5. Select materials for different Automotive systems and components for designing.
6. Design the different Automotive systems and components by using a data book.

Module	Details	Hours
1.	**Frame-**Different types of Layouts **Design of Engine Components-**Types of Piston and Cylinder Liners,Types of Connecting Rod(Only Barrel Type) and Types of Crankshaft(Only Centered type)	**08**
2.	**Automotive Clutches and Transmission-** Necessity of clutch in a automobile, Working and Construction of Single plate,Multi-plate,Centrifugal,Semi Centrifugal, Electromagnetic clutches, Fluid Flywheel,Torque Converter Purpose and Elements of Gear Box, Characteristic Curves, Types-Sliding mesh, Constant Mesh, Synchromesh, Wear and thermal consideration. **Epicyclic Gearboxes used in automatic transmissions-** Principle of Planetary gear trains, Continuously Variable Transmission-Types and Operation of typical CVT **Design of Gearbox-**Constant Mesh	**12**

3.	**Drive Line**: UV joint, CV joint, Propeller Shaft construction and arrangement, Elements of drive line, 2WD, 4WD, Part time and Full time 2WD and 4WD.Driving thrust and its effects, Torque reaction and Side thrust, Hotchkiss drive, Torque tube drive, Radius rods, Stabilizers **Final Drive** –Types of Final drive,Loads acting on Front and Rear axles,Types of Front Axles and Stub axles. **Differential** –Principle, Constructional details of Differential unit,Housing,Non slip differential and differential locks types- **Design of Drive Line-**Design of propeller shaft and Axles	**08**
4.	**Steering**-Introduction to steering systems, Manual Steering, Ackerman and Davis Steering Mechanisms, Steering Linkages Different types of Steering gear boxes,Power steering systems, Front End Wheel Geometry.	**04**
5.	**Brakes**- Introduction to Brake System, Components of Brake System,Mechanical Brakes, Hydraulic Brake, Air Brake, Anti Lock Brake System, Braking Analysis,Materials for Brake Lining. **Design of Brakes-**Stopping Distance,Energy Absorbed by a Brake, Heat to be dissipated during Braking.	**08**
6.	**Suspension**- Introduction to Suspension System, Components of Suspension System, Dependent and Independent Suspension and Types,Types of Suspension Springs-Single leaf, Multi Leaf spring, Coil, Torsion Bar, Rubber, Pneumatic and Hydro elastic suspension spring systems. **Wheels and Tyres**- Tire requirement, tire characteristics, Constructional detail, tire dimensions and specifications, Types of wheels and Hubs.	**08**

Assessment:

Internal Assessment for 20 marks: Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I). Duration of each test shall be one hour.

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks

2. Question 1 will be compulsory and should cover maximum contents of the curriculum covered in Theory and Laboratory.

3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3) covering contents of the curriculum covered in Theory and Laboratory.

4. Only Four questions need to be solved.

Text Books:

1. Newton, Steed & Garrett, Motor Vehicles, Butterworth Heinemann.

2. N. K. Giri, Automotive Mechanics, Khanna Publishers.

3. D. Crolla, D. E. Foster, T. Kobayashi and N. Vaughan (Editors-in-Chief), Encyclopedia of Automotive Engineering, Parts 1-6, Wiley, 2015.

4. Design of machine elements - V. B. Bhandari Tata McGraw Hill Pub.

5. Recommended Data Books – PSG , K. Mahadevan,Kale Khandare

6. Gear Design Handbook - GitinMaitra

Reference Books:

1. Crouse. W. H, Automotive Chassis and Body, McGraw Hill New York.

2. Jack Erjavec, Automotive Technology – A systems approach, Cengage Learning.

3. M. J. Nunny, Automotive Technology, SAE Publication.

NOTE:

Use of standard design data books like PSG Data Book, Design Data by Mahadevan, and Design data by Kale Khandhare is permitted at the examination and shall be supplied by the institute.

Links for Online NPTEL/SWAYAM Courses:

1.https://onlinecourses.nptel.ac.in/noc20_me18/preview

2.https://nptel.ac.in/courses/112/105/112105124/

3.https://nptel.ac.in/courses/112/105/112105219/

Course Code	Course Name	Credits
AEC602	**Mechanical Vibrations**	**03**

Objectives:

1. To study the basic concepts of vibration analysis.

2. To estimate the natural frequency/frequencies of vibration systems in free vibration, using both exact and numerical methods.

3. To estimate the response of 1 degree of freedom under forced vibration.

4. To acquaint with the basic principles of vibration measuring instruments.

5. To study the balancing of rotating and reciprocating mass systems.

Outcomes: Learner will be able to...

1. Develop mathematical models to represent dynamic system.

2. Estimate natural frequency of mechanical system using various methods.

3. Analyze vibratory response of mechanical system under forced vibration.

4. To estimate the natural frequencies and mode shapes of multi-degree of freedom system, using both exact and numerical methods.

5. Balance an existing unbalanced system partially/completely.

Module	Details	Hours
01	**1.1 Basic Concepts of Vibrations:** Vibration and oscillation, causes and effects of vibrations, vibration parameters—spring, mass and damper, minimum number of parameters required for vibration to occur, vibration terminology, classification of vibrations, steps involved in vibration analysis. **1.2 Free Undamped Single Degree of Freedom Vibration Systems:** Methods to formulate differential equation—Newton's method or D'Alembert's principle, and Energy methods—Based on conservation of total energy, Rayleigh's energy method, Lagrange's energy method, equivalent system method. Springs in series and parallel combination, inclined spring, effect of spring's own mass to	**07**

