

MECHANICS OF MATERIALS		Semester	03
Course Code	BME301	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	2:2:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3 hrs
Examination type (SEE)	Theory		
Course objectives: <ul style="list-style-type: none">• To provide the basic concepts and principles of strength of materials.• To give an ability to calculate stresses and deformations of objects under external loadings.• To give an ability to apply the knowledge of strength of materials on engineering applications and design problems.			
Teaching-Learning Process (General Instructions) <p>These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.</p> <ul style="list-style-type: none">• Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Videodemonstrations or Simulations.• Chalk and Talk method for Problem Solving.• Adopt flipped classroom teaching method.• Adopt collaborative (Group Learning) learning in the class.• Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analyzing information.			
Module-1			
Simple stress and strain: Definition/derivation of normal stress, shear stress, and normal strain and shear strain – Stress strain diagram for brittle and ductile materials - Poisson's ratio & volumetric strain – Elastic constants – relationship between elastic constants and Poisson's ratio – Generalised Hook's law – Deformation of simple and compound bars, Resilience, Gradual, sudden, impact and shock loadings – thermal stresses.			
Module-2			
Bi-axial Stress system: Introduction, plane stress, stresses on inclined sections, principal stresses and maximum shear stresses, graphical method - Mohr's circle for plane stress. Thick and Thin cylinders: Stresses in thin cylinders, Lamé's equation for thick cylinders subjected to internal and external pressures, Changes in dimensions of cylinder (diameter, length and volume), simple numerical.			
Module-3			
Bending moment and Shear forces in beams: Definition of beam – Types of beams – Concept of shear force and bending moment – S.F and B.M diagrams for cantilever, simply supported and overhanging beams subjected to point loads, uniformly distributed loads, uniformly varying loads and combination of these loads – Point of contra flexure.			
Module-4			
Theory of simple bending – Assumptions – Derivation of bending equation - Neutral axis – Determination of bending stresses – section modulus of rectangular and circular sections (Solid and Hollow), I, T and Channel sections – Design of simple beam sections, Shear Stresses: Derivation of formula – Shear stress distribution across various beams sections like rectangular, circular, triangular, I, and T sections.			
Module-5			
Torsion of circular shafts: Introduction, pure torsion, assumptions, derivation of torsional equations, polar modulus, torsional rigidity / stiffness of shafts, power transmitted by solid and hollow circular shafts.			

Theory of columns – Long column and short column - Euler's formula – Rankine's formula.
<p>Course outcome (Course Skill Set) At the end of the course, the student will be able to:</p> <p>CO1: Understand the concepts of stress and strain in simple and compound bars.</p> <p>CO2: Explain the importance of principal stresses and principal planes & Analyse cylindrical pressure vessels under various loadings</p> <p>CO3: Apply the knowledge to understand the load transferring mechanism in beams and stress distribution due to shearing force and bending moment.</p> <p>CO4: Evaluate stresses induced in different cross-sectional members subjected to shear loads.</p> <p>CO5: Apply basic equation of simple torsion in designing of circular shafts & Columns</p>
<p>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.</p> <p>Continuous Internal Evaluation:</p> <ul style="list-style-type: none"> 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. <p>Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.</p> <p>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).</p> <ol style="list-style-type: none"> The question paper will have ten questions. Each question is set for 20 marks. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), should have a mix of topics under that module. The students have to answer 5 full questions, selecting one full question from each module. Marks scored shall be proportionally reduced to 50 marks.
<p>Suggested Learning Resources:</p> <p>Books</p> <ol style="list-style-type: none"> Mechanics of Materials, S.I. Units, Ferdinand Beer & Russell Johnstan, 7th Ed, TATA McGrawHill-2014 Mechanics of Materials, K.V.Rao, G.C.Raju, Subhash Stores, First Edition, 2007 Strength of Materials by R.K. Bansal ,Laxmi Publications 2010.
Web links and Video Lectures (e-Resources):

1. Statics and Strength of Materials, Shehata, 2nd edition, 1994.
(http://www.astm.org/DIGITAL_LIBRARY/JOURNALS/TESTEVAL/PAGES/JTE12637J.htm)
2. http://www.astm.org/DIGITAL_LIBRARY/JOURNALS/TESTEVAL/PAGES/JTE12637J.htm
3. <http://www.freeengineeringbooks.com/Civil/Strength-of-MaterialBooks.php>

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

- Use Mdsolids (<https://web.mst.edu/mdsolids/>) or any open source software for active teaching and learning.

MANUFACTURING PROCESS		Semester	III
Course Code	BME302	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	03
Examination nature (SEE)	Theory /Viva-Voce /Term-work/Others		
Course objectives: <ul style="list-style-type: none">To provide knowledge of various casting process in manufacturing.To provide in-depth knowledge on metallurgical aspects during solidification of metal and alloys, also to provide detailed information about the moulding processes.To acquaint with the basic knowledge on fundamentals of metal forming processes and also to study various metal forming processes.To impart knowledge of various joining process used in manufacturing.To impart knowledge about behaviour of materials during welding, and the effect of process parameters in welding			
Teaching-Learning Process (General Instructions) <p>These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.</p> <ol style="list-style-type: none">Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.Arrange visits to nearby power plants, receiving station and substations to give brief information about the electrical power generation.Show Video/animation films to explain functioning of various machinesEncourage collaborative (Group Learning) Learning in the classAsk at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinkingAdopt 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.Topics will be introduced in a multiple representation.Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.Individual teacher can device the innovative pedagogy to improve the teaching-learning.			
MODULE-1			
Introduction & basic materials used in foundry: <i>Introduction: Definition, Classification of manufacturing processes. Metals cast in the foundry-classification, factors that determine the selection of a casting alloy. Introduction to casting process & steps involved – (Brief Introduction)-Not for SEE</i>			
Patterns: Definition, classification, materials used for pattern, various pattern allowances and their importance.			
Sand moulding: Types of base sand, requirement of base sand. Binder, Additive's definition, need and types; preparation of sand moulds. Molding machines- Jolt type, squeeze type and Sand slinger.			
Study of important moulding process: Green sand, core sand, dry sand, sweep mould, CO2mould, shell mould, investment mould, plaster mould, cement bonded mould.			
Cores: Definition, need, types. Method of making cores,			

