3rd Semester

PCC	AUTOMOTIVE ENGINES	Semester	3
Course Code	**BAU301**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3-0 -0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	3	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

1. Differentiate between the constructions details of spark ignition and compression ignition engines and to classify engines.
2. Explain the construction and working principle of fuel systems
3. Explain combustion process in SI and CI engines and identify the abnormal combustion
4. Explain supercharging and turbo charging and apply the same to IC engines
5. Choose cooling and lubrication systems for automotive engines

Teaching-Learning Process (General Instructions)

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

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby plants, start -up ecosystem, incubation centers or MSME industries to give information about the industry culture and demand.
3. Show Video/animation films to explain functioning of various machines.
4. Encourage collaborative (Group Learning) Learning in the class
5. Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking
6. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
10. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

Module-1

Construction and Operation:

Engine classification, Constructional details of spark ignition (SI) and compression ignition (CI) engines. Working principles. Two stroke SI and CI engines – construction and working. Comparison of SI and CI engines and four stroke and two stroke engines, theoretical and actual valve timing diagrams for engines.

Engine Cycles: theoretical Otto, diesel and dual cycles, Fuel-air Cycles and Actual Cycles, simple numericals

Module-2

Fuel Systems:

Air fuel ratio requirements of SI engines, Working of a simple fixed venturi carburetor and limitations, gasoline injection system, types, Diesel fuel injection systems-inline pumps, distributor pumps, Types of Nozzles, Unit injector and common rail injection systems, Need and types of governor for diesel engines and their comparison.

Teaching-Learning Process	Chalk and Talk, Video/animation films, Problem Based Learning (PBL), Lab session

Module-3

Combustion in S. I. and C. I. engines:

Introduction to combustion in SI and CI engines and stages of combustion. Factors effecting ignition lag and flame propagation in S.I. Engines, factors effecting delay period and uncontrolled combustion in C.I. Engines. Importance of Swirl, squish and turbulence in C.I. Engines.

Teaching-Learning Process	Chalk and Talk, Video/animation films, Problem Based Learning (PBL), Lab session

Module-4	
Supercharging, Turbocharging Supercharging and Turbocharging, Different methods of turbocharging, Intercooling, Turbocharger controls including, waster gate, variable geometry **Cooling systems:** Need for cooling, types of cooling systems- air and liquid cooling systems. Thermo-syphon and forced circulation and pressurized cooling systems. Properties of coolants.	
Teaching-Learning Process	Chalk and Talk, Video/animation films, Problem Based Learning (PBL), Lab session
Module-5	
Fuels for S.I and C. I engines **Fuels for S.I and C. I engines** and their requirements, Fuel ratings necessity of lubrication systems. Types-mist, pressure feed, dry and wet sump systems. **Properties of lubricants.** BIS standards for fuels and lubricants.	
Teaching-Learning Process	Chalk and Talk, Video/animation films, Problem Based Learning (PBL), Lab session

Course outcome (Course Skill Set)

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

1. Explain the constructional details of SI and CI engines and classify engines.
2. Explain the construction and working of carburettors and fuel injection pumps.
3. Explain the combustion process in SI and CI engines, and suggest an efficient cooling system for IC engines.
4. Select a proper lubricant to be used in an automobile used in various environmental conditions.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

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

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

Suggested Learning Resources:

Books

Text Books:

1. Internal Combustion Engines- V. Ganesan 2007, Tata McGraw Hill
2. Internal Combustion Engines - Ramalingam K. K., Sci-Tech Publications, 2005.

Reference Books:

1. Advanced Engine Technology- Heisler SAE Publication
2. Internal Combustion Engines- Edward F. Obert
3. Fundamentals of Internal Combustion Engines- H. N. Gupta, PHI
4. Internal Combustion Engines- Mathur and Sharma, Dhanpat Rai and Sons 2002
5. Fundamentals of Internal Combustion Engines- John B. Heywood.

Web links and Video Lectures (e-Resources):

1. https://www.youtube.com/watch?v=Y32gDgLq6hE
2. https://www.youtube.com/watch?v=9lse1SfDq7M
3. https://www.youtube.com/watch?v=mmmcj53TNic
4. https://studentlesson.com/cooling-system-definition-functions-components-types-working/
5. https://www.youtube.com/watch?v=fw8Jfoif1BM

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

1. Visit nearby Automotive service centres for hands on experience on ICE vehicles and prepare a report

IPCC-	MATERIAL SCIENCE AND METALLURGY	Semester	3
Course Code	BAU302	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	3
Examination nature (SEE)	Theory		

Course objectives:

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

1. Explain different crystal structures, mechanism of various types of failure, types of heat treatment processes, types and methods of manufacturing of composites.
2. Draw stress strain diagram for various metals.
3. Select various non-ferrous metals and alloys based on composition and properties for a given application.
4. Understand the basics of Batteries and Super capacitors

Teaching-Learning Process (General Instructions)

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

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby plants, start -up ecosystem, incubation centers or MSME industries to give information about the industry culture and demand.
3. Show Video/animation films to explain functioning of various machines
4. Encourage collaborative (Group Learning) Learning in the class
5. Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking
6. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
10. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

MODULE-1

Crystal Structure: BCC, FCC and HCP Structures, coordination number and atomic packing factors, crystal imperfections –point, line and surface imperfections. Atomic Diffusion: Flick's laws of diffusion, factors affecting diffusion.

Stress &Strains: Introduction, Hooke's law, Stress-strain diagram for ductile and brittle materials, True stress and true strain, linear and non-linear elastic behaviour and properties, mechanical properties in plastic range, yield strength, offset yield strength, ductility, ultimate tensile strength, and toughness. Calculation of stresses in Composite sections, Shear stress and strain, Lateral strain and Poisson's ratio, Bulk modulus, Relationship between elastic constants, factor of safety, criteria for selection of factor of safety, Numerical problems on the above wherever applicable

Teaching-Learning Process	Chalk and talk method, Power Point Presentation, Experiential learning through laboratory sessions (Experiments 1-4)

MODULE-2

Analysis of Stress and Strain:

Plane stress, Principal stresses and maximum shear stress, Maximum shear stress, Mohr circle for plane stress, Shear stresses on principal planes., Numerical problems on the above wherever applicable

Fracture: Type I, Type II and Type III.

Creep: Description of the creep phenomenon with examples, three stages of creep, stress relaxation.

Fatigue: Types of fatigue and S-N Curve

Teaching-Learning Process	Chalk and talk method, Power Point Presentation, Experiential learning through laboratory sessions (5-9)

MODULE-3
Materials for Batteries; Primary and Secondary cells, Materials used for various components in batteries - electrolytes, electrodes, separators, binders. Different types of Batteries, Performance and Manufacturing of batteries, Numerical problems on the above wherever applicable **Electrochemical Energy Storage Systems**- Fundamentals of Electrochemical Super capacitors, Fuel Cells, Battery Safety and abuse tolerance.
MODULE-4
Heat Treatment of Metals; Iron-Carbon Equilibrium Diagram, Annealing and its types. Normalizing, hardening, tempering, martempering, austempering, hardenability, surface hardening methods like carburizing, cyaniding, nitriding, flame hardening and induction hardening, age hardening of Aluminium-copper alloys. **Ferrous Metals:** Properties, Composition and uses of grey cast iron, malleable iron, S.G iron and steel.
MODULE-5
Non-Ferrous Metals; Copper alloys-brasses and bronzes, Aluminium alloys-Al-Cu, Al-Si, Al-Zn alloys-composition, properties, advantages and disadvantages and applications. **Composite Materials**: Definition, classification, types of matrix materials & reinforcements, fundamentals of production of FRP' and MMC's advantages and application of composites.

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

Sl.NO	Experiments
1	Preparation of specimen for Metallographic examination of different engineering materials.
2	Identification of microstructures of plain carbon steel, tool steel, gray CI, SG iron, Brass, Bronze& composites.
3	Brinell, Rockwell and Vickers's Hardness test.
4	Fatigue Test
5	To study the defects of Cast and Welded specimens
6	Tensile, Shear and Compression tests of metallic and non-metallic specimens using Universal Testing Machine
7	Torsion Test
8	Bending Test on metallic and non-metallic specimens., Izod and Charpy Tests on M.S, and CI specimen.
9	**Demo experiments for CIE**- Identify and list the Materials used for various components in batteries - electrolytes
10	**Demo experiments for CIE**- Write typical battery specifications for different electric vehicle segments
11	**Demo experiments for CIE**- Heat treatment: Annealing, normalizing, hardening, and tempering of steel. Hardness studies of heat-treated samples.
12	**Demo experiments for CIE**- Non-destructive test experiments like, a. Ultrasonic flaw detection b. Magnetic crack detection, c. Dye penetration testing.

Course outcomes (Course Skill Set):

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

1 Explain different crystal structures, mechanism of various types of failure, types of heat treatment processes and types and methods of manufacturing of composites.

2 Draw stress strain diagram for various metals,

3 Select various non-ferrous metals and alloys based on composition and properties for a given application.

4 Understand the basics of Batteries and Super capacitors

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

CIE for the theory component of the IPCC (maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

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**)

5. The question paper will have ten questions. Each question is set for 20 marks.
6. 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.
7. The students have to answer 5 full questions, selecting one full question from each module.
8. Marks scored by the student shall be proportionally scaled down to 50 Marks

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 may include questions from the practical component.

Suggested Learning Resources:

Books

1.Foundations of Materials Science and Engineering Smith, McGraw Hill, 2009 3 rd Edition

2. Materials Science Shackleford. & M. K. Muralidhara, Pearson Publication 2007.

3. An introduction to Metallurgy Alan Cottrell University Press India Oriental Longman Pvt. Ltd., 1974.

4. Materials Science and Engineering V. Raghavan, PHI 2002

5. Materials Science and Engineering William D. Callister Jr. John Wiley & Sons. Inc 5th Edition, 2001.

6. C. Daniel and Jurgen O. Besnard, Handbook of Battery Materials, Willey-VCH verlg-2011

7. Strength of Materials, S. S. Bhavikatti, Vikas publications House-1 Pvt. Ltd2006

Web links and Video Lectures (e-Resources):

1. https://nptel.ac.in/courses/113102080
2. https://nptel.ac.in/courses/113106032
3. https://www.digimat.in/nptel/courses/video/113102080/L01.html
4. https://www.youtube.com/watch?v=b4jvpYxxZco

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

1. http://mrmsmtbs-iitk.vlabs.ac.in/creep.html
2. http://vlabs.iitb.ac.in/vlabs-dev/labs/nitk_labs/physical-metallurgy/labs/index.php
3. https://www.youtube.com/watch?v=v7uS9_bUg-E

IPCC	MANUFACTURING PROCESSES	Semester	3
Course Code	**BAU303**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3-0-2	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	3
Examination nature (SEE)	Theory		

Course objectives:

1. To provide detailed theoretical knowledge of various methods of manufacturing, metal shaping and fabrication processes such as casting, forging, welding, soldering, brazing, rolling, press working and machining.
2. To provide detailed theoretical knowledge of construction and working of various machine tools (lathe, planer, shaper, grinding, milling etc.), metal joining equipment, foundry tools, forging tools.
3. To provide hands on training to students on various manufacturing processes through integrated practical sessions.

Teaching-Learning Process (General Instructions)

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

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby plants, start -up ecosystem, incubation centers or MSME industries to give information about the industry culture and demand.
3. Show Video/animation films to explain functioning of various machines
4. Encourage collaborative (Group Learning) Learning in the class
5. Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking
6. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
10. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

MODULE-1

Foundry: Patterns and Moulds

Patterns and Pattern making:

Introduction to Foundry - Steps involved in casting, advantages, limitations and applications of casting process. Pattern making-Pattern types, allowances for pattern, pattern materials, colour coding and storing of patterns, Numerical on above wherever applicable.

Moulding:

Moulding methods and processes-materials, equipment, moulding sand ingredients, essential requirements, sand preparation and control, testing, cores and cores making. Gating Runners and Risers - Solidification in castings, metallurgical aspects of Casting, Numerical problems on the above wherever applicable

Teaching-Learning Process	• Conventional classroom teaching using teaching aids such as chalk & talk, PPTs and videos/animations. • Experiential learning through laboratory sessions (Exp 1-4, Exp- 10)

MODULE-2
Foundry technology: Casting Processes: Sand castings, pressure die casting, permanent mould casting, centrifugal casting, precision investment casting, shell casting, Co2 casting, electro slag casting, Fettling, and finishing. Defects in castings; Melting, Pouring and Testing; Numerical problems on the above wherever applicable. **Melting furnaces:** Crucible oil fired furnaces- electric furnaces-cupola, selection of furnace, calculation of cupola charges-Degasification, inoculation, pouring techniques casting defects and their elimination, Casting inspection,

Teaching-Learning Process	• Conventional classroom teaching using teaching aids such as chalk & talk, PPTs and videos/animations. • Experiential learning through laboratory sessions (Exp 12)

MODULE-3
Basic Joining Processes **Welding:** Types of welding- Gas welding, -Arc welding, - Shielded metal arc welding, GTAW, GMAW, SAW, ESW-Resistance welding (spot, seam, projection, percussion, flash types)-thermit welding, Flame cutting - Use of Oxyacetylene, modern cutting processes. (Equipment used in each welding/cutting processes and important consumables used must be dealt in) **Special Welding Processes:** Soldering, brazing and braze welding and their application., welding of special materials – Stainless steel, Aluminium etc. weldability of cast iron, steel, stainless steel, aluminium alloys. Introduction to Electron beam and Laser welding.
MODULE-4
Metal Shaping and Forming **Metal working**: Elastic and Plastic deformation, Strain Hardening, Forging**:** Methods of forging, Forging hammers and presses , Numerical on the above, wherever applicable **Press working:** Process of Shearing, Drawing Squeezing, Blanking, Trimming, Notching, Lancing, Piercing, Deep drawing, Coining, and embossing, Metal working defects. **Rolling:** Hot and cold rolling technique Types of rolling operations, General description of rolling machines and processes, Numerical problems on the above wherever applicable
MODULE-5
Cutting tools and Machine tools: **Cutting tool materials and their geometry:** Introduction, desirable properties and characteristics of cutting tool materials, cutting tool geometry, cutting fluids and its applications, surface finish, effect of machining parameters on surface finish. **Machine Tools**: Introduction, Classification, construction, and specifications of lathe, drilling machine, milling machine, shaping machine, planning machine, grinding machine (Simple sketches showing major parts of the machines along with different operations performed on each of the machine tools) **Machining equations for cutting operations:** Turning, Shaping, Planing, Slab milling, cylindrical grinding and internal grinding. Numerical problems on the above wherever applicable