	calculate natural frequency of system. Application of these methods in longitudinal, transverse and torsional single degree of freedom vibration systems, or a combination of these.	
02	**2.1 Free Damped Single Degree of Freedom Vibration Systems:** Need of damping in vibration systems, introduction to damper models—viscous, Coulomb (dry friction), slip/interfacial, solid/structural/hysteresis damping (Note: only basic introduction to slip and solid dampings, no calculations expected). Viscous damping—Derivation of differential equation of motion, derivation of solution (response) equations, damping ratio or damping factor, critical damping coefficient, underdamped, critically damped and over damped systems. Logarithmic decrement, Work done by viscous damper, inclined damper, dampers in series and parallel combinations. Coulomb/dry-friction damping—derivation of differential equation, number of cycles covered by the mass to stop once disturbed (disturbance in the form of initial displacement only), comparison of viscous and Coulomb dampings.	**08**
03	**3.1 Free Undamped Multi Degree of Freedom Vibration Systems:** Exact methods for derivation of differential equations of motion for multi degree of freedom systems—Newton method and Lagrangian energy method, matrix analysis to estimate eigenvalues and eigenvectors & hence natural frequencies and mode shapes for multi-mass undamped vibration systems (limited to 2 degree of freedom only), Holzer's method for longitudinal and torsional unbranched vibration systems, Dunkerley's and Rayleigh's methods for estimating fundamental frequency of tranverse vibration of simply supported and cantilever beams (up to a maximum of 4 point loads only), influence coefficients and Maxwell's reciprocal theorem.	**07**
04	**4.1 Forced Single Degree of Freedom Vibration Systems:** Analysis of linear and torsional systems subjected to harmonic excitation in terms of force and motion (viscous damping only), force isolation and transmissibility, isolators and mounts. **4.2 Vibration Measuring Instruments:** Principle of seismic instruments, vibrometer, accelerometer, velometer—with and without measurement errors. Principle of frequency-measuring instruments, Fullarton's tachometer and Frahm's reed tachometer.	**07**
05	**5.1 Balancing of Rotating Masses:**	**07**

	Static and dynamic balancing of multi-rotor system. **5.2 Balancing of Reciprocating Masses:** Approximate analytical method for finding acceleration of reciprocating piston (mass of connecting rod and crank neglected), primary and secondary unbalanced forces, inline engine, direct and reverse crank method.	
06	**6.1 Whirling of Shafts / Rotor Dynamics / Critical Speed:** Critical speed of a single rotor—undamped and damped.	**03**

Theory Examination:

Internal Assessment (20 marks):

Consisting of **2 compulsory class tests.**

First test based on initial 40% of the content, and second test based on remaining content (but excluding contents covered in Test-1).

End Semester Examination (80 marks):

Weigtage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.

i. Question paper will comprise of total six questions.

ii. All questions carry equal marks.

Iii. Questions will be mixed in nature (for example Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

iv. Only four questions need to be solved.

Term Work (25 marks):

This shall consist of a file submission that includes **laboratory work (10 marks)**, **assignments (10 marks),** and **attendance in theory and practicals (rounded off to 5 marks)**.

Viva -voce (Orals) and Practical Examination (25 marks):

Viva-voce (Orals) and Practical Examination shall be conducted in the presence of one Internal Examiner (from parent college) and one External Examiner (from other college/industy expert), and marks should be allotted as per the following scheme:

(i) Viva-voce (Orals): 10 marks

(ii) Practical : 15 marks

Links for online NPTEL/SWAYAM courses:

1. https://nptel.ac.in/courses/112/107/112107212/

2. https://nptel.ac.in/courses/112/103/112103112/

3. https://nptel.ac.in/courses/112/103/112103111/

4. https://nptel.ac.in/courses/112/107/112107087/

Text/Reference Books:

1. Mechanical Vibrations 4th ed- S. S. Rao - Pearson Education
2. Mechanical Vibrations - G. K. Grover
3. Fundamentals of Mechanical Vibration - S.Graham Kelly - Tata McGraw Hill 4.
4. Vibration Analysis - P. Srineevasan - Tata McGraw Hill
5. Mechanical Vibrations - Schaum's outline series - S.Graham Kelly- McGraw Hill
6. Mechanical Vibrations - Schaum's outline series - William W. Seto- McGrmvHill .Theory and Practice of mechanical vibrations - J. S. Rao, K. Gupta - New Age International Publications.
7. Mechanical Vibrations - Den; Chambil, Hinckle
8. Mechanical Vibrations, J.P. Den Hartog, McGrawhill Book Company Inc.
9. Leonard Meirovitch, Introduction to Dynamics and Conti'oJ. Wiley, New York,
10. Leonard Meirovitch, Elements of Vibration Analysis. McGrmv-Hill, New York,
11. Leonard Meirovitch, Dynamics and Control of Structures. Wiley, New York. 4. Antony J. Pettofrezzo,
12. Matrices and Transformations. Dover, New York.
13. Benson H. Tongue, Principles of Vibration. Oxford University Press.
14. W. Thomson, Theory of Vibrations with Applications, Second Edition, Pearson Education
15. Vibrations-BalakumarBalachandan, Edward Magrab, CENGAGAE Learning.

Course Code	Course Name	Credits
AEC603	**Vehicle Body Engineering and Safety**	**03**

Objectives:

1. To Understand fundamentals of Vehicle Body design.
2. To Study different vehicle structural design and their requirements.
3. To Study various static and dynamics load acting on the vehicle.
4. To familiarize with basic concepts of vehicle safety.
5. To study safety features and safety regulations.

Outcomes: Learner will be able to…

1. Illustrate different types of Vehicle structures.
2. Comprehend various loads acting on vehicle body.
3. Classify different materials related to vehicle body.
4. Discuss Aerodynamic concept related to vehicle body.
5. Comprehend Vehicle design from safety point of view.
6. Enumerate interrelation ship among occupant, restraint systems and vehicles in accidents.