Concept of gating (top, bottom, parting line, horn gate) and risers (open, blind) Functions and types.
MODULE-2
<p>Melting furnaces: Classification of furnaces, Gas fired pit furnace, Resistance furnace, Coreless induction furnace, electric arc furnace, constructional features & working principle of cupola furnace.</p> <p>Casting using metal moulds: Gravity die casting, pressure die casting, centrifugal casting, squeeze casting, slush casting, thixocasting, and continuous casting processes. Casting defects, their causes and remedies.</p>
MODULE-3
<p>METAL FORMING PROCESSES</p> <p>Introduction of metal forming process: Mechanical behaviour of metals in elastic and plastic deformation, stress-strain relationships, Yield criteria, Application to tensile testing, strain rate and temperature in metal working; Hot deformation, Cold working and annealing.</p> <p>Metal Working Processes: Fundamentals of metal working, Analysis of bulk forming processes like forging, rolling, extrusion, wire drawing by slab method,</p> <p>Other sheet metal processes: Sheet metal forming processes (Die and punch assembly, Blanking, piercing, bending etc., Compound and Progressive die), High Energy rate forming processes.</p>
MODULE-4
<p>JOINING PROCESSES</p> <p>Operating principle, basic equipment, merits and applications of: Fusion welding processes: Gas welding - Types – Flame characteristics; Manual metal arc welding – Gas Tungsten arc welding - Gas metal arc welding – Submerged arc welding</p>
MODULE-5
<p>Weldability and thermal aspects: Concept of weldability of materials; Thermal Effects in Welding (Distortion, shrinkage and residual stresses in welded structures); Welding defects and remedies.</p> <p>Allied processes: Soldering, Brazing and adhesive bonding</p> <p>Advance welding processes: Resistance welding processes, friction stir welding (FSW).</p>

PRACTICAL COMPONENT OF IPCC

Course objectives:

- Impart fundamental understanding of various casting, welding and forming processes
- To provide in-depth knowledge on metallurgical aspects during solidification of metal and alloys
- Discuss design methodology and process parameters involve in obtaining defect free component

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

Sl.NO	Experiments
1	Preparation of sand specimens and conduction of the following tests: Compression, Shear and Tensile tests on Universal Sand Testing Machine.
2	To determine permeability number of green sand, core sand and raw sand.
3	To determine AFS fineness no. and distribution coefficient of given sand sample.
4	Studying the effect of the clay and moisture content on sand mould properties
5	Use of Arc welding tools and welding equipment Preparation of welded joints using Arc Welding equipment L-Joint, T-Joint, Butt joint, V-Joint, Lap joints on M.S. flats
6	Foundry Practice: Use of foundry tools and other equipment for Preparation of molding sand mixture. Preparation of green sand molds kept ready for pouring in the following cases: 1. Using two molding boxes (hand cut molds). 2. Using patterns (Single piece pattern and Split pattern).
7	Preparation of green sand molds kept ready for pouring in the following cases: 1. Incorporating core in the mold.(Core boxes).
8	Forging Operations: Use of forging tools and other forging equipment. Preparing minimum three forged models involving upsetting, drawing and bending operations.
Demo experiments for CIE	
9	Demonstration of forging model using Power Hammer.
10	To study the defects of Cast and Welded components using Non-destructive tests like: a) Ultrasonic flaw detection b) Magnetic crack detection c) Dye penetration testing
11	Mould preparation of varieties of patterns, including demonstration
12	Demonstration of material flow and solidification simulation using Auto-Cast software
Course outcomes (Course Skill Set): At the end of the course, the student will be able to: CO1: Describe the casting process and prepare different types of cast products. Acquire knowledge on Pattern, Core, Gating, Riser system and to use Jolt, Squeeze, and Sand Slinger Moulding machines. CO2: Compare the Gas fired pit, Resistance, Coreless, Electrical and Cupola Metal Furnaces. Compare the Gravity, Pressure die, Centrifugal, Squeeze, slush and Continuous Metal mold castings. CO3: Understand the Solidification process and Casting of Non-Ferrous Metals. CO4: Describe the Metal Arc, TIG, MIG, Submerged and Atomic Hydrogen Welding processes etc. used in manufacturing. CO5: Describe the methods of different joining processes and thermal effects in joining process	
Assessment Details (both CIE and SEE) The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 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. Ghosh, A. and Mallik, A. K., (2017), Manufacturing Science, East-West Press.
2. Parmar R. S., (2007), Welding Processes and Technology, Khanna Publishers.
3. Little R. L. – 'Welding and Welding Technology' – Tata McGraw Hill Publishing Company Limited, New Delhi – 1989
4. Grong O. – 'Metallurgical Modelling of Welding' – The Institute of Materials – 1997 – 2nd Edition
5. Kou S. – 'Welding Metallurgy' – John Wiley Publications, New York – 2003 – 2nd Edition.