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

Sl.NO	Experiments
1	Testing of Moulding Sand and Core Sand
2	Sieve Analysis to find Grain Fineness number of Base Sand
3	Clay content determination in Base Sand
4	Preparation of sand specimens and conduction of the following tests: Compression, Shear and Tensile tests on Universal Sand Testing Machine. Permeability test

5	. Use of foundry tools and other equipment. And Preparation of moulds using two moulding boxes with patterns or without patterns. (Split pattern, Match plate)
6	Calculation of length of the raw material required to prepare the model by forging.
7	Preparing minimum one forged models involving upsetting, drawing, and bending operations.
8	Preparation of two models on Lathe involving Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning.
9	Demo experiments for CIE - Cutting of V- Groove/ Dovetail / Rectangular groove using a shaper, Cutting of Gear Teeth using Milling Machine.
10	Demo experiments for CIE - Core hardness & Mould hardness tests.
11	Can be Demo experiments for CIE- Preparation of one casting -Aluminum or cast iron-
12	Can be Demo experiments for CIE - A demonstration in the workshop on welding

Course outcomes (Course Skill Set):

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

1. . Prepare moulds using moulding sand and tools and explain different types of casting methods.
2. Fabricate simple models using various joining techniques.
3. Explain various hot and cold forming processes.
4. Produce simple models/jobs using necessary cutting tools, machining operations and machine tools.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

CIE for the theory component of the IPCC (maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory

component of IPCC for **25 marks**.

- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

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**)

9. The question paper will have ten questions. Each question is set for 20 marks.
10. 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.
11. The students have to answer 5 full questions, selecting one full question from each module.
12. Marks scored by the student shall be proportionally scaled down to 50 Marks

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 may include questions from the practical component.

Suggested Learning Resources:

Books

1. Manufacturing & Technology: Foundry, Forming and Welding, P. N. Rao, Tata McGraw Hill, 2nd Ed, 2003
2. Manufacturing Engineering and Technology, Serope Kalpak Jain, Steuen. R. Sechmid, Pearson Education Asia, 5tEd. 2006.
3. Workshop Technology, Hazara Choudhry, Media Promoters & Publishers Pvt. Ltd., Vol-II, 2004
4. Production Technology, R. K. Jain, Khanna Publications (2003)
5. Manufacturing Process, Dr. K. Radhakrishna, Sapna Book House, 5th Revised Edition 2009.

Web links and Video Lectures (e-Resources):

1. https://www.youtube.com/watch?v=jdFrBtHeJbs&list=PLSGws_74K01-g9nnTMBssGURHawYYQfMQ

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

1. Experiential learning through laboratory sessions
2. Visit to machine shop in the college and experience the working of available machine tools
3. Preparation of one job on Lathe involving Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring.
4. Cutting of V- Groove/ Rectangular groove using a shaper (one job)
5. Cutting of Gear Teeth using Milling Machine (one job)
6. Visit to nearest manufacturing MSME

PCC	ENGINEERING THERMODYNAMICS	Semester	3
Course Code	**BAU304**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3-0 -0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

1. To define work, heat, and laws of thermodynamics, entropy, principle and working of refrigeration, jet propulsion.
2. To evaluate thermal performance of refrigeration cycles.
3. To calculation of efficiency of gas power and vapor power cycles.
4. To analyse gas power cycles

Teaching-Learning Process (General Instructions)

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

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby plants, start -up ecosystem, incubation centers or MSME industries to give information about the industry culture and demand.
3. Show Video/animation films to explain functioning of various machines
4. Encourage collaborative (Group Learning) Learning in the class
5. Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking
6. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
10. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

Module-1

Fundamentals of Thermodynamics:

Thermodynamic definition and scope, Microscopic and Macroscopic approaches. Thermodynamic properties; intensive, extensive properties, specific properties, pressure, specific volume, Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic; processes; Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium, Zeroth law of thermodynamics, Temperature; concepts, various temperature scales, Numerical on the above wherever applicable

Work and Heat:

Thermodynamic definition of work; examples, sign convention, Shaft work, Electrical work, other types of work. Heat; definition, units, and sign convention., Numerical problems on the above wherever applicable

Module-2

First law of thermodynamics and its applications:

Joules experiments, Statement of the First law of thermodynamics, steady state-steady flow energy equation, important applications, analysis of unsteady processes such as filling and evacuation of vessels with and without heat transfer., Numerical problems on the above wherever applicable

Second law of Thermodynamics and its applications:

Kelvin –Planck &Clausius statement of Second law of Thermodynamics, PMM II and PMM I. Clausius Theorem

Module-3

Entropy:

Entropy; definition, a property, principle of increase of entropy, entropy as a quantitative test for irreversibility, calculation of entropy using T-ds relations, entropy as a coordinate. Available and unavailable energy, Numerical problems on the above wherever applicable

Pure Substances:

P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, saturated liquid, mixture of saturated liquid and vapour, saturated vapour and superheated vapour states of pure substance with water as example. Enthalpy of change of phase (Latent heat). Dryness fraction (quality), T-S and H-S diagrams, representation of various processes on these diagrams, steam tables and its use, Numerical problems on the above wherever applicable

Module-4

Refrigeration:

Vapor absorption refrigeration system, vapor compression refrigeration system; description, analysis, refrigerating effect, capacity, power required, units of refrigeration, COP, Refrigerants, and their desirable properties., Numerical

Psychrometry:

Basic definitions: dry bulb temperature, wet bulb temperature, dew point temperature; specific and relative humidifies, concept of psychrometric chart Analysis of various processes; heating, cooling, dehumidifying, and humidifying. Adiabatic mixing of moist air, Numerical problems on the above wherever applicable

Module-5

ICE cycles

Analysis of Carnot cycle, Otto cycle and Diesel cycles, Comparison based on performance parameters, Numerical problems on the above wherever applicable

Engine Testing and Performance:

Performance parameters, Basic measurements, Measurements of Speed, Fuel consumption, air consumption, brake power and different types of dynamometers, frictional power measurement by William's line method, Morse test and other methods, indicated power, performance maps, and heat balance and related numerical problems.

Course outcome (Course Skill Set)

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

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

1. Understand the basic and applied concepts of thermodynamics.
2. Analyse the Evaluate thermal performance of heat engines.
3. Compare the performance of heat engines.
4. Apply the concepts to solve engineering problems related to thermodynamics

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

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

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

Suggested Learning Resources:

Books

1. Engineering Thermodynamics, P. K. Nag, Tata McGraw Hill Pub. 2002
2. Thermodynamics, An engineering approach, Yunus, A. Cenegal and Michael A.Boies, Tata Mac- Graw Hill Publishing Company, 2002
3. Basic Thermodynamics, R.K. Hegde, Sapna Book House, 2018
4. Applied Thermodynamics, R.K. Hegde, Sapna Book House, 2018
5. Fundamental of Classical Thermodynamics- G. J. Van WylenandR. E. Sontang,. Wiley eastern, 1994

Web links and Video Lectures (e-Resources):

1. http://platform.sysmoltd.com/
2. http://sourceforge.net/projects/dwsim/
3. http://sourceforge.net/projects/dwsim/
4. http://platform.sysmoltd.com/
5. http://exergy.se
6. http://demonstrations.wolfram.com/CarnotCycleOnIdealGas/
7. http://demonstrations.wolfram.com/VanDerWaalsIsothermsForRealAndIdealGases/,

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

1. NPTEL lecture videos,
2. Problem based learning (PBL)
3. Visit to Refrigeration Plant
4. Watch You tube videos on automobile vehicle AC system working

PCCL BASIC AUTOMOBILE ENGINEERING LABORATORY		Semester	3
Course Code	BAUL305	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2	SEE Marks	50
Total Hours of Pedagogy	4	Total Marks	100
Credits	01	Exam Hours	03
Examination type (SEE)	Practical		

Course objectives:

- To introduce the students to various tools and equipment used for dismantling and assembly of automobile systems.
- To introduce the students to various automobile assemblies and make them to gain the knowledge of various parts/components through dismantling and assembly activities.

Sl.NO	Experiments	
1	Performance test on Single Cylinder and multi cylinder SI / CI engines	
2	Study on SI and CI engines performance by changing parameters like valve timing, ignition timing, compression ratio, etc	
3	Morse test on multi cylinder engine for finding FP, IP, Indicated thermal efficiency and Mechanical efficiency	
4	Study of engine performance using alternate fuels like alcohol blends/ bio diesel / LPG.	
5	Study and testing on MPFI Engine and Variable compression ratio Engine.	
6	Exhaust Emission test of S. I. and C I Automotive engine.	
	Demonstration Experiments (For CIE)	
9	Dismantling, Study and Assembling of Single cylinder / Multi Cylinder SI Engine	
10	Dismantling, Study and Assembling of Single cylinder and Multi Cylinder C I Engine	
11	Study of Oil filter, Fuel filter, Fuel injection system and Carburettor .	
12	Study of MPFI and CRDI Systems	
13	Study of Ignition Systems – Battery coil, Magneto and Electronic	
14	List charging methods and calculate power ratings of 2 and 4 wheeled electric vehicles	

Course outcome (Course Skill Set)

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

1. Dismantle and assemble the various automobile systems(assemblies)
2. Sketch the automobile assemblies/systems and name the various parts.
3. Explain the working of various automobile systems

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

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

OR

MCQ (Multiple Choice Questions) are preferred for 01 credit courses, however, if course content demands the general question paper pattern that followed for 03 credit course, then

1. The question paper will have ten questions. Each question is set for 10 marks.
2. There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub-questions (with maximum sub-questions of 02, with marks distributions 5+5, 4+6, 3+7).
3. The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Books

- http://vlabs.iitkgp.ernet.in/rtvlas/
- https://www.thi.de/en/mechanical-engineering/laboratories/laboratory-for-engine-and-vehicle-technology/
- https://www.youtube.com/watch?v=hqvEDWLPyLo
-

Web links and Video Lectures (e-Resources):

- . https://www.youtube.com/watch?v=x70VqMrXrbs
- https://www.youtube.com/watch?v=oVaBqefSj0g

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

1. Conduct experiment on engine performance using alternate fuels and technology, publish the experimental findings in an indexed journal.
2. Use CFD analysis for modelling and analysing different types of combustion chambers / flow process

ESC/ETC/PLC	NON TRADITIONAL MACHINING	Semester	3
Course Code	BAU306A	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

1. Discuss the difference between conventional and non-conventional machining process.
2. Characterize the USM and AJM with the effect of parameters and process characteristics.
3. Explain the working principle ECM and CHM with the effect of parameters and process characteristics.
4. Discuss about the working principle of EDM with the effect of parameters and process characteristics.
5. Describe the working principle PAM and LBM with the effect of parameters and process characteristics.

Teaching-Learning Process (General Instructions)

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

1. Teaching in classroom through Chalk, Talk and ICT
2. Assignment of Home/field work on real-life problem
3. Adoption of Project-based/Activity Based learning
4. Practicing the foundational knowledge.

Module-1

Introduction:

Need for non-traditional machining, History, Classification, comparison between conventional and Non-conventional machining process selection.

Ultra Sonic Machining (USM):

Introduction, equipment, cutting tool system design, Effect of various parameters on USM process characteristics: Material removal rate, tool wear, Accuracy, surface finish, applications, advantages & Disadvantages of USM

Module-2

Abrasive Jet Machining (AJM):

Introduction, Equipment, Variables in AJM: Carrier Gas, Type of abrasive, size of abrasive grain, velocity of the abrasive jet, mean No. abrasive particles per unit volume of the carrier gas, work material, standoff distance (SOD), nozzle design, shape of cut. Process characteristics-Material removal rate, Nozzle wear, Accuracy & surface finish. Applications, advantages & Disadvantages of AJM.

Water Jet Machining:

Principle, Equipment, Operation, Application, Advantages and limitations of water Jet machinery Electron Beam Machining (EBM): Principles, equipment, operations, applications, advantages and limitation of EBM

Module-3

Electrochemical Machining (ECM):

Introduction, study of ECM machine, elements of ECM process classification of ECM process: Cathode tool, Anode work piece, source of DC power, Electrolyte, chemistry of the process, ECM Process characteristics – Material removal rate, Accuracy, surface finish,

Chemical Machining (CHM) :

Introduction, elements of process, chemical blanking process: Preparation of work piece, preparation of masters, masking with photo resists, etching for blanking, accuracy of chemical blanking, applications of chemical blanking, chemical milling (contour machining): process steps –masking, Etching, process characteristics of CHM: material removal rate accuracy, surface finish, Hydrogen embrittlement.

Module-4

Electrical Discharge Machining (EDM):

Introduction, machine, mechanism of metal removal, dielectric fluid, spark generator, EDM tools (electrodes) Electrode feed control, Electrode manufacture, Electrode wear , EDM tool design choice of machining operation electrode material selection, under sizing and length of electrode , machining time. Flushing pressure flushing suction flushing, side flushing, pulsed flushing synchronized with electrode movement, EDM process characteristics: metal removal rate, accuracy surface finish, Heat affected Zone. Machine tool selection, Application EDM, electrical discharge grinding, Traveling wire

Module-5

Plasma Arc Machining (PAM):

Introduction, equipment non-thermal generation of plasma, selection of gas, Mechanism of metal removal, PAM parameters, process characteristics. Safety precautions, Applications, Advantages and limitations.