Module	Details	Hrs.
01	**1.1 Vehicle Chassis:** Introduction, functions and design considerations, Chassis frame components, Sections used, types of frames. Location of different chassis components, exterior and interior trims, Location of power plant. structure types: Open, Semi integral and Integral bus structure **1.2 Vehicle Body:** Introduction, Classification of vehicle based on body types, Requirements of body, Loads on the vehicle body. **1.3 Vehicle body materials** Introduction to materials used in vehicle body building (Steel sheet, timber, plastics, aluminium alloy, glass, Ultralight Steel Auto Body (ULSAB), FRP, GRP etc., properties of materials-Corrosion anticorrosion methods, selection of paint and painting process)	**08**

02	**2.1 Visibility:** Regulations, driver's visibility, Methods of improving visibility. Bus Floor height, engine location, entrance and exit location, seating dimensions. Driver cabin design. **2.2 Structural surface:** Terminology and overview of structural surface types, Vehicle structure analysis by simple structural surface (SSS) Method. Thin Walled Structures-General Principle, Torsion, Torsion centre, Forces in End Load Carrying Members. **2.3 Overall Criteria for Vehicle Comparison:** Design, Running costs, Overall Design Efficiency. **2.4 Aerodynamics:** Objectives, Various types of forces and moments, body optimization techniques for minimum drag.	**08**
03	**3.1 Preliminary design:** Drawing of the preliminary design, Vehicle Body Weight Analysis, Calculation of C.G for Vehicle, Master Model. **3.2 Body Loads:** Bending, Torsion, Lateral and Braking and Acceleration Load Cases. Idealized structure, Structural surface, Shear panel method, Symmetric and asymmetric vertical loads in a car, Longitudinal load, Different loading situations.	**07**
04	**4.1 Vehicle safety** : Introduction, energy equation, types of vehicle collision, Types of safety (Active and Passive). **4.2 Basic concepts of vehicle safety** Fail-safe, Alternative design, Redundancy and derating, Fault tolerance, Universal design. **4.3 Design of seat:** Design and requirement of Driver, Passenger and child seat**,** Occupant Protection, Biomechanics and Occupant Simulation. Role of seat and seat belt in vehicle crash.	**07**
05	**5.1 Crash Testing:** Introduction, Crash testing methods, vehicle body testing, Dynamic Vehicle Simulation, Pedestrian Protection. **5.2 Body repair techniques:** Introduction, tools, repairs procedure.	**06**

06	**6.1 Passive Safety Features** Air bags, Crumple zone, bumper design for safety**.** **6.2 Active Safety Features** Anti-lock braking system, Electronic Stability Control (ESP), Collision warning system, adaptive cruise control. **6.3 Overview of Vehicle Scrapping Policy in India, Scrapping Methodology.** **6.4 Introduction to automotive standards (AIS, FMVSS, CMVR/CMVSS).**	**05**

Theory Examinations:

Internal Assessment for 20 marks:

Consisting **two compulsory class tests**

First test based on initial 40% of the content and second test based on remaining content (but excluding contents covered in Test I).

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the syllabus.

i. Question paper will comprise of total six questions.

ii. All questions carry equal marks.

iii. Questions will be mixed in nature (for example Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)

iv. Only four questions need to be solved.

Text/Reference Books:

1. John Fenton, “Vehicle Body Layout & Analysis”, Hutchinson, London.
2. J Powloski, “Vehicle Body Engineering”, Business Books Ltd., London.
3. J.G. Giles, “Body Construction and Design”, Vol. 6. llefe Books/Butterworth & Co. London
4. P. L. Kohli, “Automotive Chassis & Body”, Papyrus Publishing House, New Delhi.
5. John Fenton, “Handbook of Automotive Body Construction and Design Analysis” Professional Engineering Publishing.
6. Automotive vehicle safety by George Peters and Barbara Peters, CRC Press, 2002.
7. Role of the seat in rear crash safety by David C. Viano, SAE International, 2002.
8. Automotive Safety Handbook by Ulrich W. Seiffert and LotharWech, SAE International, 2007.
9. Public Safety Standards of the Republic of India

Links for online NPTEL/SWAYAM courses:

1. https://nptel.ac.in/courses/107/103/107103084/
2. https://nptel.ac.in/courses/107/106/107106080/

Course Code	Course Name	Credits
AEC604	**Automation and Artificial Intelligence**	**03**

Objectives:

1. To understand the need and justification of automation.
2. To study design of pneumatic and hydraulic circuits.
3. To study and understand electropneumatic circuits and PLC Design
4. To familiarize with robotic systems in automated manufacturing processes.
5. To study and understand AI and machine learning technologies for automation.

Outcomes: Learner will be able to…

1. Demonstrate understanding of fundamentals of industrial automation and AI.
2. Design & develop pneumatic / hydraulic circuits.
3. Design and develop electropneumatic circuits and PLC ladder logics.
4. Demonstrate understanding of robotic control systems and their applications.
5. Demonstrate understanding of various AI and machine learning technologies.

Module	Details	Hrs
1	**1.1 Introduction to Automation** Definition and fundamentals of automation, Elements of Automated system, Automation principles and strategies, Levels of automation, types of automation, Advanced automation functions **1.2 Introduction to Artificial Intelligence** Introduction, Historical development, Intelligent Systems, Types of Intelligent Agents, Components of AI, Foundations of AI, Scope of AI, Current trends in AI, Relevance to Mechanical Engineering	**04**
2	**2.1 Design of Pneumatic Circuits** Design of Pneumatic sequencing circuits using Cascade method and Shift register method (up to 2 cylinders) **2.2 Design of Hydraulic Circuits** Basic Hydraulic Circuits: Meter in, meter out and Bleed off circuits; Intensifier circuits, Regenerative Circuit, Counter balance valve circuit and sequencing circuits.	**08**
3	**3.1 Electro-pneumatic Circuits** Design of Electro-Pneumatic Circuits using single solenoid and double solenoid valves; with and without grouping; **3.2 PLC Discrete Control Systems** Design of Pneumatic circuits using PLC Control (ladder programming only) up to 2 cylinders, with applications of Timers and Counters and concept of Flag and latching.	**08**
4	**Robots and their applications**: Introduction to Robots, Types,	**07**

	Classifications, Selection of Robots, Robot Degrees of freedom, Robot configuration, Accuracy and repeatability, Specification of a Robot, Robot feedback controls: Point to point control and Continuous path control, Control system for Robot joint, Adaptive control, Drives and transmission systems, End effectors, Industrial robot applications, Nex-gen robots.	
5	**(Concept and Algorithms, No programming or numericals)** **5.1 Problem Solving:** Tree and Graph Search, Uninformed v/s informed search, uninformed methods: depth first search, breadth first search, Informed search: heuristic search, Best first search, branch and bound **5.2 Machine Learning:** Introduction, types of machine learning: supervised, unsupervised, reinforcement learning **5.3 Learning with Decision Trees:** Introduction to Decision Trees, Classification and Regression Trees, K means clustering algorithm, K nearest neighbours algorithm, hierarchical clustering, Concept of ensemble methods: bagging, boosting, random forests	**06**
6	**(Concept and Algorithms, No programming or numericals)** **6.1 Learning with regression:** Linear regression, Logistic regression **6.2 Artificial Neural Networks** Concept of ANN, Basic Models of Artificial Neural Networks Important Terminologies of ANNs McCulloch-Pitts Neuron, NN architecture, perceptron, delta learning rule, backpropagation algorithm, Gradient Descent algorithm, feed forward networks, activation functions **6.3 Introduction to AI Technologies in the realm of Automation** Concept of Natural Language Processing, Machine Vision, Deep learning, Expert systems, Genetic Algorithms, Industry 4.0	**06**