6. Serope Kalpakjian and Steven R. Schmid – ‘Manufacturing Engineering and Technology’ – Prentice Hall – 2013 – 7th Edition
7. Principles of foundry technology, 4th edition, P L Jain, Tata McGraw Hill, 2006.
8. Advanced Welding Processes technology and process control, John Norrish, Wood Head Publishing, 2006.

Web links and Video Lectures (e-Resources):

- (Link:<http://www.springer.com/us/book/9781447151784><http://nptel.ac.in/courses/112105127/>)
- http://www.astm.org/DIGITAL_LIBRARY/MNL/SOURCE_PAGES/MNL11.htm
- http://www.astm.org/DIGITAL_LIBRARY/JOURNALS/COMPTECH/PAGES/CTR10654J.htm
- MOOCs: <http://nptel.ac.in/courses/112105126/>

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

Metal Casting: Design pattern/core for a given component drawing and develop a sand mould with optimum gating and riser system for ferrous and non-ferrous materials. Melting and casting, inspection for macroscopic casting defects.

- Welding: TIG and MIG welding processes – design weld joints – welding practice –weld quality inspection.
- Metal Forming: Press working operation – hydraulic and mechanical press -load calculation: blanking, bending and drawing operations – sheet metal layout design.

MATERIAL SCIENCE AND ENGINEERING		Semester	III
Course Code	BME303	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	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: <ul style="list-style-type: none">• Explain the basic concepts of geometrical crystallography, crystal structure and imperfections in Solids.• Construct the phase diagrams to know the phase transformations and concept of diffusion in solids.• Identify the heat treatment, cooling method for controlling the microstructure and plastic deformation to modify their properties.• Explain the powder metallurgy process, types and surface modifications.• Apply the method of materials selection, material data, properties and knowledge sources for computer-aided selection of materials.			
Teaching-Learning Process (General Instructions) <p>These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.</p> <ul style="list-style-type: none">• Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Videodemonstrations or Simulations.• Chalk and Talk method for Problem Solving.• Adopt flipped classroom teaching method.• Adopt collaborative (Group Learning) learning in the class.• Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.			
MODULE-1			
Structure of Materials <p>Introduction: Classification of materials, crystalline and non-crystalline solids, atomic bonding: Ionic Bonding and Metallic bonding.</p> <p>Crystal Structure: Crystal Lattice, Unit Cell, Planes and directions in a lattice, Planar Atomic Density, Coordination number, atomic Packing Factor of all the Cubic structures and Hexa Close Packed structure. Classification and Coordination of voids, Bragg's Law.</p> <p>Imperfections in Solids: Types of imperfections, Point defects: vacancies, interstitials, line defects, 2-D and 3D-defects, Concept of free volume in amorphous solids. Slip, Twinning.</p>			
MODULE-2			
Physical Metallurgy <p>Alloy Systems: Classification of Solid solutions, Hume- Rothery Rules</p> <p>Diffusion: Diffusion Mechanisms: Vacancy Diffusion and Interstitial Diffusion, Fick's laws of diffusion, Factors affecting diffusion.</p> <p>Phase Diagrams: Gibbs Phase Rule, Solubility limit, phase equilibrium and Phase Diagrams: Isomorphous systems, Invariant Binary Reactions: Eutectic reaction, Eutectoid reaction and Peritectic reaction, Lever Rule, Iron-Carbon Diagram. Effect of common alloying elements in steel. Numerical on Lever rule.</p>			
MODULE-3			
Nucleation and growth: Introduction to homogeneous and heterogeneous nucleation, critical radius for nucleation.			
Heat treatment: Annealing, Normalizing, hardening, Tempering, Nitriding, Cyaniding, Induction Hardening and Flame Hardening, Recent advances in heat treat technology. TTT diagram, Recovery-Recrystallization-Grain Growth. Strengthening mechanisms: Strain hardening, Precipitation hardening (Solid-Solution Strengthening), Grain refinement.			

MODULE-4	
<p>Surface coating technologies: Introduction, coating materials, coating technologies, types of coating: Electro-plating, Chemical Vapor Deposition(CVD), Physical Vapor Deposition(PVD), High Velocity Oxy-Fuel Coating, advantages and disadvantages of surface coating.</p> <p>Powder metallurgy: Introduction, Powder Production Techniques: Different Mechanical methods: Chopping or Cutting, Abrasion methods, Machining methods, Ball Milling and Chemical method: Chemical reduction method.</p> <p>Characterization of powders (Particle Size & Shape Distribution), Powder Shaping: Particle Packing Modifications, Lubricants & Binders, Powder Compaction & Process, Sintering and Application of Powder Metallurgy.</p>	
MODULE-5	
<p>Engineering Materials and Their Properties: Classification, Ferrous materials: Properties, Compositions and uses of Grey cast iron and steel. Non-Ferrous materials: Properties, Compositions and uses of Copper, Brass, Bronze.</p> <p>Composite materials - Definition, classification, types of matrix materials & reinforcements, Metal Matrix Composites (MMCs), Ceramic Matrix Composites (CMCs) and Polymer Matrix Composites (PMCs), Particulate-reinforced and fiber- reinforced composites, Applications of composite materials.</p> <p>Mechanical and functional properties of Engineering Materials</p> <p>The Design Process and Materials Data: Types of design, design tools and materials data, processes of obtaining materials data, materials databases.</p> <p>Material Selection Charts: Selection criteria for materials, material property Charts, deriving property limits and material indices.</p>	