Laser Beam Machining (LBM):

Introduction, equipment of LBM mechanism of metal removal, LBM parameters, Process characteristics, Applications, Advantages & limitations.

Course outcome (Course Skill Set)

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

1. Characterize the USM and AJM with the effect of parameters and process characteristics.
2. Explain the working principle ECM and CHM with the effect of parameters and process characteristics.
3. Discuss working principle of EDM with the effect of parameters and process characteristics.
4. Describe the working principle PAM and LBM with the effect of parameters and process characteristics.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

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

5. The question paper will have ten questions. Each question is set for 20 marks.
6. 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.
7. The students have to answer 5 full questions, selecting one full question from each module.
8. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Text Books:

1.Modern Machining Process- Pandey and Shah, Tata McGraw Hill 2000
2. New technology - Bhattacharaya 2000.

Reference Books:

1.Production Technology- HMT TATA McGraw Hill. 2001
2. Modern Machining Process -ADITYA. 2002
3. Non-Conventional Machining - P. K. Mishra, The Institution of Engineers (India) Test book series, Narosa Publishing House – 2005.
4. Metals Handbook: Machining(Hardcover) - Joseph R. Davis (Editor), American Society of Metals (ASM) volume 16

Web links and Video Lectures (e-Resources):
1. https://studentlesson.com/definition-application-diagram-types-methods-advantages-and-disadvantages-of-non-traditional-machining-processes/ 2. https://themechanicalengineering.com/ultrasonic-machining/ 3. . https://www.youtube.com/watch?v=dmHv42wda9k 4. https://www.youtube.com/watch?v=l3JHECSW6H8 5. https://www.youtube.com/watch?v=L1D5DLWWMp8 6. https://www.youtube.com/watch?v=kvlBEoLiOGw
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning
1. Students are encouraged to visit the industries for getting the practical exposure

ESC/ETC/PLC	AUTOMOTIVE TRANSMISSION	Semester	3
Course Code	BAU306B	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		

Course objectives:

1. Explain the Constructional, design and working principles of different types of clutches, fluid couplings, torque convertors, different gear box etc.
2. Determine the gear ratio, speed of vehicle and number of teeth on driving and driven gears.
3. Explain the constructional and principle of operation of different types epicyclic gear box, Calculation of gear ratio for epicyclic gear box.
4. Understand necessity, advantages, constructional and principle of operation of different types of automatic transmissions and hydraulic control of ICE and Electric Vehicles.

Teaching-Learning Process (General Instructions)

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

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby plants, start -up ecosystem, incubation centers or MSME industries to give information about the industry culture and demand.
3. Show Video/animation films to explain functioning of various machines.
4. Encourage collaborative (Group Learning) Learning in the class
5. Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking
6. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
10. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

Module-1

Power Required for Propulsion:

The need for transmission, Various Resistances to Motion of the Automobile, Traction, tractive effort Performance curves, acceleration gradeability, drawbar pull, Numerical Problems.

Transmission in ICE vehicles:

Necessity of gear box, Calculation of gear ratios for vehicles, Performance characteristics in different gears, Desirable speed ratios of gear boxes, Constructional details of - Sliding-mesh gear box, Constant-mesh gear box, Synchromesh gear box, auxiliary transmissions, numerical problems.

Module-2

Clutch:

Necessity of clutch in an automobile, requirements of a clutch, Clutch materials, clutch lining, different types of clutches, friction clutches-Single plate clutch, multi plate clutch, cone clutch, centrifugal clutch, electromagnetic clutch, hydraulic clutches, Vacuum operated clutch, Clutch adjustment, Clutch troubles and their causes, Numerical problems.

Fluid Coupling &One-way clutches:

Constructional details of various types, percentage slip, one-way clutches (Over running clutch) like sprag clutch, ball and roller one way clutches, necessity and field of application, working fluid requirements, fluid requirements, fluid requirements and fluid coupling characteristics.

Teaching-Learning Process	Chalk and Talk, Video/animation films, Problem Based Learning (PBL), Lab session

Module-3	
Epicyclic Transmission: Principle of operation, types of planetary transmission, Wilson planetary transmission, Ford-T model gear box , Pre selective mechanism, Vacuum control, pneumatic control, hydraulic control in the planetary gear system, Over drives, Numerical problems.	
Teaching-Learning Process	Chalk and Talk, Video/animation films, Problem Based Learning (PBL), Lab session
Module-4	
Hydrostatic Drives: Principles of hydrostatic drives, different systems of hydrostatic drives, constant displacement pump and constant displacement motor, variable displacement pump and constant displacement motor and variable displacement motor, variable displacement pump and variable displacement motor, applications, plunger type pump and plunger type motor, advantages and limitations, typical hydrostatic drives, hydrostatic shunt drives. **Automatic Transmission:** Principle, general description and working of representative types like Borge - warner, 4-speed and 6-speed automatic transmission longitudinally mounted four speed automatic transmission, hydramatic transmission, the fundamentals of a hydraulic control system, basic four speed hydraulic control system.	
Teaching-Learning Process	Chalk and Talk, Video/animation films, Problem Based Learning (PBL), Lab session
Module-5	
Electric Vehicle Drivetrain EV Transmission Configurations, Transmission Components, Gears, Automobile Differential, Clutch, Brakes , Ideal Gearbox: Steady State Model , Gear Ratio (GR), Torque-Speed Characteristics , EV Motor Sizing , Initial Acceleration , Rated Vehicle Velocity, Maximum Velocity, Maximum Grade ability **Control of the Electric Drive** Introduction to Control- Feedback Controller Design Approach, Modelling the Electromechanical System, The Mechanical System, The PM DC Machine, The DC-DC Power Converter, The PI Controller, Designing Torque Loop Compensation. Designing Speed Control Loop Compensation, Acceleration of Battery Electric Vehicle (BEV) using PM DC Machine, Acceleration of BEV using WF DC Machine, Numerical	
Teaching-Learning Process	Determining Compensator Gain Coefficients, for Torque Loop, Determining Compensator Gain Coefficients for Speed Loop

Course outcome (Course Skill Set)

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

1. Understand and explain the constructional, design and working principles of different types of ICE and EV transmission systems.
2. Determine the various parameters of vehicle transmission systems.
3. Analyse the design parameters, necessity, advantages, constructional and principle of operation of different types of automatic transmissions and hydraulic control.
4. Apply the concept of transmission systems to design new systems for ICE and EVs.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

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- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

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

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

Suggested Learning Resources:

Books

1. Electric Powertrain-Energy Systems, Power Electronics and Drives for Hybrid,Electric and Fuel Cell Vehicles, John G. Hayes ,G. Abas Goodarzi, © 2018 John Wiley & Sons Ltd
2. Advanced Vehicle Technology, Heinz Heisler 2002.
3. Automotive Transmissions and Power trains, Crouse W.H McGraw Hill Co. 5thedn, 1976.
4. Motor Vehicle Newton K and Steeds. W Butter Worth's & Co. Publishers Ltd,1997.
5. Automotive Mechanics , N.K. Giri Khanna Publication, New Delhi, 2014

Automobile Engineering. KirpalSingh, Standard Pub. 2011

Web links and Video Lectures (e-Resources):

1. .https://www.q8oils.com/automotive/automatic-transmission-systems/
2. https://www.leithcars.com/blogs/1421/tutorials/how-manual-transmission-works/
3. https://www.artofmanliness.com/skills/manly-know-how/how-automatic-transmission-works/
4. https://gomechanic.in/blog/automatic-transmission-system-explained/
5. https://www.youtube.com/watch?v=HfN5dEeUyuE
6. https://www.youtube.com/watch?v=WfiTscWVfWI

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

1. Visit nearby EV dealer to understand and for hands on experience on ICE and EV transmission systems, compare and write a report

ESC/ETC/PLC	ADDITIVE MANUFACTURING	Semester	3
Course Code	BAU306C	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	
Examination type (SEE)	Theory		

Course objectives:

1. Understand the principal methods, areas of usage, possibilities and limitations of Additive Manufacturing technologies.
2. To study and analyze the characteristics of the different materials used in Additive Manufacturing
3. To study the basic principles of different processes like polymerization and powder metallurgy, extrusion-based system printing, sheet lamination, beam deposition, and direct write technologies and Direct Digital Manufacturing.
4. To be able to use appropriate additive manufacturing tolls in Automotive engine components and systems.

Teaching-Learning Process (General Instructions)

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

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby plants, start -up ecosystem, incubation centers or MSME industries to give information about the industry culture and demand.
3. Show Video/animation films to explain functioning of various machines.
4. Encourage collaborative (Group Learning) Learning in the class.
5. Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking.
6. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
10. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

Module-1

Introduction and basic principles: Need for Additive Manufacturing, Generic AM process, stereo lithography or 3dprinting, rapid proto typing, the benefits of AM, distinction between AM and CNC machining, other related technologies- reverse engineering technology.

Development of Additive Manufacturing Technology: Introduction, computers, computer-aided design technology, other associated technologies, the use of layers, classification of AM processes, metals systems, hybrid systems, milestones in AM development.

Additive Manufacturing Process chain: Introduction, the eight steps in additive manufacture, variations from one AM machine to another, metal systems, maintenance of equipment, materials handling issues, design for AM, and application areas.

Module-2

Photo polymerization processes: Stereo lithography (SL), Materials, SL resin curing process, Micro- Stereo lithography,

Process Benefits and Drawbacks, Applications of Photo polymerization Processes.

Powder bed fusion processes: Introduction, Selective laser Sintering (SLS), Materials, Powder fusion mechanism, SLS

Metal and ceramic part creation, Electron Beam melting (EBM), Process Benefits and Drawbacks, Applications of Powder

Bed Fusion Processes.

Extrusion-based systems: Fused Deposition Modelling (FDM), Principles, Materials, Plotting and path control, Bio-Extrusion, Process Benefits and Drawbacks, Applications of Extrusion-Based Processes.

Module-3

Printing Processes: evolution of printing as an additive manufacturing process, research achievements in printing deposition, technical challenges of printing, printing process modelling, material modification methods, three-dimensional printing, advantages of binder printing

Sheet Lamination Processes: Materials, Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing,

Thermal bonding, LOM and UC applications.

Beam Deposition Processes: introduction, general beam deposition process, description material delivery, BD systems, process parameters, typical materials and microstructure, processing–structure–properties relationships, BD benefits and drawbacks.

Direct Write Technologies: Background, ink –based DW, laser transfer, DW thermals pray, DW beam deposition, DW liquid-phase direct deposition.

Module-4

Guidelines for Process Selection: Introduction, selection methods for apart, challenges of selection, example system for preliminary selection, production planning and control.

Software issues for Additive Manufacturing: Introduction, preparation of cad models – the STL file, problems with STL files, STL file manipulation.

Post- Processing: Support material removal, surface texture improvements, preparation for use as a pattern, property enhancements using non-thermal techniques and thermal techniques.

Module-5

The use of multiple materials in additive manufacturing: Introduction, multiple material approaches, discrete multiple material processes, porous multiple material processes, blended multiple material processes, commercial applications using multiple materials, future directions.

AM Applications: Functional models, Pattern for investment and vacuum casting, medical models, art models, Engineering analysis models, Rapid tooling, new materials development, Bi-metallic parts, Remanufacturing.

Application: Examples for Aerospace, defence, automobile, Bio-medical and general engineering industries.

Direct digital manufacturing: Align Technology, Siemens and phonak, DDM drivers, manufacturing vs. prototyping, lifecycle costing, future of direct digital manufacturing.

Course outcome (Course Skill Set)

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

1. Demonstrate the knowledge of the broad range of AM processes, devices, capabilities and materials that are available.
2. Demonstrate the knowledge of the broad range of AM processes, devices, capabilities and materials that are available.
3. Understand the various software tools, processes and techniques that enable advanced/additive manufacturing.
4. Apply the concepts of additive manufacturing to design and create components that satisfy product development/prototyping requirements, using advanced/additive manufacturing devices and 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 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

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

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

Suggested Learning Resources:

Books

1. Additive Manufacturing Technologies Rapid Prototyping to Direct Digital Manufacturing I. Gibson l D. W. Rosen l B. Stucker Springer New York Heidelberg Dordrecht, London ISBN: 978-1- 4419-1119-3 e-ISBN: 978- 1-4419-1120-9 DOI:10.1007/978 -1-4419- 1120-9
2. Rapid Prototyping: Principles & Applications Chua Chee Kai, Leong Kah Fai World Scientific 2003
3. Rapid Prototyping: Theory & Practice Ali K. Kamrani, Springer 2006 Emand Abouel Nasr,
4. Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling" D.T. Pham, S.S. Dimov Springer 2001
5. Rapid Prototyping: Principles and Applications in Manufacturing Rafiq Nooran John Wiley & Sons 2006
6. Additive Manufacturing Technology Hari Prasad, A.V. Suresh Cengage 2019
7. Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing Andreas Gebhardt Hanser Publishers 2011

Web links and Video Lectures (e-Resources):

1. https://www.twi-global.com/technical-knowledge/faqs/what-is-additive-manufacturing
2. https://learn-xpro.mit.edu/additive-manufacturing
3. https://www.ge.com/additive/
4. https://archive.nptel.ac.in/courses/112/103/112103306/
5. https://www.digimat.in/nptel/courses/video/112103306/L20.html
6. https://onlinecourses.nptel.ac.in/noc22_me130/preview

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

1. Experimentation – gathering knowledge through experience through lab.
2. Exploration – gathering knowledge and attaining skills through active investigation.
3. Expression – encouraging students to express their views through visual presentations.
4. Case studies, Quiz, Topic Seminar presentation, Assignments

ESC/ETC/PLC	INTRODUCTION TO AI & ML	Semester	3
Course Code	BAU306D	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