Assessment:

Internal Assessment for 20 marks:

Consisting**Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total **six questions, each carrying 20 marks**

2. **Question 1** will be **compulsory** and should **cover maximum contents of the curriculum**
3. **Remaining questions will be mixed in nature** (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only **Four questions need to be solved**

Text/Reference Books:

1. Applied Mechatronics- A. Smaili and F. Mrad, OXFORD university press
2. Mechatronics System Design , Shetty and Kolk, Cengage Learning, India Edition
3. Mechatronics - Electronic Control Systems in Mechanical Engineering , Bolton Pearson eduaction
4. Introduction to Mechatronics, AppuKuttan K.K., OXFORD Higher Education
5. Pneumatic Circuits and Low Cost Automation by Fawcett JR
6. Electromechanical Design Handbook , Walsh, McGraw-Hill
7. Electro-mechanical Engineering - An Integrated Approach , Fraser and Milne
8. Industrial Hydraulics: Pippenger
9. Vickers Manual on Hydraulics
10. Hydraulic Valves and Controls: Pippenger
11. Fundamentals of pneumatics: Festo series
12. Mechatronics, NitaigourMahalik, Tata McGraw-Hill
13. Mechatronics, HMT
14. M.P.Groover "Automation, Production Systems and Computer Integrated Manufacturing", Pearson Education,New Delhi
15. M.P. Groover, M. Weiss, R.N. Nagel, and N.G. Odrey, "Industrial Robotics Technology programming and Applications", McGraw-Hill,
16. Yoram Korean, "Robotics for engineers", McGrew Hill Co
17. John W Webb and Reis, Ronald A., "Programmable Logic Controllers: Principles & Applications", Prentice Hall.
18. Frank Petruzella," Programmable Logic Controllers", McGraw-Hill Education; 4 edition
19. Artificial Intelligence: A Modern Approach by Peter and Norvig ISBN-0-13103805-2,
20. Artificial Intelligence by Elaine Rich, Kevin Knight and Nair ISBN-978-0-07008770-5, TMH,
21. Artificial Intelligence by Saroj KausikISBN:- 978-81-315-1099-5, Cengage Learning
22. Artificial Intelligence and Intelligent Systems by Padhy, Oxforfd University Press,
23. Artificial Intelligence & Machine Learning by Vinod Chandra .S.S. Anand Harindran. S. (PHI)
24. A first course in Artificial Intelligence – By Deepak Khemani. Mc GrawHill

Links for online NPTEL/SWAYAM courses:
https://nptel.ac.in/courses/112/103/112103174/
https://nptel.ac.in/courses/112/103/112103293/
https://nptel.ac.in/courses/112/102/112102011/
https://nptel.ac.in/courses/112/101/112101098/
https://nptel.ac.in/courses/112/103/112103280/
https://nptel.ac.in/courses/106/106/106106139/

Course Code	Course Name	Credit
AEDLO6021	**Press Tool Design**	**03**

Objectives:

1. To acquaint with various press working operations for mass production of sheet metal components
2. To familiarise with sheet metal working techniques for design of press tools
3. To inculcate knowledge about scrap minimization, safety aspects and automation in press working

Outcomes: Learner will be able to…

1. Demonstrate various press working operations for mass production of sheet metal parts
2. Identify press tool requirements to build concepts pertaining to design of press tools
3. Prepare working drawings and setup for economic production of sheet metal components
4. Select suitable materials for different elements of press tools
5. Illustrate the principles and blank development in bent & drawn components
6. understand safety aspects and automation in press working

Module	Details	Hrs
1	**Introduction to Press Working** 1.1 Classification of common Press working operations, Benefits and limitations of using Press tools. Applications of pressed parts/components. 1.2 Theory of Shearing in Press Working. Optimum Cutting clearance & its effect on tolerances of pressed components. Press working terminology, Functions of different elements of a press tool. material handling equipment, Methods of feeding the strip/coil material.	**06**
2	**Design Progressive die** 2.1 Calculations for Economic Strip Layout, Calculations of Cutting force and Stripping force, recommending minimum tonnage of a press, Methods of reducing cutting loads on press tools 2.2 Design aspects of Press tool elements viz. Punches & methods of mounting punches, types of Die block, Stripper, Pilot, stock guides, stock stops, Selection and arrangement of Hardware used in Press tools. Selection of steels and its hardness for different elements of Press tools. 2.3 Centre of pressure, Different types Die sets and its selection, shut height of die, Problems based design of progressive die	**10**
3	**Bending and Drawing-** 3.1 Theory of Bending, Spring back and measures to control it, Calculations for Blank development of Simple Bent components, Minimum bend radius, Types of Bending dies, roller bending, bending force problems on bend length calculation and bending force, 3.2 Theory of Drawing, Metal flow in Drawing & forming operations; reduction ratio and redrawing limits, draw clearance, drawing and blank holding forces for cylindrical draws only. Blank development of Cup, problems on drawing 3.3 Defects in drawn parts	**08**

	3.4 Basic construction and working of Bending and Drawing dies	
4	**Miscellaneous Dies-** Basic construction & working of Shaving dies, Trimming dies, Compound dies, Combination dies, Coining dies, Embossing dies, Simple Progressive & Compound Progressive dies, drop through and inverted die, curling die, transfer die	**04**
5	**Selection of Presses and its setting** Classification of presses, Selection of Press and Press setting, calculation of shut press shut height and die shut height, Overloading of presses (load, energy considerations)	**04**
6	**Introduction to Automation & Safety in Press shop** Types of CNC Press, Types of CNC press controller, Basic hydraulic and pneumatic circuit used in press for stock feeding and ram movement, different types sensors used for hand protection, stock feeding etc., other safety equipment like break, clutch, face shield etc.	**04**