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

Sl.NO	Experiments
1	Specimen preparation for macro and micro structural examinations and study the macrostructure and microstructure of a sample metal/ alloys.
2	Study the heat treatment processes (Hardening and tempering) of steel/Aluminium specimens.
3	To determine the hardness values of Mild Steel/ Aluminium by Rockwell hardness/Vickers Hardness.
4	To determine the hardness values of Copper/ Brass by Brinell's Hardness testing machine.
5	To determine the tensile strength, modulus of elasticity, yield stress, % of elongation and % of reduction in area of Cast Iron, Mild Steel/Brass/ Aluminium and to observe the necking.
6	To conduct a wear test on Mild steel/ Cast Iron/Aluminium/ Copper to find the volumetric wear rate and coefficient of friction.
7	To determine the Impact strength of the mild steel using Izod test and Charpy test.
8	Study the chemical corrosion and its protection. Demonstration
9	Study the properties of various types of plastics. Demonstration
10	Computer Aided Selection of Materials: Application of GRANTA Edupack for material selection: Case studies based on material properties. Demonstration
<p>Course outcomes (Course Skill Set): At the end of the course the student will be able to:</p> <ol style="list-style-type: none"> 1. Understand the atomic arrangement in crystalline materials and describe the periodic arrangement of atoms in terms of unit cell parameters. 2. Understand the importance of phase diagrams and the phase transformations. 3. Explain various heat treatment methods for controlling the microstructure.. 	

4. Correlate between material properties with component design and identify various kinds of defects.
5. Apply the method of materials selection, material data and knowledge sources for computer-aided selection of materials.

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 220B4.2. 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:

Text Books:

1. Callister Jr, W.D., Rethwisch, D.G., (2018), Materials Science and Engineering: An Introduction, 10th Edition, Hoboken, NJ: Wiley.
2. Ashby, M.F. (2010), Materials Selection in Mechanical Design, 4th Edition, Butterworth-Heinemann.
3. Azaroff, L.V., (2001) Introduction to solids, 1st Edition, McGraw Hill Book Company.
4. Avner, S.H., (2017), Introduction to Physical Metallurgy, 2nd Edition, McGraw Hill Education.

Reference Books

1. Jones, D.R.H., and Ashby, M.F., (2011), Engineering Materials 1: An Introduction to Properties, Application and Design, 4th Edition, Butterworth-Heinemann.
2. Jones, D.R.H., and Ashby, M.F., (2012), Engineering Materials 2: An Introduction to Microstructure and Processing, 4th Edition, Butterworth-Heinemann.
3. Abbaschian, R., Abbaschian, L., Reed-Hill, R. E., (2009), Physical Metallurgy Principles, 4th Edition, Cengage Learning.
4. P. C. Angelo and R. Subramanian: Powder Metallurgy- Science, Technology and Applications, PHI, New Delhi, 2008.

Web links and Video Lectures (e-Resources):

Web links and Video Lectures (e-Resources):

1. Bhattacharya, B., Materials Selection and Design, NPTEL Course Material, Department of Mechanical Engineering, Indian Institute of Technology Kanpur, <http://nptel.ac.in/courses/112104122/>
2. Prasad, R., Introduction to Materials Science and Engineering, NPTEL Course Material, Department of Materials

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

Course seminar

Industrial tour/Visit to Advanced Research Centres

BASIC THERMODYNAMICS		Semester	3rd
Course Code	BME304	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:2:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		
Course Objectives: <ul style="list-style-type: none">• Learn about thermodynamic system and its equilibrium, basic law of zeroth law of thermodynamics.• Understand various forms of energy - heat transfer and work, Study the first law of thermodynamics.• Study the second law of thermodynamics.• Interpret the behaviour of pure substances and its application in practical problems.• Study of Ideal and real gases and evaluation of thermodynamic properties.			
Teaching-Learning Process (General Instructions) <p>These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.</p> <ol style="list-style-type: none">1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.2. Chalk and Talk method for Problem Solving.3. Adopt flipped classroom teaching method.4. Adopt collaborative (Group Learning) learning in the class5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.			
Module-1			
Introduction and Review of fundamental concepts: Thermodynamic definition and scope, Microscopic and Macroscopic approaches. Characteristics of system boundary and control surface, examples. Thermodynamic properties; definition and units, 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 (<i>The topics are Only for Self-study and not to be asked in SEE. However, may be asked for CIE</i>) Zeroth law of thermodynamics, Temperature; concepts, scales, international fixed points and measurement of temperature. Constant volume gas thermometer, constant pressure gas thermometer, mercury in glass thermometer, thermocouples, electrical resistance thermometer. Numerical.			
Work and Heat: Mechanics, definition of work and its limitations. Thermodynamic definition of work; examples, sign convention. Displacement work; as a part of a system boundary, as a whole of a system boundary, expressions for displacement work in various processes through p-v diagrams. Shaft work; Electrical work. Other types of work. Heat; definition, units and sign convention. Problems.			
Module-2			
First Law of Thermodynamics: Joules experiments, equivalence of heat and work. Statement of the First law of thermodynamics, extension of the First law to non - cyclic processes, energy, energy as a property, modes of energy, Problems.			
Extension of the First law to control volume; steady flow energy equation (SFEE), Problems.			