1. To understand the basic principles, and applications of AI
2. To demonstrate the reasoning to internal representations of knowledge.
3. To make to understand the of challenges in Artificial Intelligence domain.
4. To acquaint with the future trends of Artificial Intelligence in automotive sector

Teaching-Learning Process (General Instructions)

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

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby plants, start -up ecosystem, incubation centers or MSME industries to give information about the industry culture and demand.
3. Show Video/animation films to explain functioning of various machines.
4. Encourage collaborative (Group Learning) Learning in the class.
5. Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking.
6. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
10. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

Module-1

AI Foundations

History of AI, Turing test, Cybernetics, The Origin Story, AI Winter, Rise and Fall of Expert systems, Technology drivers for Modern AI, Structure of AI

Problem Representation

Problem Characteristics, Problem Representation in AI: 1) State Space Representation; 2) Problem Reduction, Production System, Types of Production Systems, Conflict Resolution

Module-2

Machine Learning

General Model for Machine Learning (ML), Characteristics of ML, Standard Deviation, Normal Distribution and Baye's Theorem, Feature Extraction, Applications of ML, ML process, Supervised Unsupervised & Reinforcement Learning

Types of Machine Learning

Naïve Bayes Classifier, K-Nearest Neighbour, Linear Regression, Decision Tree, Ensemble Modelling, K-Means Clustering

Module-3

Deep Learning

Introduction, Difference between ML Deep Learning, Artificial Neural Networks, Backpropagation, Drawbacks

Various Neural Networks

Recurrent Neural Networks, Convolutional Neural Networks, Generative Adversarial Networks, Applications and case studies

Module-4

Robotic Process Automation (RPA)

Introduction to RPA, Advantages and Disadvantages, RPA Implementation, RPA & AI

Natural Language Processing (NLP)

Introduction to NLP, Challenges, Steps behind translating language, NLP in real world (Case Studies), Chatbots

Module-5
Python for AI Significance of Python in AI, Python Libraries for AI, Features of Python: Lists, Tuples, Dictionaries and Conditionals (Definition, formats and examples), Loops, Conditional statements **Implementation of AI & Future** Steps to implement AI, Autonomous Cars, Technological Unemployment, Weaponization of AI, AGI, Social Good

Course outcome (Course Skill Set)

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

1. Understand the basic principles and goals of AI tasks.
2. Outline the role of AI in different real-time applications.
3. Construct a problem with the suitable AI task.
4. Demonstrate the importance of biology in AI and could take independent survey for the future development of AI.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered.
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

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

5. The question paper will have ten questions. Each question is set for 20 marks.
6. 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.
7. The students have to answer 5 full questions, selecting one full question from each module.
8. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:

Books

Text Book:

1. Artificial Intelligence Basics A Non-Technical Introduction — Tom Taulli A
2. Artificial Intelligence Basics: A self-teaching Introduction – Gupta N, Mangla R.

Reference Books:

1. Blay Whitby, Artificial Intelligence: A Beginners Guide, Second Edition, One World Publisher, 2008.
2. Ian H. Witten, Eibe Frank, Data Mining: Practical Machine Learning Tools and Techniques, Morgan Kaufman Publishers, 3rd Edition, 2011.
3. AurélienGéron ,Hands on Machine Learning with Scikit-Learn and TensorFlow [Concepts, Tools, and Techniques to Build Intelligent Systems], Published by O'Reilly Media,2017
4. Elaine Rich, Kevin Knight and Shivashankar B. Nair, Artificial Intelligence , TMH Education Pvt. Ltd., 2008.
5. Dan W. Patterson, Introduction to Artificial Intelligence and Expert Systems, Pearson.

Web links and Video Lectures (e-Resources):

1. https://www.youtube.com/watch?v=4RixMPF4xis
2. https://www.youtube.com/watch?v=wnqkfpCpK1g
3. https://www.techtarget.com/searchenterpriseai/definition/machine-learning-ML
4. https://marutitech.com/artificial-intelligence-and-machine-learning/
5. https://www.youtube.com/watch?v=lTzHlU3OrXs

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

1. Course seminar
2. Term projects
3. Assignments

UHV SOCIAL CONNECT AND RESPONSIBILITY		Semester	3
Course Code	**BSCK307**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1-0-0-0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	01	Exam Hours	1
Examination type (SEE)	Theory/practical/Viva-Voce /Term-work/Others		

AEC/SEC	RURAL DEVELOPMENT	Semester	3
Course Code	BAU358A	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1 0 0 0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	01	Exam Hours	1
Examination type (SEE)	Theory (OBJECTIVE TYPE)		

Course objectives:

1. To provide the students the flavour of basics of rural development
2. To motivate students to contribute towards rural development

Teaching-Learning Process (General Instructions)

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

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby plants, start -up ecosystem, incubation centers or MSME industries to give information about the industry culture and demand.
3. Show Video/animation films to explain functioning of various machines
4. Encourage collaborative (Group Learning) Learning in the class
5. Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking
6. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
10. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

Module-1

Introduction to Rural Development:
Concept of Rural Development- meaning and definition, Scope and Importance of Rural Development, Approaches of Rural Development, Need of Rural Development.

Module-2

Rural Development Planning and Management:
Rural Development Planning –District Rural Development Agency (DRDA)- Organisation Structure, Functions of DRDA, NGO's and Rural Development, Self Help Groups (SHG's) formation.

Module-3

Agriculture Enterprise &Agro-based industries:Agricultural Entrepreneur- Meaning, Definition and Importance, Agri-business Enterprises-Issues and prospectus

Module-4

Micro-financing, Food and Agricultural Marketing and Management of agro-products, Agro-based industries.

Module-5

Rural Development and Internet, Information & Communication Technology (ICT) for Rural Development, IT – Enable Services for an e-village, Challenges of Rural Development

Course outcome (Course Skill Set)

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

1. Explain the need/significance of rural development and prepare rural development plans
2. Implement development plans in rural agro-based industries
3. Make use of ICT in the rural development
4. Demonstrate the significance of rural development to rural people

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

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

OR

Suggested Learning Resources:

Books

1. Fundamentals of rural development, Dr. Mangesh Wagmore, Dr. S. G. Walke, Thakur Publications Pvt. Ltd., Pune.

Web links and Video Lectures (e-Resources):

1. https://www.youtube.com/watch?v=1_w2gDpemcc
2. https://www.youtube.com/watch?v=lcQWQWf5XiU
3. https://www.youtube.com/watch?v=R6qvm0AgWRQ
4. https://www.youtube.com/watch?v=QVWhnJP4rcU

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

1. Students should visit nearby rural areas to study the present situation.
2. Identify such practices which will improve the standard of living, income of rural folks and prepare action plan for the same.
3. Organize awareness camps in rural areas on use of information and communication tools.
4. Experiential learning through field visits

AEC/SEC	BHARAT STAGES (BS) OF EMISSION STANDARDS	Semester	3
Course Code	**BAU358B**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	01	Exam Hours	1
Examination type (SEE)	Theory (OBJECTIVE TYPE)		

Course objectives:

1. To understand the INDIA BHARAT STAGE EMISSION STANDARDS
2. To apply the higher engineering skills acquired to minimize the vehicle pollution.
3. To use /develop new technology to address the pollution from vehicles

Teaching-Learning Process (General Instructions)

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

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby plants, start -up ecosystem, incubation centers or MSME industries to give information about the industry culture and demand.
3. Show Video/animation films to explain functioning of various machines
4. Encourage collaborative (Group Learning) Learning in the class
5. Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking
6. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
10. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

Module-1

Effect of Air Pollution: Effect of air pollution on Human Health, Effect of air pollution on animals, Effect of air pollution on plants and global warming.,Contribution of ice vehicles to atmospheric pollution,

Module-2

Mechanism of pollutant formation in Engines:
Nitrogen Oxides: Formation of nitrogen oxides, formation of NO2, NO formation in spark ignition engines, NOx formation, in compression ignition engines.
Carbon Monoxide: Formation of carbon monoxide in SI and CI Engines.

Module-3

Unburned Hydrocarbons: Back ground, flame quenching and oxidation fundamentals, HC emissions from spark ignition engines, HC emission mechanisms in diesel engines.
Particulate emissions: Spark ignition engine particulates, characteristics of diesel particulates, soot formation fundamentals, soot oxidation, crankcase emissions.India

Module-4

Bharat stage I&II emission standards , India Bharat stage III emission standards , Data comparison and analysis, Depict the data on an excel sheet and analyse the changes over each stage

Module-5

India Bharat stage IV emission standards , India Bharat stage V emission standards , India Bharat stage VI emission standards, Data comparison and analysis, Depict the data on an excel sheet and analyse the changes over each stage

Course outcome (Course Skill Set)

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

1. Understand the essence of pollution control in Indian Context
2. Analyze the various stages of BS emission and explore the possibility of limit the pollution levels further
3. Apply the engineering knowledge acquired to provide the solution to reduce the pollution from ICE vehicles.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

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

OR

Suggested Learning Resources:

Books:

1 Automobiles and pollution Paul Dagobert (SAE) ,2001

2 Internal combustion engine fundamentals ,John B. Heywood McGraw Hill Book, publication, 1998.

Web links and Video Lectures (e-Resources):

1. . https://www.araiindia.com/pdf/Indian_Emission_Regulation_Booklet.pdf
2. https://www.youtube.com/watch?v=PSIqPK-k17Y

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

1.Conduct emission testing of 2 and 4 wheeled vehicles and compare the emission levels visa-vis Bharat V and VI standards, draw conclusion

2. Visit nearby emission testing center , interact and learn the testing procedure for petrol and diesel vehicles

AEC/SEC	EXCEL SHEET FOR ENGINEERS	Semester	3
Course Code	BAU358C	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	01	Total Marks	100
Credits	01	Exam Hours	03
Examination type (SEE)	Practical		

Course objectives:

1. To Identify and use different functions of excel sheet.
2. To solve simple integration and differential equations related to engineering applications.
3. To do regression analysis, solve differential and integral equations of engineering problems using the tools/ functions.

Sl.NO	Experiments	
1	**Introduction & Basics** To carry out data analysis for a given set of data, using the formula command, highlighting the following: a) Length b) Count c) Average d) Mathematical Operations (Add, Multiply, Divide, Subtract) e) trigonometric functions (Sine, Cosine, Tan and Cos functions)	
2	**Loops** To carry out FOR & WHILE loop in a spreadsheet using functions	
3	**Conditional Statement** To implement conditional IF statement in a spreadsheet	
4	**To differentiate between the data and plot and visualize data set in the spreadsheet using,** a) Scatter Plot (with Error bars) b) Line plot (with Error bars)) c) Bar charts (with error bars) d) Histogram	
5	**Regression analysis** a) Linear Regression b) Calculating Slope in Linear Regression c) Residual plot.	
6	**Matrices** a) Addition of 2 or more matrices b) Multiplication of 2 or more matrices c) Transpose d) Inverse	
7	Creation of simple 3D automobile shapes (body shape)	
	Demonstration Experiments (For CIE)	
8	**Differentiation** To evaluate, differentiate and plot the following equations a. $f(x) = 6x^2 - 12x + 4$ b. $f(x) = 2x^3 + 6x^2 - 12x + 4$ c. $f(x) = 6x^4 + 2x^3 + 6x^2 - 12x + 4$	
9	**Integration** To evaluate, integrate and plot the following equation a) $\int_{-2}^{3}(6x^2 - 12x + 4)dx$ b) $\int_{-2}^{3}(2x^3 + 6x^2 - 12x + 4)dx$ c) $\int_{-2}^{3}(6x^4 + 2x^3 + 6x^2 - 12x + 4)dx$	

10	To construct drive cycles for EVs (2, 3, and 4 wheelers) using excel sheets

Course outcomes (Course Skill Set):

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

1. Identify and use different functions of excel sheet
2. Solve simple integration and differential equations related to engineering applications
3. Do regression analysis of engineering problems and apply different techniques
4. To differentiate between the data and plot and visualize data set in the spreadsheet and create different plots on their own for technical paper writing

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

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

OR

MCQ (Multiple Choice Questions) are preferred for 01 credit courses, however, if course content demands the general question paper pattern that followed for 03 credit course, then

1. The question paper will have ten questions. Each question is set for 10 marks.
2. There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub-questions (with maximum sub-questions of 02, with marks distributions 5+5, 4+6, 3+7).
3. The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Books

1. McFedries Paul Microsoft Excel 2019 Formulas And Functions Microsoft Press, U.S, 2019 Edition
2. Excel 2019 Bible, Michael Alexander, 1st edition, Wiley
3. Excel 2019 All-in-One for Dummies, Greg Harvey, 1st edition For Dummies

Web links and Video Lectures (e-Resources):
Lectures (e-Resources): 1. https://www.instructables.com/Spreadsheet-Calculus-Derivatives-and-Integrals/ 2. https://www.microsoft.com/en-in/microsoft-365/excel 3. https://support.microsoft.com/en-gb/office/video-start-using-excel-ea173bff-ff4c-476f-9c1f-3768acb9c8db
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning 1. Conduct experiments in the fluid mechanics, heat transfer, engine labs, extract data and use the appropriate tools of Microsoft excel for demonstration of the features of excel sheet. 2. Assignment based on experimental data from journals and articles.

AEC/SEC	CLAY MODELLING	Semester	3
Course Code	BAU358D	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	01	Total Marks	100
Credits	01	Exam Hours	03
Examination type (SEE)	Practical		

Course objectives:

1. To introduce the students to the methods of Clay modelling techniques.
2. To provide the students with theoretical aspects of clay modelling
3. To train students to create clay models of automobile by using the clay and modelling tools.