Assessment:
Internal Assessment for 20 marks:
Consisting Two Compulsory Class Tests First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)
End Semester Examination:
Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

Text/Reference Books:

1. Die Design Fundamentals by J. R. Paquin, Industrial Press
2. Techniques of Press Working Sheet Metal by D F Eary and E A Reed
3. Press Tools Design and Construction by P H Joshi, S Chand Publishing
4. Tool Design by C. Donaldson and V C Goold, TMH
5. Production Engineering by P. C. Sharma, S Chand Publishing
6. Metal working ASM Handbook

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/112/105/112105233/ - Metal Cutting and Machine Tools, IIT Kharagpur

Course Code	Course Name	Credit
AEDLO6022	**Tool Engineering**	**03**

Objectives:

1. To familiarize with the basic concepts of machining science like mechanics of machining, tool wear, tool life, surface roughness and tool materials.
2. To familiarize with various single and multipoint cutting tools designing processes
3. To study the economics of machining process

Outcomes: Learner will be able to…

1. Calculate the values of various forces involved in the machining operations
2. Design various single and multipoint cutting tools
3. Analyze heat generation in machining operation and coolant operations
4. Illustrate the properties of various cutting tool materials and hence select an appropriate tool material for particular machining application
5. Demonstrate the inter-relationship between cutting parameters and machining performance measures like power requirement, cutting time, tool life and surface finish
6. Analyze economics of machining operations

Module	Details	Hrs
1	1.1 **Metal Cutting Theory:** Orthogonal and oblique cutting, various types of chips, Mechanics of orthogonal steady state metal cutting, shear plane and shear plane angle, Merchant's force circle, stresses, shear strain, velocity relations, rate of strain, energy considerations, Concept of specific power consumption in machining, Ernst and Merchant's model & modified model for orthogonal cutting, problems on above topic. 1.2 **Dynamometry:** Dynamometer requirements, force measurement, electric transducers, strain gauge lathe dynamometer, strain rings, milling dynamometer, drilling dynamometer, piezoelectric dynamometry	**08**
2	2.1 **Temperatures in metal cutting and cutting fluids**: Heat generation in metal cutting, heat transfer in a moving material, temperature distribution in metal cutting, effect of cutting speed on temperature, prediction of temperature distribution in machining, measurement of cutting temperature, work tool thermocouple, direct thermocouple measurement, radiation methods, hardness changes in steel tools, Cutting fluid types, the action of coolants, the action of lubricants, characteristics of an efficient lubricant in metal cutting, application methods of cutting fluid, dry cutting and minimum quantity lubrication, cryogenic cooling, cutting fluid maintenance and environmental considerations, disposal of cutting fluids	**05**
3	**Cutting tool materials and machining induced surface integrity** 3.1 Properties of cutting tool materials, Major tool material types, Plain carbon steel, high speed steel, cast alloys, cemented tungsten carbide, titanium carbides, ceramic and cermet tools, synthetic diamond,	**04**

	polycrystalline diamond (PCD), cubic boron nitride (CBN), coated tools, Techniques for manufacturing coated tools 3.2 Measurement and specification of surface finish, primary cutting edge finish, fracture roughness, BUE formation and its influence on finish, secondary cutting edge finish,	
4	**Tool life and Machining Economics**: 4.1 Definition, tool wear, criteria for tool failure, effect of cutting parameters and tool geometry on tool life, Taylor's tool life equation, machinability of material, factors affecting machinability, 4.2 Components of product cost, Optimum cutting velocity for minimum cost of production and maximum production rate, problems on above topic.	**06**
5	**Design of single point cutting tools**: Different systems of tool nomenclature like MRS and ORS, Constructional features of solid tool, tipped tools, mechanically held regrindable insert type tools and throw away tip type tools, Design of shanks, cutting tip and chip breakers for HSS and Carbide tools, ISO coding system for tipped tools and tool holders, Tool design for EDM and USM.	**05**
6	**Design of multi point cutting tools**: Introduction to various form tools, Broach nomenclature, design steps for circular pull type, key way and spline broaches, Design of face and peripheral milling cutters, Drill, Reamer and Tap design using standard procedure.	**08**

Assessment:

Internal Assessment for 20 marks:

Consisting**Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

References

1. Fundamentals of Metal Machining and Machine Tools, Third Edition by Winston A. Knight, Geoffrey Boothroyd, CRC press Taylor and Francis group
2. Metal Cutting Principles by Milton Clayton Shaw,2nd Edition, Oxford University Press
3. Cutting Tools by P H Joshi, A H Wheeler Publishing Co Ltd
4. ASM Handbook, Vol. 16: Machining by Joseph R. Davis,9th Edition, ASM International

5. Fundamentals of Metal Cutting and Machine Tools by B. L. Juneja, G. S. Sekhon and Nitin Seth,2nd Edition, New Age International
6. Metal Cutting Theory and Cutting Tool Design, by V. Arshinov and G. Alekseev, Mir publishers, Moscow
7. Typical Examples and Problems in Metal Cutting and Tool Design, by N. Nefedov and K. Osipov, Mir publishers, Moscow
8. Production Technology – HMT handbook

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/112/105/112105233/ - Metal Cutting and Machine Tools, IIT Kharagpur

Course Code	Course Name	Credits
AEDLO6023	**Metal FormingTechnology**	**03**

Objectives:

1. To conversant with the basic knowledge on fundamentals of metal formingprocesses
2. To study various metal formingprocesses
3. Understanding plastic deformation and technical analysis of forming processes

Outcomes: Learner will be able to

1. Understand the concept of different metal formingprocess.
2. Approach metal forming processes both analytically andnumerically
3. Design metal formingprocesses
4. Develop approaches and solutions to analyze metal forming processes and the associated problems andflaws.