Module-3
<p>Second Law of Thermodynamics: Limitations of first law of thermodynamics, Thermal reservoir, heat engine and heat pump: Schematic representation, efficiency and COP. Reversed heat engine. Kelvin - Planck statement of the Second law of Thermodynamics; PMM I and PMM II, Clausius statement of Second law of Thermodynamics, Equivalence of the two statements; Carnot cycle, Carnot principles. Problems</p> <p>Entropy: Clausius inequality, Statement- proof, Entropy- definition, a property, change of entropy, entropy as a quantitative test for irreversibility, principle of increase in entropy, entropy as a coordinate. Problems</p>
Module-4
<p>Availability, Irreversibility and General Thermodynamic relations. Introduction, Availability (Exergy), Unavailable energy, Relation between increase in unavailable energy and increase in entropy. Maximum work, maximum useful work for a system and control volume, irreversibility. Problems</p> <p>Pure Substances: P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, saturated liquid, mixture of saturated liquid and vapor, saturated vapor and superheated vapor 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. Throttling calorimeter, separating and throttling calorimeter. Problems.</p>
Module-5
<p>Ideal gases: Ideal gas mixtures, Daltons law of partial pressures, Amagat's law of additive volumes, evaluation of properties of perfect and ideal gases, Air- Water mixtures and related properties (<i>Processes are not to be asked for SEE</i>).</p> <p>Real gases – Introduction, Van-der Waal's Equation of state, Van-der Waal's constants in terms of critical properties, Beattie-Bridgeman equation, Law of corresponding states, compressibility factor; compressibility chart. Difference between Ideal and real gases.</p> <p>Thermodynamic relations: Maxwell's equations, TdS equation. Ratio of Heat capacities and Energy equation, Joule-Kelvin effect, Clausius-Clapeyron equation.</p>
<p>Course outcome (Course Skill Set)</p> <p>At the end of the course, the student will be able to :</p> <p>CO1: Explain fundamentals of thermodynamics and evaluate energy interactions across the boundary of thermodynamic systems.</p> <p>CO2: Apply 1st law of thermodynamics to closed and open systems and determine quantity of energy transfers.</p> <p>CO3: Evaluate the feasibility of cyclic and non-cyclic processes using 2nd law of thermodynamics</p> <p>CO4: Apply the knowledge of entropy, reversibility and irreversibility to solve numerical problems and Interpret the behaviour of pure substances and its application in practical problems.</p> <p>CO5: Recognize differences between ideal and real gases and evaluate thermodynamic properties of ideal and real gas mixtures using various relations.</p>

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 (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 220B2.4, 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. Basic and Applied Thermodynamics P.K.Nag, Tata McGraw Hill 2nd Ed., 2002.
2. Basic Engineering Thermodynamics A.Venkatesh Universities Press, 2008.
3. Basic Thermodynamics, B.K Venkanna, Swati B. Wadavadagi PHI, New Delhi 2010.
4. Thermodynamics- An Engineering Approach YunusA.Cengel and Michael A.Boles Tata McGraw Hill publications 2002

Web links and Video Lectures (e-Resources):

- <https://www.youtube.com/watch?v=9GMBpZZtjXM&list=PLD8E646BAB3366BC8>
- https://www.youtube.com/watch?v=jkdMtmXo664&list=PL3zvA_WajfGAwLuULH-L0AG9fKDgplYne
- <https://www.youtube.com/watch?v=1lk7XLOxtzs&list=PLkn3QISf55zy2Nlqr5F09o02qclwNNfrZ&index=3>
- https://www.youtube.com/watch?v=Dy2UeVCSRYs&list=PL2_EyjPqHc10CTN7cHiM5xB2qD7BHUr7

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

- Organise Industrial visits to Thermal power plants and submission of report
- Case study report and power point presentation on steam power plant
- .List of thermal energy devices at homes, hostels and college premises and applicable laws



ವಿಶ್ವೇಶ್ವರಯ್ಯ ತಾಂತ್ರಿಕ ವಿಶ್ವವಿದ್ಯಾಲಯ

("ವಿ ಟಿ ಯು ಅಧಿನಿಯಮ ೧೯೯೪" ರ ಅಡಿಯಲ್ಲಿ ಕರ್ನಾಟಕ ಸರ್ಕಾರದಿಂದ ಸ್ಥಾಪಿತವಾದ ರಾಜ್ಯ ವಿಶ್ವವಿದ್ಯಾಲಯ)



VISVESVARAYA TECHNOLOGICAL UNIVERSITY

(State University of Government of Karnataka Established as per the VTU Act, 1994) "Jnana Sangama" Belagavi-590018, Karnataka, India

Prof. B. E. Rangaswamy, Ph.D.
REGISTRAR

Phone: (0831) 2498100

Fax: (0831) 2405467

REF: VTU/BGM/BOS/New UG-PG Prog/2023-24/468

DATE:

5 DEC 2023

CIRCULAR

Subject: The syllabus of BMEL305-Introduction to Modelling and Design for Manufacturing is revised...