Sl.NO	Experiments	
1	Introduction to clay modelling.	
2	Different types of clay materials and their properties used for modelling.	
3	Different tools required for clay modelling.	
4	Mould making.	
5	Clay preparation.	
6	Creating simple 3D forms with clay	
7	Creation of simple 3D automobile shapes (body shape)	
	Demonstration Experiments (For CIE)	
8	Basics of dynamic forms Methods of clay modelling	
9	Visit to fine arts school to get hands on experience , Watch https://www.youtube.com/watch?v=j_xN30_4q1U and try to replicate using clay Methods of clay modelling	
10	Express visual ideas through making drawings and creating a three-dimensional clay models.	
11	Use imagination and invention to represent form, texture, and detail in a clay sculpture	

Course outcomes (Course Skill Set):

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

1. Prepare clay material for creating simple 3D forms.
2. Prepare simple 3D forms by using clay modelling tools and techniques.
3. Create 3D automobile body shapes and other simple show piece models.

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Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

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

OR

MCQ (Multiple Choice Questions) are preferred for 01 credit courses, however, if course content demands the general question paper pattern that followed for 03 credit course, then

1. The question paper will have ten questions. Each question is set for 10 marks.
2. There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub-questions (with maximum sub-questions of 02, with marks distributions 5+5, 4+6, 3+7).
3. The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Books

1. Clay Modelling for Beginners: An Essential Guide to Getting Started in the Art of Sculpting Clay ~ (Clay Modelling | Clay Modeling | Clay Art) - by Jeanie Hirsch-
2. The Indian Technique of Clay Modelling- Motilal Banarsidass Publishers -1970 Web links and Video

Web links and Video Lectures (e-Resources):

Lectures (e-Resources):

1. .https://www.youtube.com/watch?v=1n7apcgQiz0
2. https://www.youtube.com/watch?v=AFKnG-vENUw
3. https://www.youtube.com/watch?v=CDPlLhfvxPg

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

1. Construct the clay models of different commercial vehicles.

4th- Semester

PCC	THEORY OF MACHINES	Semester	4
Course Code	BAU401	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3-0 -0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

1. Define and explain the basic terms associated with the kinematics of machinery
2. Determine the velocity and acceleration of links using graphical methods.
3. Define gear terminology and determine the velocity ratio in different gear trains.
4. Calculate static and dynamic forces at various points in different types of mechanisms.

Teaching-Learning Process (General Instructions)

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

1. Lecturer method (L) does not mean only the traditional lecture method. Still, different teaching methods may be adopted to develop the outcomes.
2. Arrange visits to manufacturing units of various mechanisms and machines to give brief information about the role of mechanisms in existing systems.
3. Show Video/animation films to explain the functioning of various mechanisms
4. Encourage collaborative (Group Learning) Learning in the class
5. Ask at least three HOTS (Higher-order Thinking) questions in the class, which promotes critical thinking
6. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
7. Topics will be introduced in multiple representations.
8. Show the different ways to solve the same problem and encourage the students to come up with creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the= students' understanding.
10. Individual teachers can devise innovative pedagogy to improve teaching-learning.

Module-1

Introduction, kinematic chains, inversions & mechanisms: Definitions Link or element, kinematic pairs, Degrees of freedom, Grubler's criterion (without derivation), Kinematic chain, Mechanism, Structure, Mobility of Mechanism, Inversion, Machine. Inversions of Four bar chains; Single slider crank chain and Double slider crank chain.

Velocity and acceleration analysis of mechanisms: Velocity and acceleration graphical analysis of Four Bar mechanism, slider-crank mechanism: Relative velocity and acceleration of particles in a shared link, Angular velocity and angular acceleration of links, the velocity of rubbing. Definition.

Module-2

Gears & Gear Trains: Gear terminology, Law of gearing, Characteristics of involute action, Path of contact, Arc of contact, Contact ratio of Spur & Helical gears, Interference in involute gears. Methods of avoiding interference, Back lash, Types of Gear trains, velocity ratio, Train value, tabular methods of finding velocity ratio of epicyclic gear trains.

Cams: Classification of cams, Types of followers, Cam nomenclature, Follower motions and motion analysis, of SHM, Motion with uniform acceleration and deceleration, uniform velocity, Cam profile with offset knife-edge follower. (Simple numerical on the above)

Module-3

Static Force Analysis: Introduction, Static equilibrium, Equilibrium of two forces, three force and four force members, Members with two forces and torque, Free body diagrams, Static force analysis (graphical) of four-bar mechanism slider-crank mechanism without and without friction.

Dynamic/Inertia Force Analysis: Introduction, D'Alembert's principle, Inertia force, inertia torque, dynamically equivalent systems, correction couple, line of action of inertia force in a link, inertia force analysis (graphical) of a four-bar mechanism, inertia force analysis (analytical) of slider-crank mechanism [(i) neglecting the mass of the connecting rod; (ii) considering the mass of the connecting rod]

Module-4
Flywheel: Introduction, Turning moment diagrams, Fluctuation of Energy and speed, energy stored in a flywheel, determination of size of flywheels. **Governors:** Introduction, Types of governors; force analysis of Porter and Hartnell governors. Controlling force, stability, condition for stability, sensitiveness, isochronism, hunting, effort, and governor power.
Module-5
Friction: Types friction, the law of friction, force analysis of the sliding body, screw friction, screw jack, flat pivot bearing, flat collar bearing. **Belt and Chain drive:** Types of belts and chains, flat belts; angular velocity, the law of belting, length of open and cross belts, centrifugal tension, and condition for maximum power. V-belts, the ratio of tensions, chain drives, chain pits and chain length.

Course outcome (Course Skill Set)

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

1. Define and explain the basic terms such as kinematic chain, kinematic pair, degree of freedom etc., associated with the kinematics of machinery, inversions of four-bar mechanism, single slider crank mechanism and double slider-crank mechanism.
2. Determine the mobility of given mechanisms.
3. Determine the velocity and acceleration of links using graphical methods.
4. Plot cam profiles using displacement diagrams for various types of motions.
5. Calculate static and dynamic forces at various points in different types of mechanism flywheel dimensions.
6. Find the controlling force in various governors.
7. Describe the fluctuation of energy in flywheel, various types of governors, and understand the method of finding.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

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

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

Suggested Learning Resources:

Books

Textbook/s

1. Theory of Machines Rattan S. S. Tata McGraw Hill, Publishing Company Ltd 2012
2. Theory of Machines Sadhu Singh Pearson Publications, New Delhi 2000

Reference Books

1. Theory of Machines and Mechanisms, Joseph E. Shigley, Jr. Uicker John, McGraw Hill publications, 1998
2. Dynamics of Machinery A. R. Holowenko, John Wiley & sons. 2000
3. Theory of Machines R. S. Khurmi and J. K. Gupt S. Chand and Co 2015

Web links and Video Lectures (e-Resources):

1. https://nptel.ac.in/courses/112106270
2. https://www.youtube.com/watch?v=QSUOsQokxS8

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

1. https://mm-nitk.vlabs.ac.in/List%20of%20experiments.html

IPCC	MECHANICAL MEASUREMENT AND METROLOGY	Semester	4
Course Code	**BAU402**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	3
Examination nature (SEE)	Theory		

Course objectives:

1. Expound the significance of mechanical measurements, elements of a generalized measuring system, theory and working principle of measuring instruments for the measurement of force, torque, flow, temperature, pressure, and strain.
2. Define Metrology, appreciate the objectives of Metrology, and explain the importance of standards.
3. Interpret the limits specified, identify fits and explain the concept of tolerance.
4. Use comparators, screw and gear metrology

Teaching-Learning Process (General Instructions)

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

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby plants, start -up ecosystems, incubation centers or MSME industries to give information about the industry culture and demand.
3. Show Video/animation films to explain functioning of various measurement systems
4. Encourage collaborative (Group Learning) Learning in the class
5. Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking
6. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
10. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

MODULE-1

Measurements, Measurement Systems and Standards of Measurement: Definition, significance of measurement, generalized measurement system, definition and concept of accuracy, precision, sensitivity, Calibration, threshold, hysteresis, repeatability, linearity, loading effect, system response, time delay, errors classification in measurement.

Characteristics of Measurement Systems: Review of Basic Fourier Series and its implementation to signal transformations, understanding of systems subjected to step, ramp, impulse and sinusoidal signals.

Transducers, Intermediate Modifying and Display Devices:

Primary and secondary transducers, Mechanical, electrical transducers (resistive capacitive and piezoelectric

MODULE-2

Definition and objectives of metrology, Standard of length-International prototype meter, Imperial standard yard, Wave length standard, Subdivision of standards, line and end standard, comparison, Transfer from line standard to end standard, calibration of end bars (Numerical)

System of Limits, Fits, Tolerance and essence of Gauging:

Definition of tolerance, Specification in assembly, Principle of interchangeability and selective assembly, limits of size, Indian standards, concept of limits of size and tolerances, definition of fits, hole basis system, shaft basis

MODULE-3

Comparators:

Introduction to Comparator and its Classification, dial indicators, optical comparators, Zeiss ultra-optimeter, Electric and electronic comparators –principles, LVDT, pneumatic comparators, solex comparators

Angular Measurements and Interferometer:

Bevel protractor. Sine principle, use of sine bars, sine centre, angle gauges (numerical on building of angles), Clinometers. Principle of interferometry, autocollimator, optical flats

MODULE-4

Measurement of Force, Torque, Displacement, Velocity and strain: Principle, analytical balance, Piezo type force transducer – Principle, Strain-based force transducer – principle, torque measurement (for driveline shaft), types of dynamometers, Eddy current dynamometer, Laser Pickup for displacement measurement, Particle image velocimetry for velocity measurement, Preparation and mounting of strain gauges, Methods of strain measurement

Flow measuring devices – turbine meter, electromagnetic and ultrasonic flow meter

MODULE-5

Pressure and Temperature Measurement:

Principle, use of elastic members, bridge man gauge, McLeod gauge, thermal conductivity gauge, (Pirani gauge and thermocouple vacuum gauge) ionization gauge, Resistance thermometers, thermocouple, law of thermocouple, thermocouple circuits, thermocouple materials, pyrometers, optical pyrometer.

Advanced metrology:

Inherent problems with present systems, ultra-violet recorders, Universal measuring machine (UMM) and Coordinate measuring machine (CMM), Feature measurement using CMM, Laser vision

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

Sl.NO	Experiments
1	Calibration of Thermocouple
2	Calibration of LVDT,
3	Calibration of Load cell
4	Measurement of Cylindricity and Circularity of Automobile Components
5	Measurement of Straightness and Flatness
6	Measurement of Angle using Sine Center / Sine bar / bevel protractor
7	Measurements using Optical Projector / Toolmaker Microscope, Measurement using Optical Flat
8	1. Determination of modulus of elasticity of a mild steel specimen using Strain gauges. 2. Speed measurement-using Stroboscope
9	Can be Demo experiments for CIE: Calibration of Pressure Gauge (Bourdon tube pressure gauge)
10	Can be Demo experiments for CIE: Display of various signals through programming software
11	Can be Demo experiments for CIE: Practical demonstration of tolerances, Measurement of gear tooth profile using Gear Tooth Vernier/Gear Tooth Micrometer
12	Can be Demo experiments for CIE: Measurements of Surface roughness using Tally Surf/Mechanical Comparator

Course outcomes (Course Skill Set):

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

1. Explain significance of mechanical measurements, elements of a generalized measuring system, theory and working principle of measuring instruments for the measurement of force, torque, flow, temperature, pressure and strain
2. Define Metrology, appreciate the objectives of Metrology, and explain the importance of standards.
3. Interpret the limits specified, identify fits, and explain the concept of tolerance.
4. Use comparators, screw, and gear metrology

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

CIE for the theory component of the IPCC (maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

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

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 may include questions from the practical component.

Suggested Learning Resources:

Books

1. Engineering Metrology. R. K. Jain Khanna Publishers, New Delhi 2007
2. Mechanical Measurements and Control D. S. Kumar Metropolitan Book Co. Pvt. Ltd, New Delhi 2005
3. Handbook of Industrial Metrology ASTME PHI 4th edition
4. Engineering Metrology K. J. Hume Kalyani publishers Third (metric) Edition

Web links and Video Lectures (e-Resources):

1. https://www.youtube.com/watch?v=8DTt-f6wQxE
2. https://www.youtube.com/watch?v=HpIEeBtJupY
3. https://www.slideshare.net/taruian/introduction-to-mechanical-measurements-and-metrology
4. https://nitsri.ac.in/Department/Mechanical%20Engineering/MEC_405_Book_2,_for_Unit_2B.pdf
5. https://nptel.ac.in/courses/112106179
6. https://nptel.ac.in/courses/112105048
7. https://www.youtube.com/watch?v=YmSvQe2FDKs

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

1 http://vlabs.iitb.ac.in/vlabs-dev/vlab_bootcamp/bootcamp/mmsynergy/labs/exp1/index.html

2 https://cgpit-bardoli.edu.in/mechanical-measurement-and-metrology-mmm-lab/

IPCC	FLUID MECHANICS AND FLUID MACHINES	Semester	4
Course Code	**BAU403**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	3
Examination nature (SEE)	Theory		

Course objectives:

1. Define fluid properties; describe Pascal's law, Hydrostatic law.
2. Calculate total pressure given point and between sections of pipe, Buoyancy and Stability of floating objects.
3. Apply Bernoulli's principle to solve fluid flow problems.
4. Make dimensional analysis of fluid mechanics problems.
5. Analyze various forces acting on submerged bodies

Teaching-Learning Process (General Instructions)

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

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby power plants, receiving stations and substations to give brief information about electrical power generation.
3. Show Video/animation films to explain functioning of various machines.
4. Encourage collaborative (Group Learning) Learning in the class.
5. Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking.
6. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
10. Individual teachers can device innovative pedagogy to improve teaching-learning.

MODULE-1

Properties of fluids: Introduction, Properties of fluids, properties of solid, liquid and gaseous fuels, viscosity, thermodynamic properties, surface tension, Capillarity, vapor pressure and cavitation.