Module	Details	Hrs
1.	**Introduction to Metal Forming:** Metallurgical aspects of metal forming, slip, twinning mechanics of plastic deformation, effects of temperature, strain rate, microstructure and friction in metal forming-yield criteria and their significance, Classification of Metal Forming Processes, Advantages and Limitations, Stress strain relations in elastic and plastic deformation, concept of flow stresses, deformation mechanisms, Hot and Cold Working Processes and Its Effect on MechanicalProperties.	**08**
2.	**Rolling:** Introduction and Classification, Types of Rolling Mills, Forces andGeometrical Relationships in Rolling, Calculation of Rolling Load, Roll Pass Design, and Defects in Rolled Products.	**07**
3.	**Forging:** Introduction and Classification, operation and principle of Forging Processes and Equipment, Methods of forging, Open and Close Die Forging Processes, Defects, Structure and Properties of Forged Products. Force Analysis inforging.	**07**
4.	**Extrusion:** Introduction and Classification, Extrusion Equipment, Forces inextrusion, Analysis of Extrusion Process, Extrusion of components including Seamless Pipes and Tubes. Extrusion of pipes by cold working,	**06**
5.	**Drawing:** Introduction and Classification, Wire Drawing, Rod Drawing, Tube	**06**

	Drawing, Deep Drawing, Analysis of Wire Drawing Process and Load Calculations.	
6.	**Sheet Metal Forming:** Principle, process parameters, equipment and application of the following processes: spinning, stretch forming, plate, V and edge bending, Curling, Ironing, Roll Bending, Metal Spinning. Press brake forming, explosive forming, Hydro forming, electro hydraulic forming, and magnetic pulse forming.High Velocity forming of metals and High energy Rate forming	**06**

Assessment:

Internal Assessment for 20 marks:

Consisting**Two Compulsory Class Tests**

First test based on approximately 40% of contents and second test based on remaining contents (approximately 40% but excluding contents covered in Test I)

End Semester Examination:

Weightage of each module in end semester examination will be proportional to number of respective lecture hours mentioned in the curriculum.

1. Question paper will comprise of total six questions, each carrying 20 marks
2. Question 1 will be compulsory and should cover maximum contents of the curriculum
3. Remaining questions will be mixed in nature (for example if Q.2 has part (a) from module 3 then part (b) will be from any module other than module 3)
4. Only Four questions need to be solved.

Text/Reference Books: -

1. Lin D Balint M Pietrzyk, Microstructure Evolution in Metal Forming Processes 1st Edition
2. Amitabha Ghosh and Asok Kumar Mallick, Manufacturing Science, Affiliated East-West Press
3. Christian Brecher and Ozdemir , Advances in Production Technology, Springer Publications
4. P.C.Sharma , A Text Book on Production Engineering, S.Chand Publications
5. P. N. Rao, “Manufacturing Technology”, Tata McGraw Hill
6. Aviter, “Fundamental of Metal Working”, McGraw Hill Publisher
7. Dieter, “Mechanical Metallurgy”

Links for online NPTEL/SWAYAM courses:

https://nptel.ac.in/courses/112/107/112107250/ - Principles of Metal Forming Technology, IIT Roorkee
https://nptel.ac.in/courses/112/106/112106153/ - Forming, IIT Madras

Course Code	Course Name	Credits
AEL601	**Automotive System Design**	**01**

Objectives:

1. To help students better understand Automotive systems and subsystems through Dismantling and assembling of various subsystems components.
2. To give hands on experience to students on designing different automotive components.
3. To Understand and apply concepts in designing automotive components.

Outcomes: Learner will be able to…

1. Identify Automobile systems and subsystems.
2. Dismantle and assemble Clutch and gearbox
3. Dismantle and assemble Propeller shaft
4. Dismantle and assemble Steering Gearbox
5. Dismantle and assemble Differential
6. Demonstrate design calculations for various automotive components.

Term Work :(Comprises both A & B)

A.List of Experiments

1. Dismantling and reassembling of Clutch.

2. Dismantling and reassembling of Gear box.

3. Dismantling and reassembling of Propeller Shaft.

4. Dismantling and reassembling of Differential.

5. Dismantling and reassembling of Steering gear linkages and steering gear box.

6. Dismantling and reassembling of any one type of braking systems.

B.Design Calculations

a.Exercises on the following in the form of design calculations(Any Three)

A. Design of any one Engine Component

B.Design of clutches (Single,Multi and Centrifugal)

C. Design of Gearbox

D. Design of Brakes

E.Design of Propeller Shaft/Axles

The distribution of marks for term work shall be as follows:

1) Part A: 10 marks

2) Part B: 10 marks

3) Attendance (Theory and Practical): 05 marks

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

End Semester Practical/Oral Examination:

1. Pair of Internal and External Examiner should conduct practical/Oral based on contents Distribution of marks for practical/Oral examination shall be as follows:

Practical performance:15 marks

Oral: 10 marks

2. Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination

Students work along with evaluation report to be preserved till the next examination

Course Code	Course Name	Credits
AEL602	**Mechanical Vibrations**	**01**

Objectives:

1. Study some single undamped degree of freedom systems theoretically and experimentally, and validate the time period of small vibrations/oscillations.
2. Obtain displacement vs. time graphs experimentally, and plot the same through response equations by the use of graphing and programming software viz., MS Excel etc.
3. Plot dimensionless steady-state amplitude vs. frequency ratio curves for various values of damping ratio for the case of forced vibrations, by the use of some programming software.
4. Balance a rotating system statically and dynamically.
5. Perform virtual experiments using Sakshat Virtual Laboratory.

Outcomes: Learner will be able to…

1. Derive the differential equation of motion, frequency & time-period, for the given single degree of freedom vibration system, for small oscillations.
2. Perform experiments on physical vibration systems and compare the theoretical and experimental results, for validation and verification.
3. Program using scientific mathematical software or using basic programming software, to obtain the necessary plots in time and frequency domains, and interpret the results thus obtained.
4. Balance a rotating unbalanced system completely, by making use of analytical and/or graphical methods.
5. Perform simulation of experiments through Sakshat Virtual Laboratory interface.