Reference: The email from Chairperson BoS Mechanical Engineering, VTU Belagavi dated 27.11.2023

The Hon'ble Vice Chancellors' approval dated 04.12.2023

The faculty development program has been conducted on the course/subject BMEL305: Introduction to Modelling and Design for Manufacturing between the 6th and 8th of November 2023 at 6 different places in Karnataka to cover the faculty of all zones of VTU Belagavi (ref. VTU/BGM/BOS/FDP/2023-24/3728, Dated October 31, 2023).

Based on the feedback received from the faculty, the syllabus of the course/subject **BMEL305: Introduction to Modelling and Design for Manufacturing** has been revised and submitted to the university for circulation to all concerned by the Board of Studies in Mechanical Engineering, VTU Belagavi.

A revised syllabus copy has been enclosed in this circular for stakeholder reference. The revised syllabus of the course will take effect in the academic year 2023-24 for Mechanical Engineering and its allied branches.

All the principals of the engineering colleges are hereby informed to bring the content of the circular to the notice of all concerned.

Sd/-
Registrar

To,

All the Principals of Affiliated /Constituent Engineering Colleges, under the University.

The Chairperson / Program Coordinator, University Department at Kalaburagai, Belagavi, Bengaluru and Mysuru

Copy to:

1. The Hon'ble Vice-Chancellor through the secretary to VC VTU Belagavi for information
2. The Registrar (Evaluation) VTU Belagavi for information and needful

3. The Director, ITI SMU, VTU Belagavi for information and request to make arrangements for uploading this circular on the VTU web portal in the section of Circular/Notification @ <https://vtu.ac.in/en/category/administration/>
4. The Chairperson/s Board of Studies in Mechanical Engineering and its allied branches
5. The Special Officer, QPDS Examination Section VTU Belagavi for needful.
6. Office Copy

R. 05/11/23
REGISTRAR
25/11/23

Introduction to Modelling and Design for Manufacturing		Semester	3
Course Code	BMEL305	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	14 Sessions	Total Marks	100
Credits	01	Exam Hours	3
Examination nature (SEE)	Practical		
Course objectives:			
<ul style="list-style-type: none">• Develop a comprehensive understanding of mechanical assemblies and design for manufacturing principles.• Learn and apply best practices to create designs that are robust, adaptable, and cost-effective.• Master the art of maintaining control over designs throughout the entire lifecycle, from initial sketch to final production.• Gain hands-on experience in practical exercises and projects to reinforce theoretical concepts.• Acquire effective communication and collaboration skills for multidisciplinary teamwork in design and production processes.			
Teaching-Learning Process (General Instructions)			
These are sample strategies, which teachers can use to accelerate the attainment of the various course outcomes.			
<ul style="list-style-type: none">• Project-Based Learning: Engage students in hands-on projects that simulate real-world design scenarios, enabling practical application of concepts and fostering deeper understanding.• Interactive Workshops: Conduct collaborative workshops where students work together to solve design challenges, encouraging active participation and knowledge sharing.• Design Reviews with Feedback: Regularly review student designs, providing constructive feedback to guide iterative improvement and promote attention to detail.• Industry Insights: Invite guest speakers from the industry to share experiences and insights, helping students connect theoretical knowledge to real-world applications.• Multidisciplinary Teams: Form diverse teams for group projects, allowing students to leverage different skill sets and perspectives to develop comprehensive designs.			
Module-1		02 Sessions	
Introduction to Computer Aided Sketching Review of graphic interface of the software. Review of 2D Sketching, Parametric Solid Modelling, Assembly creation and product rendering. Limits, Fits and Tolerances: Introduction, Fundamental tolerances, Deviations, Methods of placing limit dimensions, Types of fits with symbols and applications, Geometrical tolerances on drawings, Standards followed in industry. (Above topics to be studied as a review) Geometrical Dimensioning and Tolerances (GD&T): Introduction, Fundamental tolerances, Deviations, Methods of placing limit dimensions, machining symbols, types of fits with symbols and applications, geometrical tolerances on drawings. Standards followed in industry. (Only for CIE) The basics of sketching and modelling: Explore Fusion 360 User Interface, Navigation and display settings, create new projects and designs, creating basic 2D sketches, Creating & Modifying a solid 3D body with Sections. (For SEE)			
Module-2		02 Sessions	
Create draft during a feature, create draft as a feature, Add ribs and plastic supports, Create holes and threads. Thread Forms: Terminologies, ISO Metric, BSW, Square & Acme. Seller threads, American Standard Thread. Use a coil feature, Mirrors and patterns. Fasteners: 3D & Section views - Hexagonal headed bolt and nut with washer, Square headed bolt and nut with washer. Keys: Parallel Key, Taper Key & Feather Key.			
Module-3		04 Sessions	
The different ways to create components, Use scripts to create gears, Component color swatch and color cycling, Use McMaster-Carr parts in a design. Assembly of Joints and Coupling using 3D environment. Joints: Like Cotter joint (socket and spigot), knuckle joint (pin joint). Couplings: Like flanged coupling, universal coupling.			

21-11-2023.



Module-4

06 Sessions

Assembly Drawings: (Part drawings shall be given) Drawing Basics-Detailing Drawings. Explode a 3D model for a drawing. Create a drawing sheet and views, Add geometry and dimensions to a drawing, Add GD & T text, BOM, tables and symbols, Place an exploded view, Edit a title block, Export to different file formats.