Fluid Statics:

Fluid pressure at a point, Pascal's law, pressure variation in a static fluid, concept of absolute, gauge, atmospheric and vacuum pressures, simple manometers and differential manometers. Total pressure and center of pressure on submerged plane surfaces; horizontal, vertical and inclined plane surfaces, curved surface submerged in liquid.

MODULE-2

Buoyancy:

Buoyancy, centre of buoyancy, meta centre and meta-centric height, conditions of equilibrium of Floating and submerged bodies, determination of Meta-centric height experimentally and theoretically.

Fluid Kinematics:

Types of fluid flow, continuity equation in 2D and 3D (Cartesian Co-ordinates only), Velocity and acceleration, velocity potential function and stream function.

MODULE-3

Fluid dynamics: Introduction, equation of motion, Euler's equation of motion, Bernoulli's equation from first principles and from Euler's equation, limitations of Bernoulli's equation. Fluid Flow Measurements: Venturi meter, orifice meter, pitot-tube, vertical orifice, V-Notch, and rectangular notches.
MODULE-4
Flow through pipes: Minor losses through pipes. Darcey's and Chezy's equation for loss of head due to friction in pipes. HGL and TEL. Laminar flow and viscous effects: Reynolds's number, critical Reynolds's number, laminar flow through Circular pipe-Hagen Poiseuille's equation, laminar flow between parallel and stationary plates. Definition of displacement momentum, energy thickness
MODULE-5
Dimensional analysis: Introduction, derived quantities, dimensions of physical quantities, dimensional homogeneity, Rayleigh's method, Buckingham π theorem, dimensionless numbers, similitude, types of similitude. **Centrifugal pumps, air compressors and blowers** Centrifugal pump terminology, working, Minimum starting speed, Operation of a single stage reciprocating compressor, work input through P-V diagram, efficiencies, minimum work for compression, multistage compressor, working of a blower, simple numerical.

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

Sl.NO	Experiments
1	Determination of flash and fire point of fuels.
2	Determination of calorific value of solid, liquid and gaseous fuel.
3	Determination of viscosity of oils using Torsion viscometer.
4	Determination of viscosity of oils using redwood, viscometer.
5	Determination of viscosity of oils using Say bolt viscometer.
6	Determination of coefficient of discharge of venturi meter and orifice meter V-Notch and rectangular notches.
7	Determination of major and minor losses in pipe flow (sudden enlargement, contraction, bend, entry and exit).
8	Performance testing of fluid pumps (Centrifugal, reciprocating and gear pumps). Performance testing of air blowers.
9	Can be Demo experiments for CIE.- Determination of carbon residue and moisture content in a
10	Can be Demo experiments for CIE- Determination of cloud and pour point of oils.
11	Can be Demo experiments for CIE- Flow visualization in a wind tunnel / using a directed fan

Course outcomes (Course Skill Set):

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

1. Understand the properties of fluids, basic principles, laws and concepts of fluid mechanics and fluid machineries like pumps and compressors.
2. Analyze the fluid flow problems concerning pressure, force, flow measurement, buoyancy and stability, dimensionless parameters, and fluid machineries.
3. Apply the fluid kinetics and dynamics principles to solve fluid flow problems.
4. Design and compare the various instruments propelled by fluid machines

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

CIE for the theory component of the IPCC (maximum marks 50)

- IPCC means practical portion integrated with the theory of the course.
- CIE marks for the theory component are **25 marks** and that for the practical component is **25 marks**.
- 25 marks for the theory component are split into **15 marks** for two Internal Assessment Tests (Two Tests, each of 15 Marks with 01-hour duration, are to be conducted) and **10 marks** for other assessment methods mentioned in 22OB4.2. The first test at the end of 40-50% coverage of the syllabus and the second test after covering 85-90% of the syllabus.
- Scaled-down marks of the sum of two tests and other assessment methods will be CIE marks for the theory component of IPCC (that is for **25 marks)**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the theory component of IPCC.

CIE for the practical component of the IPCC

- **15 marks** for the conduction of the experiment and preparation of laboratory record, and **10 marks** for the test to be conducted after the completion of all the laboratory sessions.
- On completion of every experiment/program in the laboratory, the students shall be evaluated including viva-voce and marks shall be awarded on the same day.
- The CIE marks awarded in the case of the Practical component shall be based on the continuous evaluation of the laboratory report. Each experiment report can be evaluated for 10 marks. Marks of all experiments' write-ups are added and scaled down to **15 marks**.
- The laboratory test **(duration 02/03 hours)** after completion of all the experiments shall be conducted for 50 marks and scaled down to **10 marks.**
- Scaled-down marks of write-up evaluations and tests added will be CIE marks for the laboratory component of IPCC for **25 marks**.
- The student has to secure 40% of 25 marks to qualify in the CIE of the practical component of the IPCC.

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**)

5. The question paper will have ten questions. Each question is set for 20 marks.
6. 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.
7. The students have to answer 5 full questions, selecting one full question from each module.
8. Marks scored by the student shall be proportionally scaled down to 50 Marks

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 may include questions from the practical component.

Suggested Learning Resources:

Books

1. Fluid Mechanics Piyush. K. Kundu ELSEVIER 3rd Ed. 2005.
2. Fluid Mechanics Bansal, R. K. Lakshmi Publications 2004.
3. Fluid Mechanics and hydraulics Dr. Jagadishlal, Metropolitan Book Co-Ltd. 1997
4. Fluid Mechanics (SI Units) Yunus A. Cengel John M.Cimbala TMH 2006.
5. Fluid Mechanics and Fluid Power Engineering Kumar. D. S. Kataria and Sons 2004

Web links and Video Lectures (e-Resources):

1. http://elearning.vtu.ac.in/econtent/index.php#
2. http://nptel.vtu.ac.in/econtent/courses/CV/15CV33/index.php
3. https://www.youtube.com/watch?v=PgKsr2_-oxc
4. http://nptel.vtu.ac.in/econtent/Web/CV/15CV33/index.php
5. https://backbencher.club/fluid-mechanics/
6. https://www.youtube.com/watch?v=2yFgWu73hzo

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

1. Virtual Lab link- http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/fluid_mechanics/index.php
2. http://vlabs.iitb.ac.in/vlabs-dev/labs/mit_bootcamp/fluid_mechanic_13082019/labs/index.php

PCCL	COMPUTER AIDED MACHINE DRAWING				Semester	4
Course Code	BAU404				CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0	0	2	0	SEE Marks	50
Total Hours of Pedagogy	1				Exam Hours	100
Credits	1				Exam Hours	3
Examination type (SEE)	Practical					

Course objectives:

1. Use tools of drafting and modelling software
2. Draw the sections of solids, orthographic views of simple machine parts using software,
3. Sketch and explain various thread forms and their application.
4. Calculate parameters related to riveted joints and sketch them.
5. Create solid models and draw the sectional views of automotive systems.

Sl. NO	Experiments
1	**Introduction:** Review of graphic interface of the software. Basic sketching commands and navigational Commands. Starting a new drawing sheet. Sheet sizes. Naming a drawing. Drawing units, grid and snap. **Sections of Solids:** Sections of Pyramids, Prisms, Cubes, Tetrahedrons, Cones and Cylinders resting only on their bases (No problems on, axis inclinations, spheres and hollow solids). True shape of sections. **Orthographic views:** Conversion of pictorial views into orthographic projections of simple machine parts with or without section. (Bureau of Indian Standards conventions are to be followed for the drawings) Hidden line conventions. Precedence of lines.
2	**Thread forms:** Thread terminology, forms of threads – BSW Thread, Sellers thread, ISO Metric thread, square and Acme thread. Conventional representation of threads. **Fasteners:** Hexagonal headed bolt and nut with washer (assembly), square-headed bolt and nut with washer (assembly). Types of Bolt heads, special types of nuts, locking of nuts, Studs, set screws, grub screws.
3	**Keys, cotter and knuckle joints:** Types of Keys, Cotter and knuckle Joints **Riveted Joints: lap joints-** single and double riveted lap joints, butt joints with single/double cover straps (Chain and Zigzag, using snap head rivets).
4	**Automotive components:** Spark plug, IC Engine valve, Rocker arm, Cylinder liner, Stub-axle, Oldham's coupling and universal coupling (Hooks' Joint) **Couplings:** Split Muff coupling, Protected type flanged coupling.
5	**Assembly drawing of following machine parts (**3D parts to be created and assembled and then getting 2D drawing with required views, along with 3D part drawings). 1. Plummer block (Pedestal Bearing) 2. Petrol Engine piston 3. I.C. Engine connecting rod 4. Screw Jack 5. Single cylinder crank shaft
	Demonstration Experiments (For CIE)
6	Exercise on reading the industrial machine parts drawing
7	Exercise on reading the industrial assembly drawings and list out the observations

Course outcomes (Course Skill Set):

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

1. Use tools of drafting and modeling software
2. Draw the sections of solids, orthographic views of simple machine parts using software.
3. Sketch various thread forms, different types of joints and fasteners and explain their application.
4. Prepare assembly drawing from the list of components and read / interpret standard industry drawings.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

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

OR

MCQ (Multiple Choice Questions) are preferred for 01 credit courses, however, if course content demands the general question paper pattern that followed for 03 credit course, then

1. The question paper will have ten questions. Each question is set for 10 marks.
2. There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub-questions (with maximum sub-questions of 02, with marks distributions 5+5, 4+6, 3+7).
3. The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

1. Engineering Drawing and Design, David A. Madsen, David P. Madsen · Cengage Learning, 2012,
2. Machine Drawing K. R. Gopala Krishna, Subhash Publication.
3. A Primer on Computer Aided Machine Drawing Published by VTU
4. A Textbook of Computer Aided Machine Drawing S. Trymbaka Murthy CBS Publishers, New Delhi 2007
5. Machine Drawing with Auto CAD Goutam Purohit & Goutham Ghosh 1st Indian print Pearson Education, 2005
6. Machine Drawing N. Siddeshwar, P. Kanniah, V. V. S. Sastri Tata McGraw-Hill, 2006

Web links and Video Lectures (e-Resources):

1. https://www.wikihow.com/Read-Engineering-Drawings

ESC/ETC/PLC	AUTOMOTIVE POLLUTION AND CONTROL	Semester	4
Course Code	BAU405A	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

1. Explain air pollution and pollutants, their sources & their effects.
2. Describe different parameters responsible for pollutant formation.
3. Choose instruments for pollution measurements.
4. Analyze measurement of pollutants.

Teaching-Learning Process (General Instructions)

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

1. These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.
2. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
3. Arrange visits to nearby power plants, receiving station and substations to give brief information about the electrical power generation.
4. Show Video/animation films to explain functioning of various machines
5. Encourage collaborative (Group Learning) Learning in the class
6. Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking
7. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
8. Topics will be introduced in a multiple representation.
9. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
10. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
11. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

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Module-1

Laws and Regulations:

Historical background, regulatory test procedure (European cycles), Exhaust gas pollutants (European rail road limits), particulate pollutants, European statutory values, inspection of vehicle in circulation (influence of actual traffic conditions and influence of vehicle maintenance).

Effect of Air Pollution:

Effect of air pollution on Human Health, Effect of air pollution on animals, Effect of air pollution on plants.

Module-2

Mechanism of pollutant formation in Engines:

Nitrogen Oxides:

Formation of nitrogen oxides, kinetics of NO formation, formation of NO2, NO formation in spark ignition engines, NOx formation, in compression ignition engines.

Carbon Monoxide:

Formation of carbon monoxide in SI and CI Engines.

Unburned Hydrocarbons:

Background, flame quenching and oxidation fundamentals, HC emissions from spark ignition engines, HC emission mechanisms in diesel engines.

Particulate emissions:

Spark ignition engine particulates, characteristics of diesel particulates, soot formation fundamentals, soot oxidation.

Crankcase emissions, piston ring blow by, evaporative emissions.

Module-3

Pollution Control Techniques:

Pollution control measures inside SI Engines & lean burn strategies, measures in engines to control Diesel Emissions

Pollution control in SI & CI Engines, Design changes, optimization of operating factors and Exhaust gas recirculation, fuel additives to reduce smoke & particulates, Road draught crankcase ventilation system, positive crankcase ventilation system, fuel evaporation control.

Influence of Fuel Properties:

Effect of petrol, Diesel Fuel, Alternative Fuels and lubricants on emissions.

Module-4

Post combustion Treatments:

Available options, physical conditions & exhaust gas compositions before treatment, Catalytic mechanism, Thermal Reactions, Installation of catalyst in exhaust lines, catalyst poisoning, catalyst light-off, NOx treatment in Diesel Engines, particulate traps, Diesel Trap oxidizer.

Module-5

Sampling procedures:

Combustion gas sampling: continuous combustion, combustion in a cylinder Particulate sampling: soot particles in a cylinder, soot in exhaust tube,

Sampling Methods-sedimentations, and filtration, and impinge methods electrostatic precipitation thermal precipitation, centrifugal methods, determination of mass concentration, analytical methods- volumetric gravimetric- calorimetric methods etc.

Instrumentation for Pollution Measurements:

NDIR analysers, Gas chromatograph, Thermal conductivity and flame ionization detectors, Analyzers for NOx, Orsat apparatus, Smoke measurement, comparison method, obscuration method, Ringelmann chart, Continuous filter type smoke meter, Bosch smoke meter, Hart ridge smoke meter

Course outcome (Course Skill Set)

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

1. Explain air pollution and pollutants, their sources & their effects.
2. Describe different parameters responsible for pollutant formation.
3. Choose instruments for air pollution measurement.
4. Analyze measurement of pollutants.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

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

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

Suggested Learning Resources:

Books

1. Automobiles and pollution - Paul Dagobert (SAE)
2. Internal combustion engine fundamentals-John B. Heywood, McGraw Hill Book publications, 1998.