List of Experiments: At least 6 experiments based on the **serial numbers 01 – 07** as follows:

Sr. No.	Title of the Experiment	Lab. Sessions (Hours)
01	Determining the undamped natural frequency / time period of free undamped vibrations/oscillations of the following systems, theoretically and experimentally: (**any 4**) 1. Simple spring-mass system 2. Simple pendulum 3. Compound pendulum 4. Single rotor-shaft system 5. Bifilar suspension system	**08**

02	Free damped torsional oscillations.	**02**
03	Forced vibration of one degree of freedom system, subjected to frequency-squared excitations (rotating unbalance).	**02**
04	Computer program on frequency-domain plots of dimensionless steady-state amplitudes for various values of damping ratio.	**02**
05	Dunkerley's / Rayleigh's experiment on transverse vibration of beam for finding fundamental frequency.	**02**
06	Balancing of rotating masses.	**02**
07	Virtual Laboratory Experiments using Sakshat VLab portal.	**04**

Text/Reference Books:

1. Vibration Monitoring, Testing, and Instrumentation (Mechanical Engineering Series) - Clarence W. deSilva - CRC Press.

2. Vibration Testing: Theory and Practice - Kenneth G. McConnell, Wiley.

3. Modal Testing: A Practitioner's Guide - Peter Avitabile - Wiley.

Course Code	Course Name	Credits
AEL603	**Vehicle Body Engineering and Safety**	**01**

Objectives:

1. To help student understand and model various cross-sections used in chassis frame.
2. To help student to understand different vehicle body styles.
3. To give hands on experience to students on Designing and analysis of Chassis Frame.
4. To study vehicle comparison criteria.

Outcome: Learner will be able to

1. Model various cross sections used in Chassis frame.
2. Calculate various loads acting on chassis frame.
3. Compare to vehicles of same class.
4. Illustrate different vehicle body styles.
5. Compute tractive force and centre of gravity of the vehicle.

Term Work: (Comprises of parts A, B & C)

A. List of Experiments

1. Structural analysis of Chassis Frame using any FEA Software's for different sections (C-section, I- section, L-section, O-section, Hat section, Tubular section).

2. Case study on crash test dummy.

3. Comparison of two vehicles under same class based on overall design criteria and safety features.

4. Case study on tractive force analysis.

5. Case study on Centre of gravity calculation.

6. Case study on automotive standards (AIS, FMVSS, CMVR/CMVSS).

(Perform any four experiments from the list)

B. Mini Project

Analysis of Chassis frame containing a 3D Model of any existing Automobile Chassis or Body or combination of both (Min 2 Max 4 Students per Group)

C. Drawing sheet

Three A2 size sheets based on

1. Car body style
2. Bus body style
3. Commercial Vehicle body style

The distribution of marks for term work shall be as follows:

1) Laboratory work (Experiments) : **05 marks**

2) Mini project : **10 marks**

3) Drawing sheets : **05 marks**

4) Attendance (Theory and Practical) : **05 marks**

The final certification and acceptance of term work ensures the satisfactory performance of laboratory work and minimum passing in the term work.

End Semester Practical/Oral Examination:

1. Pair of Internal and External Examiner should conduct practical/Oral based on contents
   Distribution of marks for practical/Oral examination shall be as follows:
   Practical performance 15 marks
   Oral 10 marks
2. Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination

Note:- Students work along with evaluation report to be preserved till the next examination

Course Code	Course Name	Credits
AESBL601	**Measurements and Automation**	**02**

Objectives:

1. To study fundamentals of inspection methods and systems.
2. To study working of mechanical measurement system.
3. To familiarise with different types of control systems.
4. To study different hydraulic and pneumatic systems.
5. To study various design principles of robotics through kinematic analysis, workspace analysis and trajectory planning.

Outcomes: Learner will be able to…

1. Apply inspection gauge to check or measure surface parameters.
2. Measure surface parameters using precision measurement tools and equipment.
3. Measure different mechanical parameters by using sensors.
4. Analyse the response of a control systems.
5. Demonstrate use of automated controls using pneumatic and hydraulic systems.
6. Implement program on PLC system and demonstrate its application

The laboratory experiments should be based on the following:

Group A (Metrology):

1. Experiments on linear and angular measurement using Vernier calliper, micrometer and Bevel protractor.
2. Experiments on surface measurement by using Surface roughness tester.
3. Experiments on measurement of gear parameters using Gear tooth Vernier calliper / Parkinson gear tester.
4. Experiments on screw thread measurement using screw thread micrometer, Floating carriage micrometer / bench micrometer.
5. Experiments on linear / angular measurements of screw / gear /single point tool using Optical profile projector or Tool maker's microscope.
6. Experiment using Mechanical / Pneumatic type Comparator.
7. Experiments on flatness measurement by Autocollimator / Interferometry method

Group B (Mechanical Measurement):

1. Experiments on measurement of displacement by sensors like LVDT, Potentiometers etc.
2. Experiments on measurement of pressure by gauges or sensors like vacuum Gauges, pressure gauge, piezoelectric sensors, strain gauge sensors etc.
3. Experiments on measurement of vibration by accelerometers or NI.
4. Experiments on feedback control systems and servomechanisms
5. Experiment on frequency response system identification / transient state response of a control system.
6. Experiment on design of PID controller for a system or simulate and tune a PID controller using lab view.

Group C (Automation):

1. Experiment on trainer kit (Any one)

a) Designing sequential operation for two cylinders using electro-hydraulic circuits.

or

b) Designing sequential operation for two cylinders using electro- pneumatic circuits.

2. Experiment on simulation using software like Festo, AutoSim etc.

a) Simulation of basic pneumatic and electro-pneumatic circuits.

or

b) Simulation of hydraulic and electro-hydraulic circuits.

3. Experiments on Ladder programming

a) Experiments on Ladder programming on PLC for simple ON OFF control, timers, counter, two motor system, simple control applications with logic/ timers/counters.

or

b) Experiments on Ladder programming for Mechatronics system (e.g. bottle filling plant, control of electro-pneumatic or electro-hydraulic systems).

4. Experiments on Robotics

a) Demonstration and study of functions of components of robotics arm.

or

b) Visualization of DH (Denavit–Hartenberg) parameters in Roboanalyzer (*Roboanalyzer is free software developed by IIT Delhi, available on www.roboanalyzer.com).