1. **LIFTING DEVICE (Screw Jack)**
2. **BEARINGS (Plumber Block)**
3. **MACHINE TOOL COMPONENT (Machine Vice or Tailstock)**
4. **VALVES (Ram's Bottom Safety Valve)**
5. **IC ENGINE COMPONENTS (Piston or Connecting Rod)**

Course outcome (Course Skill Set)

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

1. Create and modify a form-based design.
2. Use design tools for moulded parts.
3. Demonstrate proficiency in the setup and creation of a design.
4. Simulate the assembly of machine components in 3D environment.

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 (CIE):

- CIE marks for the practical course is 50 Marks.
- CIE shall be evaluated for max marks 100. Marks obtained shall be accounted for CIE final marks, reducing it by 50%.
- CIE component should comprise of
 - Continuous evaluation of Drawing work of students as and when the Modules are covered.
 - At least one closed book Test covering all the modules on the basis of below detailed weightage.
 - *Weightage for Test and Continuous evaluation shall be suitably decided by respective course coordinators.*

Module	Max. Marks weightage	Evaluation Weightage in marks	
		Computer display & printout	Preparatory sketching
Module-1	15	10	05
Module-2	15	10	05
Module-3	30	20	10
Module-4	40	30	10
Total	100	70	30

Semester End Evaluation (SEE):

SEE marks for the practical course is 50 Marks.

- The duration of SEE is 03 hours. Questions shall be set worth of 3 hours
- SEE shall be conducted jointly by the two examiners (one internal and one external) appointed by the University.
- SEE shall be conducted and evaluated for maximum of 100 marks as shown in the table below. Marks obtained shall be accounted for SEE final marks, reducing it to 50 marks.
- Question paper shall be set jointly by both examiners and made available for each batch as per schedule.
- Evaluation shall be carried jointly by both the examiners.
- Scheme of Evaluation: To be defined by the examiners jointly and the same shall be submitted to the university along with question paper.

- One full question shall be set from each Modules as per the below table weightage details. **However, the student may be awarded full marks, if he/she completes solution on computer display without sketch**

Module	Max. Marks weightage	Evaluation Weightage in marks	
		Computer display & printout	Preparatory sketching
Module-1 or Module-2	20	15	05
Module-3	30	20	10
Module-4	50	40	10
Total	100	75	25

Suggested Learning Resources:

Books

Text Books:

1. K L Narayana, P Kannaiah, K Venkata Reddy, "Machine Drawing", New Age International, 3rd Edition. ISBN-13: 978-81-224-2518-5, 2006
2. N D Bhatt, "Machine Drawing", Charotar Publishing House Pvt. Ltd., 50th Edition, ISBN-13: 978-9385039232, 2014
3. Machine drawing by K R Gopalakrishna, Subhash Publication

Web links and Video Lectures (e-Resources):

- **Learn Fusion 360 in 90 Minutes**
<https://www.autodesk.com/certification/learn/course/learn-fusion-360-in-90-minutes>

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

Electric and Hybrid Vehicle Technology		Semester	3
Course Code	BME306A	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		
Course objectives: <ul style="list-style-type: none">To understand the models, describe hybrid vehicles and their performance.To understand the different possible ways of energy storage.To understand the different strategies related to hybrid vehicle operation & energy management.			
Teaching-Learning Process (General Instructions) <p>These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.</p> <ul style="list-style-type: none">Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Videodemonstrations or Simulations.Chalk and Talk method for Problem Solving.Adopt flipped classroom teaching method.Adopt collaborative (Group Learning) learning in the class.Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such asevaluating, generalizing, and analyzing information.			
Module-1			
Introduction to Electric Vehicle (EV) & Hybrid Vehicle(HV): <p>A brief history of Electric and Hybrid vehicles, basic architecture of hybrid drive train, vehicle motion and the dynamic equations for the vehicle, types of HV and EV, advantages over conventional vehicles, limitations of EV and HV, impact on environment of EV and HV technology, disposal of battery, cell and hazardous material and their impact on environment.</p>			
Module-2			
Power Management and Energy Sources of EV and HV: <p>Power and Energy management strategies and its general architecture of EV and HV, various battery sources, energy storage, battery based energy storage, Battery Management Systems (BMS), fuel cells, their characteristics, Super capacitor based energy storage, flywheel, hybridization of various energy storage devices, Selection of the energy storage technology.</p>			
Module-3			
DC and AC Machines & Drives in EV & HV: <p>Various types of motors, selection and size of motors, Induction motor drives and control characteristics, Permanent magnet motor drives and characteristics, Brushed & Brushless DC motor drive and characteristics, switched reluctance motors and characteristics, IPM motor drives and characteristics, mechanical and electrical connections of motors.</p>			
Module-4			
Components & Design Considerations of EV & HV: <p>Design parameters of batteries, ultra-capacitors and fuel cells, aerodynamic considerations, calculation of the rolling resistance and the grade resistance, calculation of the acceleration force, total tractive effort, torque required on the drive wheel, transmission efficiency, consideration of vehicle mass.</p>			