Reference Books:

1. Internal combustion engines-V. Ganesan, Tata McGraw Hill Book Company, 1995.
2. Automotive Emission Control- Crouse William, Gregg Division /McGraw-Hill. 1980.
3. Engine emissions, Pollutant Formation and Measurement- George, Springer and Donald J. Patterson,, Plenum press, 1972.
4. Internal Combustion Engines and Air Pollution- Obert, E.F., Intext Educational Publishers, 1980.

Web links and Video Lectures (e-Resources):

1. https://www.youtube.com/watch?v=LwqZ0kU1uHE
2. https://www.youtube.com/watch?v=tsvBXUQWAOU
3. https://www.youtube.com/watch?v=OyQKSEUeV3Y
4. https://www.youtube.com/watch?v=vUdOlGxsIKo

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

1. Visit the nearby Pollution Control Testing unit to have hands on experience

ESC/ETC/PLC	MAINTENANCE ENGINEERING	Semester	4
Course Code	BAU405B	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	
Examination type (SEE)	Theory		

Course objectives:

1. Explain maintenance strategies and plan maintenance schedule and methods for preventive and bre4ak down maintenance.
2. Find most optimal maintenance frequency, understand the use of computers in maintenance of machinery.
3. Analyse accident records and accident Safety standards for Mechanical equipment.
4. Explain safety standards for mechanical, electrical and chemical systems.

Teaching-Learning Process (General Instructions)

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

1. These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.
2. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
3. Arrange visits to nearby power plants, receiving station and substations to give brief information about the electrical power generation.
4. Show Video/animation films to explain functioning of various machines
5. Encourage collaborative (Group Learning) Learning in the class
6. Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking
7. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
8. Topics will be introduced in a multiple representation.
9. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
10. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
11. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

Module-1

Introduction to Maintenance System:

Definition, Scope, Objective, functions and Importance of maintenance system, Type of maintenance system, Break down maintenance system. Preventive maintenance, Predictive maintenance, design out maintenance, corrective maintenance, planned maintenance, total productive maintenance, condition monitoring. Problems on selection of methods like preventive or breakdown maintenance.

Module-2

Maintenance of Machinery:

Causes of machine failure, performance evaluation, complete overhauling of Machines tools. Maintenance planning and scheduling. Repair order control manpower requirement, Maintenance job analysis spare parts control.

Module-3

Economics in Maintenance:

Repair, replacement, Repair complexity, Finding out most optimal preventive maintenance frequency. Numerical examples

Maintenance Planning:

Planning of maintenance junctures manpower allocation, long range planning, short range planning. Planning

techniques and procedures. Estimation of maintenance work. Maintenance control.

Module-4

Computers in Maintenance:

Features and benefits of Computer aided maintenance. Application of computers to maintenance work.

Industrial Safety:

Economic importance of accidents, Types of safety organizations, Analysis of accident records, accident investigations, Analysis of accident Safety standards for Mechanical equipment.

Module-5

Safety standards:

Safety standards for Electrical equipment and systems. Chemical hazards, material handling, exhaust systems, welding, Plant housekeeping-building, Aisles, passages, floors, tool cribs, washrooms, canteens.

Industrial Pollution Control:

Dust control -Fibre collectors, mechanical dust collectors, wet type collectors, Electrostatic precipitators, Noise pollution Control - Noise measurement and control. Industrial vibration and its control.

Course outcome (Course Skill Set)

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

1. Explain maintenance strategies, plan maintenance schedule and methods for preventive and break down maintenance.
2. Determine the most optimal maintenance frequency.
3. Analysis of accident records and accident Safety standards for Mechanical equipment.
4. Understand and apply the safety standards for mechanical, electrical and chemical systems.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

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- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester-End Examination:

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

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

Suggested Learning Resources:

Books

Text Books:

1. Maintenance Engineering and Management - R. C. Mishra and K. Pathak, Prentice Hall of India, 2002.
2. Maintenance Engineering Hand book - Morrow.

Reference Books:

1. Hand book of Maintenance Management - Frank Herbaty
2. Hand book of Industrial Engg& Management - W. Grant Lreson& Eugene L-Grant.
3. Industrial Pollution Control Handbook - LUND A. Industrial Maintenance − H. P. Garg
4. Maintenance Engineering Hand book- Lindrey Higgins, McGraw Hill, 5th edition, 2003.

Web links and Video Lectures (e-Resources):

1. https://www.youtube.com/watch?v=JbqiSOSuhC8
2. https://www.youtube.com/watch?v=qrd0OPMHnk4
3. https://www.youtube.com/watch?v=ecEHq_l_YZk
4. https://www.youtube.com/watch?v=4YR-t-Ao4cs
5. https://www.youtube.com/watch?v=qrzIrFneZnY.

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

1. Visit the nearby industry to understand the method of different types of maintenance.
2. Use few of the maintenance tools.
3. Use maintenance log book to record the maintenance data of the lab/ institution

ESC/ETC/PLC	COMPOSITE MATERIALS	Semester	4
Course Code	**BAU405C**	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

1. To explain basic concepts of composite materials and application of composite material in various engineering fields.
2. To understand the selection, requirements for production and application of various techniques used for FRP , MMC etc.
3. To learn the concepts of nanomaterials, nano technology and use of nano materials.
4. To analyze micro mechanical properties of lamina using various approaches

Teaching-Learning Process (General Instructions)

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

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby plants, start -up ecosystem, incubation centers or MSME industries to give information about the industry culture and demand.
3. Show Video/animation films to explain functioning of various machines
4. Encourage collaborative (Group Learning) Learning in the class
5. Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking
6. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
10. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

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Module-1

Introduction to Composite Materials: Definition, classification and characteristics of composite materials - fibrous composites, laminated composites, particulate composites. Properties and types of Reinforcement and Matrix materials.

Application of Composites: Automobile, Aircrafts, missiles, Space hardware, Electrical and electronics, marine, recreational and Sports equipment, future potential of composites.

Module-2

Fibre Reinforced Plastic processing: Layup and curing, fabricating process – open and closed mould process – hand layup techniques – structural laminate bag moulding, production procedures for bag moulding – filament winding, pultrusion, pulforming, thermo – forming, injection, injection moulding, liquid moulding, blow moulding.

Module-3

Metal Matrix Composites: Reinforcement materials, types, characteristics and selection base metals, Need for production, MMC's and its application.

Fabrication Process for MMCs: Powder metallurgy technique and its application, liquid metallurgy technique and its application and secondary processing, special fabrication.

Module-4

Properties of MMCs: Physical, mechanical, wear, machinability and other properties. Effect of size, shape and distribution of particulate on properties.

Nano-materials: Introduction, types of Nano materials, synthesis nano-material using Chemical vapor depositions, physical vapor deposition, phase transformation of nano-particles, magnetic, optical, electrical and mechanical properties of nanoparticles.

Module-5

Micromechanical Analysis of a Lamina: Introduction, evolution of four elastic modulii by strength of material approach, rule of mixture, Numerical.

Mechanics of Lamina: Hooks law for different types of materials, number elastic constants, two dimensional relationship of compliance and stiffness matrix.

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

1. Explain basic concepts of composite materials and application of composite material in various engineering fields.
2. Understand the selection, requirements for production and application of various techniques used for FRP , MMC etc.
3. Appreciate concepts of nano-materials, nano technology and use nano materials for practical applications..
4. Analyse micro mechanical properties of lamina using various approaches and apply suitably for engineering applications

Suggested Learning Resources:

Books

1. Composites- Science and Engineering, K. K. Chawla Springer Verlag 1998
2. Introduction to composite materials, Hull and Clyne Cambridge University Press 2nd edition , 1990.
3. Forming Metal hand book ASM handbook, 9th edition, 1988
4. Mechanics of composites Artar Kaw CRC Press , 2002
5. Composite Materials S. C. Sharma Narosa publishing House, New Delhi 2000.

Web links and Video Lectures (e-Resources):

1. https://www.youtube.com/watch?v=JBMVZpRD-Zk
2. https://www.youtube.com/watch?v=n3bWw8A2xwI
3. https://www.youtube.com/watch?v=xGYZqmGjG9s
4. https://archive.nptel.ac.in/courses/112/104/112104229/

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

1. Visit to nearby materials/ manufacturing industry to understand the concept.

ESC/ETC/PLC	EARTH MOVING EQUIPMENT	Semester	4
Course Code	BAU405D	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

1. Explain about various basic operations and applications of earth moving equipment.
2. Select under carriage, hydraulics, steering systems of tractors.
3. Select suitable machine for hauling depending on type of land, haul distance, climate, etc

Teaching-Learning Process (General Instructions)

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

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby plants, start -up ecosystem, incubation centers or MSME industries to give information about the industry culture and demand.
3. Show Video/animation films to explain functioning of various machines
4. Encourage collaborative (Group Learning) Learning in the class
5. Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking
6. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
10. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

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Module-1

Equipment and Operation: Different types, working principles and applications of bull Dozers, Loaders, Shovels, Excavators, Scrapers, Motor graders, Rollers, Compactors, Tractors and Attachments.

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, under carriage components like, tracks, roller frames, drive sprockets, track rollers, track chains and track shoes. Rubber spring suspension and air spring suspension.

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.

Final Drives:

Types of reductions like, single reduction, double reduction final drives and planetary final drives PTO shaft.

Module-4

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.

Module-5

Criterion for Selection of Equipment:

Selection of machines based on type of soil, haul distance, weather condition, calculation Of Operating Capacity and calculation of productivity of a bull dozer

Earth Moving Equipment Maintenance & Safety:

Types of maintenance schedules, purpose and advantages, organization set ups, documentation. Safety methods for earth moving equipment.

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

1. Explain about various basic operations and applications of earth moving equipment.
2. Select under carriage, hydraulics, steering systems of tractors.
3. Select suitable hauling machine depending on type of land, haul distance, climate, etc.
4. Understand the maintenance and safety features of the equipment and analyze and address the

Suggested Learning Resources:

Books

1. Diesel equipment Erich J.schulz , PHI , volume I and II
2. Construction equipment and its management, S. C. Sharma, McGraw Hill , 2002
3. Theory of ground vehicles J. Y. Wong , John Wiley and sons, 1999
4. On and with the earth Jagman Singh W. Newman and Co..Kalkata , 2005

Web links and Video Lectures (e-Resources):

1. https://www.constrofacilitator.com/different-types-of-earthmoving-equipment-used-in-construction/.
2. https://www.thebalancesmb.com/must-have-earth-moving-construction-heavy-equipment-844586
3. https://www.youtube.com/watch?v=cwNq3PI5kWI

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

1. Visit to nearby EM equipment dealer and study the operation and working

AEC/SEC THEORY AND APPLICATIONS OF SENSORS AND ACTUATORS		Semester	4
Course Code	**BAU456A**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	01	Exam Hours	1
Examination type (SEE)	Theory		

Course objectives:

1. To introduce the concepts of sensors and actuators highlighting its principles
2. To understand the basics of signal processing
3. To provide hands on experience on the usage of sensors and actuators using open source platforms

Teaching-Learning Process (General Instructions)

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

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby plants, start -up ecosystem, incubation centers or MSME industries to give information about the industry culture and demand.
3. Show Video/animation films to explain functioning of various sensors and actuators
4. Encourage collaborative (Group Learning) Learning in the class
5. Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking
6. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
10. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

Module-1

Introduction to Sensors and Actuators: Mechanics & requirement of sensor, sensor specifications; experimental error analysis; measurement uncertainty, signal conditioning, Introduction to actuators and its control.

Module-2

Fundamentals of Signal processing: Introduction to DSP, History and Applications; Sinusoids, Frequencies and Spectral Representations, Periodic Signals, Fourier Series, Sampling, Sampling Rate Conversions, Aliasing, Digital Filters

Module-3

Overview of Sensors: Sensor components: Measurement of Temperature, RH, Pressure, strain, force, torque, displacement, velocity, Acceleration, rotation, and rpm – use of different sensors.

Module-4

Overview of Actuators: Solenoids, DC motor (Brush and Brushless) and its control, stepper motor and its control, servo motors PWM generation and control

Module-5

Introduction to Open-source micro-controllers and Micro-processors: Intorduction to Micro-controllers and Microprocessors, Basic components of Arduino and Raspberry PI, Difference between Micro-controllers and Micro-processors,

Course outcome (Course Skill Set)

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

1. Explain significance of sensors and actuators for generalized measuring system, with the relevant theory and working principle of measuring instruments for the measurement of force, torque, flow, temperature, pressure and strain
2. Understand the basics of signal processing, and explain its importance of data acquisitions.
3. Hands on experience to students on acquiring data, filtering it and apply a signal to the actuator.
4. Usage of filters and sampling rate to the data

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

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

OR

MCQ (Multiple Choice Questions) are preferred for 01 credit courses, however, if course content demands the general question paper pattern that followed for 03 credit course, then

1. The question paper will have ten questions. Each question is set for 10 marks.
2. There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub-questions (with maximum sub-questions of 02, with marks distributions 5+5, 4+6, 3+7).
3. The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Books

1. Sanjay Gupta, Joseph John Virtual Instrumentation Using Lab VIEW Tata MaGraw-Hill, 2005.
2. D Patranabis, Sensors and Transducers, Phl3nd Edition, 2013.
3. J.P. Holman Experimental Methods for Engineers McGraw-Hill, 8th Edition, 2010.
4. James H McClellan, DSP First A Multimedia Approach ,Prentice Hall International , 1999.
5. Richard Crowder, Electric Drives and Electromechanical Systems: Applications and Control Elsevier, 2010.

Web links and Video Lectures (e-Resources):

1. https://www.youtube.com/watch?v=H5pUjXdyjJU
2. https://www.youtube.com/watch?v=kUHmYKWwuWs
3. https://www.youtube.com/watch?v=0qwrnUeSpYQ
4. https://www.youtube.com/watch?v=6gccSyp_uJQ

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

1. Practical based learning

AEC/SEC	MATLAB FOR ENGINEERS	Semester	3
Course Code	**BAU456B**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	01	Total Marks	100
Credits	01	Exam Hours	03
Examination type (SEE)	Practical		

Course objectives:

1. To introduce the students to various functions of MATLAB.
2. To enable the students with basic understanding of building codes, plots, numerical solutions to ODE and PDE using MATLAB.
3. To train students to solve application based regression analysis and interpolation.