Term Work

Term work shall consist of minimum Nine Experiments. Three from each group mentioned above. There will be no theoretical assignment for the lab course. The distribution of marks for term work shall be as follows:

Laboratory work (Experiments) : 20 marks

Attendance: : 05 marks

End Semester Practical/Oral Examination:

1. Pair of Internal and External Examiner should conduct practical and viva based on contents.
2. Practical examination (in a group of not more than 4 students) duration is 2 hours
3. Distribution of marks for practical/viva examination shall be as follows:

Practical performance: 15 marks

Oral: 10 marks

4. Evaluation of practical examination to be done based on the experiment performed and the output of the experiment during practical examination.
5. Students work along with evaluation report to be preserved till the next examination.

Virtual Labs

http://ial-coep.vlabs.ac.in/ - Industrial Automation Laboratory, COEP

Course code	Course Name	Credits
AEPBL601	**Mini Project - 2B**	**02**

Objectives:

1. To acquaint with the process of identifying the needs and converting it into the problem.
2. To familiarize the process of solving the problem in a group.
3. To acquaint with the process of applying basic engineering fundamentals to attempt solutions to the problems.
4. To inculcate the process of self-learning and research.

Outcome: Learner will be able to…

5. Identify problems based on societal /research needs.
6. Apply Knowledge and skill to solve societal problems in a group.
7. Develop interpersonal skills to work as member of a group or leader.
8. Draw the proper inferences from available results through theoretical/ experimental/simulations.
9. Analyse the impact of solutions in societal and environmental context for sustainable development.
10. Use standard norms of engineering practices
11. Excel in written and oral communication.
12. Demonstrate capabilities of self-learning in a group, which leads to life long learning.
13. Demonstrate project management principles during project work.

Guidelines for Mini Project

- Students shall form a group of 3 to 4 students, while forming a group shall not be allowed less than three or more than four students, as it is a group activity.
- Students should do survey and identify needs, which shall be converted into problem statement for mini project in consultation with faculty supervisor/head of department/internal committee of faculties.
- Students hall submit implementation plan in the form of Gantt/PERT/CPM chart, which will cover weekly activity of mini project.
- A log book to be prepared by each group, wherein group can record weekly work progress, guide/supervisor can verify and record notes/comments.
- Faculty supervisor may give inputs to students during mini project activity; however, focus shall be on self-learning.
- Students in a group shall understand problem effectively, propose multiple solution and select best possible solution in consultation with guide/ supervisor.
- Students shall convert the best solution into working model using various components of their domain areas and demonstrate.
- The solution to be validated with proper justification and report to be compiled in standard format of University of Mumbai.
- With the focus on the self-learning, innovation, addressing societal problems and entrepreneurship quality development within the students through the Mini Projects, it is preferable that a single project of appropriate level and quality to be carried out in two semesters by all the groups of the

students. i.e. Mini Project 1 in semester III and IV. Similarly, Mini Project 2 in semesters V and VI.

- However, based on the individual students or group capability, with the mentor's recommendations, if the proposed Mini Project adhering to the qualitative aspects mentioned above gets completed in odd semester, then that group can be allowed to work on the extension of the Mini Project with suitable improvements/modifications or a completely new project idea in even semester. This policy can be adopted on case by case basis.

Guidelines for Assessment of Mini Project:

Term Work

- The review/ progress monitoring committee shall be constituted by head of departments of each institute. The progress of mini project to be evaluated on continuous basis, minimum two reviews in each semester.
- In continuous assessment focus shall also be on each individual student, assessment based on individual's contribution in group activity, their understanding and response to questions.
- Distribution of Term work marks for both semesters shall be as below;
    - Marks awarded by guide/supervisor based on log book : 10
    - Marks awarded by review committee : 10
    - Quality of Project report : 05

Review/progress monitoring committee may consider following points for assessment based on either one year or half year project as mentioned in general guidelines.

One-year project:

- In first semester entire theoretical solution shall be ready, including components/system selection and cost analysis. Two reviews will be conducted based on presentation given by students group.
    - First shall be for finalisation of problem
    - Second shall be on finalisation of proposed solution of problem.
- In second semester expected work shall be procurement of components/systems, building of working prototype, testing and validation of results based on work completed in an earlier semester.
    - First review is based on readiness of building working prototype to be conducted.
    - Second review shall be based on poster presentation cum demonstration of working model in last month of the said semester.

Half-year project:

- In this case in one semester students' group shall complete project in all aspects including,
    - Identification of need/problem
    - Proposed final solution
    - Procurement of components/systems
    - Building prototype and testing
- Two reviews will be conducted for continuous assessment,
    - First shall be for finalisation of problem and proposed solution
    - Second shall be for implementation and testing of solution.

Assessment criteria of Mini Project.

Mini Project shall be assessed based on following criteria;

1. Quality of survey/ need identification
2. Clarity of Problem definition based on need.
3. Innovativeness in solutions
4. Feasibility of proposed problem solutions and selection of best solution
5. Cost effectiveness
6. Societal impact
7. Innovativeness
8. Cost effectiveness and Societal impact
9. Full functioning of working model as per stated requirements
10. Effective use of skill sets
11. Effective use of standard engineering norms
12. Contribution of an individual's as member or leader
13. Clarity in written and oral communication

- In **one year, project**, first semester evaluation may be based on first six criteria's and remaining may be used for second semester evaluation of performance of students in mini project.
- In case of **half year project** all criteria's in generic may be considered for evaluation of performance of students in mini project.

Guidelines for Assessment of Mini Project Practical/Oral Examination:

- Report should be prepared as per the guidelines issued by the University of Mumbai.
- Mini Project shall be assessed through a presentation and demonstration of working model by the student project group to a panel of Internal and External Examiners preferably from industry or research organisations having experience of more than five years approved by head of Institution.
- Students shall be motivated to publish a paper based on the work in Conferences/students competitions.

Mini Project shall be assessed based on following points;

1. Quality of problem and Clarity
2. Innovativeness in solutions
3. Cost effectiveness and Societal impact
4. Full functioning of working model as per stated requirements
5. Effective use of skill sets
6. Effective use of standard engineering norms
7. Contribution of an individual's as member or leader
8. Clarity in written and oral communication