Sl.NO	Experiments
1	**Introduction to MATLAB Programming** i. Variables ii. Variable Names iii. Expressions iv. Formatting
2	**Vectors and matrices** a) Row Vector b) Understanding Linspace, Logspace and Concatenation c) Column Vectors d) Creating Matrices
3	**Building Code with MATLAB -1** a) MATLAB Script b) Function files c) Conditional Statements (If, Elseif, If Elseif) d) Switch case
4	**Building Code with MATLAB -2** a) For Loop b) While Loop c) Nested Loop
5	**Functions**
6	**Linear Algebraic Equations with Plots:** a) Solve a system of Linear equations and plot (Atleast 3 equations) b) Plot the results
7	**Non-Linear Algebraic Equations with Plots:** a) Newton-Raphson method (Single Variable)
8	**Regression & Interpolation:** a) Linear Least Squares Regression b) Linear Interpolation Method
9	**Numerical Solutions-ODE:** a) First Order Linear Ordinary Differential Equations b) First Order Non-Linear Ordinary Differential Equations with Initial conditions c) Second Order Ordinary Differential Equations with Initial conditions
10	**Numerical Solutions-PDE:** a) Solution of 1-D, parabolic heat equation b) Plot the distribution of heat

Course outcomes (Course Skill Set):

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

1. Identify and use different functions of MATLAB.
2. Solve mathematical equations using functions and loops related to engineering applications.
3. Do regression analysis of engineering problems and apply different techniques.
4. Apply appropriate tools to solve ODE and PDE equations related to engineering applications.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

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

OR

MCQ (Multiple Choice Questions) are preferred for 01 credit courses, however, if course content demands the general question paper pattern that followed for 03 credit course, then

1. The question paper will have ten questions. Each question is set for 10 marks.
2. There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub-questions (with maximum sub-questions of 02, with marks distributions 5+5, 4+6, 3+7).
3. The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Books

1. Andrew Knight Basics of MATLAB and Beyond CRC Press, Inc, U.S, 2000 Edition
2. Leonid Burstein, PDE Toolbox Primer for Engineering Applications with MATLAB Basics, CRC Press, Inc., 2022
3. Rudra Pratap, Getting started with MATLAB, Oxford, 2010

Web links and Video Lectures (e-Resources):

Lectures (e-Resources):

1. https://www.youtube.com/watch?v=UNLU9e1qGBg
2. https://nptel.ac.in/courses/103106118
3. https://www.youtube.com/channel/UCq0imsn84ShAe9PBOFnoIrg

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

1. Conduct experiments in the fluid mechanics, heat transfer, engine labs, extract data and use the appropriate tools of Microsoft excel for demonstration of the features of excel sheet.
2. Assignment based on experimental data from journals and articles.

AEC/SEC	AUTONOMOUS VEHICLES	Semester	4
Course Code	BAU456C	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	1	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

This course will introduce you to the terminology, design considerations and safety assessment of self-driving vehicles. By the end of this course, student will be able to: -

1. Understand commonly used hardware used for self-driving vehicles
2. Identify the main components of the self-driving software stack - Program vehicle modelling and control
3. Analyse the safety frameworks and current industry practices for vehicle development

Teaching-Learning Process (General Instructions)

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

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby plants, start -up ecosystem, incubation centers or MSME industries to give information about the industry culture and demand.
3. Show Video/animation films to explain functioning of various machines
4. Encourage collaborative (Group Learning) Learning in the class
5. Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking
6. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
10. Individual teacher can device the innovative pedagogy to improve the teaching-learning.

Module-1	
Introduction to autonomous driving: autonomous driving technologies overview, autonomous driving algorithms: Sensing, Perception, Object Recognition and Tracking: Autonomous driving client system: Robot Operating System, Hardware platform: Autonomous driving cloud platform: Simulation, HD Map Production, Deep learning Model Training	
Teaching-Learning Process	Chalk and Talk, PPT, You Tube videos, NPTEL sourced materials

Module-2	
Autonomous vehicle localization: Localization with GNSS: GNSS overview, GNSS error analysis, satellite-based augmentation systems, real time kinematic and differential GPS, precise point positioning, GNSS INS integration, Localization with LiDAR and HD maps Visual Odometry: Stereo Visual Odometry, Monocular Visual Odometry, Visual Inertial Odometry, Dead Reckoning and Wheel Odometry; Sensor fusion	
Teaching-Learning Process	Chalk and Talk, PPT, You Tube videos, NPTEL sourced materials

Module-3

Perceptions In Autonomous driving: Introduction, Datasets, Detection, Segmentation, Sterio, Optical flow and Scene flow; Deep learning in Autonomous Driving Perception: Convolutional Neural Networks, Detection, Semantic segmentation, Stereo and optical flow	
Teaching-Learning Process	Chalk and Talk, PPT, You Tube videos, NPTEL sourced materials
Module-4	
Prediction and Routing: Planning and control overview, Traffic prediction: Behaviour prediction as classification, Vehicle trajectory generation, Lane level routing: Constructing a weighted directed graph for routing, typical routing algorithms, routing graph cost	
Teaching-Learning Process	Chalk and Talk, PPT, You Tube videos, NPTEL sourced materials
Module-5	
Decision planning and control: Behavioural decisions, Motion planning, Feedback control, Reinforcement Learning Based Planning and Control, Client systems for Autonomous Driving: Operating systems and computing platform, Cloud platform for Autonomous driving: Introduction, infrastructure, simulation	
Teaching-Learning Process	Chalk and Talk, PPT, You Tube videos, NPTEL sourced materials

Course outcome (Course Skill Set)

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

1. Understand the Autonomous systems and its requirements
2. Explain different aspects like algorithm, sensing, object recognition and tracking, plan and control motion of an Autonomous system
3. Do the error analysis of systems and use the tools and techniques and shall be able to do lane level routing and create simple algorithms

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous internal Examination (CIE)

- For the Assignment component of the CIE, there are 25 marks and for the Internal Assessment Test component, there are 25 marks.
- The first test will be administered after 40-50% of the syllabus has been covered, and the second test will be administered after 85-90% of the syllabus has been covered
- Any two assignment methods mentioned in the 22OB2.4, if an assignment is project-based then only one assignment for the course shall be planned. The teacher should not conduct two assignments at the end of the semester if two assignments are planned.
- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examinations (SEE)

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

OR

MCQ (Multiple Choice Questions) are preferred for 01 credit courses, however, if course content demands the general question paper pattern that followed for 03 credit course, then

1. The question paper will have ten questions. Each question is set for 10 marks.
2. There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub-questions (with maximum sub-questions of 02, with marks distributions 5+5, 4+6, 3+7).
3. The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Books

1. Creating Autonomous Vehicle Systems .Shaoshan Liu, Liyun Li, Jie Tang, Shuang Wu, Jean-Luc Gaudiot Morgan& Claypool Publishers, 1st Edition, 2018
2. Autonomous Vehicles for Safer Driving, Ronald K. Jurgen, SAE International Edition, 2013

Web links and Video Lectures (e-Resources):

1. https://analyticsindiamag.com/free-online-resources-get-started-autonomous-cars/.
2. https://innovationatwork.ieee.org/autonomous-vehicles-resources/
3. https://www.wired.com/story/guide-self-driving-cars/
4. https://www.nvidia.com/en-us/self-driving-cars/
5. https://www.youtube.com/watch?v=wAaSJUAKPuY
6.

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

1. Explore related videos on the subject like https://www.youtube.com/watch?v=twMHsKYtHKA
2. Build simple VOICE CONTROLLED systems
3. Discuss the levels of autonomy, as defined by SAE

AEC/SEC	DRIVE CYCLES OF ELECTRIC VEHICLES	Semester	4
Course Code	BAU456D	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	1	Exam Hours	1
Examination type (SEE)	Theory		

Course objectives:

1. Learn and compute the drive train requirements and vehicle performance parameters.
2. Basics of vehicle dynamics and power and torque calculations
3. Concept of drive cycles and application of the same with reference to Indian Standard (IDC)

Teaching-Learning Process (General Instructions)

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

1. Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.
2. Arrange visits to nearby plants, start -up ecosystems, incubation centers or MSME industries to give information about the industry culture and demand.
3. Show Video/animation films to explain functioning of various machines.
4. Encourage collaborative (Group Learning) Learning in the class
5. Ask at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinking
6. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyze information rather than simply recall it.
7. Topics will be introduced in a multiple representation.
8. Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.
9. Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.
10. Individual teachers can device the innovative pedagogy to improve the teaching-learning.

Module-1

Drive-train for a petrol vehicle, Petrol Vehicles to Electric Vehicles, Electric drive train, Engine, Motor & Controller: Force and Torque, Vehicle Speed and Power, Vehicle Performance parameters, **Infrastructure Required for Vehicles to run, EV Charging Stations, Vehicle Control Unit (or MCU), Battery Power and Range Required, Battery Energy (Capacity),Battery Power**

Teaching-Learning Process	Chalk and Talk, PPT, You Tube videos, NPTEL sourced materials

Module-2

Vehicle Dynamics, tractive force, Aerodynamic Drag, Rolling Resistance, Uphill Resistance, Acceleration, Forces acting on a vehicle in motion, Aerodynamic drag, Rolling Resistance and uphill Resistance, Typical values of Rolling Resistance, Gradient resistance,

Teaching-Learning Process	. Chalk and Talk, PPT, You Tube videos, NPTEL sourced materials.

Module-3

Power required to climb, Power and Torque to accelerate, Power required for acceleration (pick-up), Average Power required for acceleration, Power for pick-up acceleration alone

Teaching-Learning Process	Chalk and Talk, PPT, You Tube videos, NPTEL sourced materials

Module-4	
Concept of a Drive-cycle-Drive Cycle, Definition of a Drive-cycle, Standard Drive Cycle, 2-wheeler / Auto India Drive Cycle (IDC), Compute Distance and Energy for the full drive-cycle, Low-end 2-wheeler,Spread-sheet for a typical 2-wheeler,Consider Regeneration Efficiency R = 0.5	
Teaching-Learning Process	Chalk and Talk, PPT, You Tube videos, NPTEL sourced materials

Module-5	
Drive Cycles and Energy used per km, E-auto, e-rickshaw and Compact Sedan, Electric Auto-E-auto: velocity, distance and acceleration, Energy per km of e-auto with R = 0.5,e-rickshaw: IDC-Energy Efficiency of e-rickshaw (R=50%),4-Wheelers: Modified Indian Drive Cycle (MIDC), Electric compact-Sedan-Compact Sedan Energy Efficiency, Low-end Electric Trucks-Delivery Truck Specs, Trucks: Modified Indian Drive Cycle (MIDC),Traction Energy used for a drive-cycle	
Teaching-Learning Process	Chalk and Talk, PPT, You Tube videos, NPTEL sourced materials

Course outcome (Course Skill Set)

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

1. Compute the drive train requirements and vehicle performance parameters.
2. Analyse the design parameters of vehicle dynamics and apply the same to arrive at power and torque requirement of different segments of EVs.
3. Understand and apply the concept of drive cycles and create Indian Drive Cycles for different segments of Electric Vehicle IDC)

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) and for the SEE minimum passing mark is 35% of the maximum marks (18 out of 50 marks). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

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- For the course, CIE marks will be based on a scaled-down sum of two tests and other methods of assessment.

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Semester End Examinations (SEE)

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

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2. There will be 2 questions from each module. Each of the two questions under a module may or may not have the sub-questions (with maximum sub-questions of 02, with marks distributions 5+5, 4+6, 3+7).
3. The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Books

1. . Modern Electric, Hybrid Electric, and Fuel Cell Vehicles, Mehrdad Ehsani, Yimin Gao, Stefano Longo and Kambiz Ebrahimi, CRC Press, 2018, II Edition.
2. Electric Powertrain- Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles John G. Hayes ,University College Cork, Ireland ,G. Abas Goodarzi, US Hybrid, California, USA, © 2018 John Wiley & Sons Ltd

Web links and Video Lectures (e-Resources):

1. IEEE Electrification Magazine: HTTPs://ieeexplore.ieee.org/document/8546812
2. Blog “understanding the EV Elephant”: HTTP://electric electric-vehicles vehicles-in -india.blogspot.com/
3. WRI-CBEEV Report: 'A Guidance Document on Accelerating Electric Mobility in India'
4. NITI Aayog Report: Zero Emission Vehicle (ZEV): Towards a policy Framework
5. NPTEL Video Course: NOC: Electric Vehicles and Renewable Energy

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

1. Construction of IDC and MIDC for a typical 2-wheeler in a Spread-sheet
2. Construction of IDC and MIDC for a typical 4-wheeler in a Spread-sheet
3. Construction of IDC and MIDC for a typical mini -truck in a Spread-sheet

BSC-	BIOLOGY FOR ENGINEERS	Semester	4
Course Code	**BBOK407**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	03	Exam Hours	1
Examination type (SEE)	Theory/practical/Viva-Voce /Term-work/Others		

UNIVERSAL HUMAN VALUES-II: UNDERSTANDING HARMONY and ETHICAL HUMAN CONDUCT		Semester	4
Course Code	**BUHK408**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0	SEE Marks	50
Total Hours of Pedagogy	20	Total Marks	100
Credits	01	Exam Hours	01
Examination type (SEE)	Theory/practical/Viva-Voce /Term-work/Others		

MC	BNSK459	National Service Scheme (NSS)	NSS coordinator	0	0	2			100	---	100	0
	BPEK459	Physical Education (PE) (Sports and Athletics)	Physical Education Director									
	BYOK459	Yoga	Yoga Teacher									