Module-5
<p>Electric and Hybrid Vehicles charging architecture: Introduction to smart charging: Grid to vehicle and vehicle to grid, smart metering and ancillary services, preliminary discussion on vehicle to vehicle and vehicle to personal communication systems, introduction to battery charging stations and its installation and commissioning, preliminary discussion on estimation on station capacity and associated technical issues, different connectors.</p>
<p>Course outcome (Course Skill Set)</p> <p>At the end of this course, students will demonstrate the ability to</p> <ol style="list-style-type: none"> 1. Understand the architecture and vehicle dynamics of electric and hybrid vehicles 2. Analyze the power management systems for electric and hybrid vehicles 3. Understand different motor control strategies for electric and hybrid vehicles 4. Analyze various components of electric and hybrid vehicles with environment concern. 5. Understand the domain related grid interconnections of electric and hybrid vehicle.
<p>Assessment Details (both CIE and SEE)</p> <p>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.</p> <p>Continuous Internal Evaluation:</p> <ul style="list-style-type: none"> • 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 220B2.4, 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. <p>Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.</p> <p>Semester-End Examination:</p> <p>Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours).</p> <ol style="list-style-type: none"> 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.
<p>Suggested Learning Resources:</p> <p>Text Books</p> <ol style="list-style-type: none"> 1. Iqbal Hussain, "Electric and Hybrid Vehicles Design Fundamentals", 1st Edition, CRC Press, 2003. 2. James Larminie, John Lowry "Electric Vehicle Technology Explained", 1st Edition, John Wiley and Sons, 2003.

<ol style="list-style-type: none"> 3. Chris Mi, M. Abul Masrur, David Wenzhong Gao, “Hybrid Electric Vehicles: Principles and Applications with Practical Perspectives”, Wiley publication ,2011. 4. Allen Fuhs, “Hybrid Vehicles and the future of personal transportation”, CRC Press, 2009.
Web links and Video Lectures (e-Resources):
<ol style="list-style-type: none"> 1. Web course on “Introduction to Hybrid and Electric Vehicles” by Dr. Praveenkumar and Prof. S Majhi, IIT Guwahati available on NPTEL at https://nptel.ac.in/courses/108/103/108103009/ 2. Video Course on “Electric Vehicles” by Prof. Amitkumar Jain, IIT Delhi available on NPTEL at https://nptel.ac.in/courses/108/102/108102121/
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

Smart Materials & Systems		Semester	III
Course Code	BME306B	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		
Course objectives: <ul style="list-style-type: none">● To make the students understand about smart materials● To make students to know about making of material smart● To enable the students to appreciate the material properties			
Teaching-Learning Process (General Instructions) <p>These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.</p> <ol style="list-style-type: none">1. Class room teaching through chalk & talk, PPT, Appropriate Videos, etc2. Industry visit3. Activity based learning4. Display the sample materials in class room / laboratory			
Module-1			
Smart materials and structures: System intelligence- components and classification of smart structures, common smart materials and associated stimulus-response, Application areas of smart systems			
Module-2			
Electrically Activated Materials: Piezoelectricity, Piezoresistivity, Ferroelectricity, Piezoelectric materials- piezoelectric effect, Piezoceramics, Piezopolymers, Piezoelectric materials as sensors, Actuators and bimorphs, nanocarbon tubes			
Module-3			
Thermally activated materials: Shape memory materials; Shape memory alloys (SMAs), Classification - Transformation - Ni-Ti Alloys, Shape memory effect, Martensitic transformation, One way and two-way SME, binary and ternary alloy systems, Functional properties of SMAs, Shape memory ceramics - Shape memory polymers – Applications			
Module-4			
Smart polymers: Thermally responsive polymers, Electroactive polymers microgels, Synthesis, Properties and Applications, Protein-based smart polymers, pH-responsive and photo-responsive polymers, Self-assembly, Drug delivery using smart polymers			
Module-5			
Chemically Activated Materials - Chemical Gels - Self healing materials Optically Activated Materials - Optically activated polymers - Azobenzene - Liquid Crystal, Smart materials for space applications: Elastic memory composites, Smart corrosion protection coatings, Sensors, Actuators, Transducers,			

Course outcome (Course Skill Set)

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

1. Apply the knowledge for materials characterisation
2. Evaluate the materials based on actuation
3. Select and justify appropriate materials for specific application

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks 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 220B2.4, 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**).

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

Suggested Learning Resources:**Books**

1. D.J. Leo, Engineering Analysis of Smart Material Systems, Wiley 2007.
2. M. Addington, D.L. Schodek, Smart Materials and New Technologies in Architecture, Elsevier 2005.
3. Donald R. Askeland and Pradeep P. Fulay, Essentials of Materials Science and Engineering, 2009, Cengage Learning.

References

1. Gandi, M.V. and Thompson, B.S., "Smart Materials and Structures," Chapman & Hall, UK, 1992,
2. Culshaw, B., "Smart Structures and Materials," Artech House, Inc., Norwood, USA, 1996.
3. Dimitris C. Lagoudas, Shape Memory Alloys: Modelling and Engineering Applications, Springer, 2008.
4. T. Yoneyama & S. Mayazaki, Shape memory alloys for biomedical applications, CRC Press, 200

Web links and Video Lectures (e-Resources):

- Smart materials intelligent system design NPTEL course

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

- Prepare a smart material sample
- Visit to industry

INTERNET OF THINGS		Semester	3
Course Code	BME306C	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	
Examination type (SEE)	Theory		
Course objectives: The Internet is evolving to connect people to physical things and also physical things to other physical things all in real time. It's becoming the Internet of Things (IoT). The course enables student to <ul style="list-style-type: none">• Understand the basics of Internet of things and protocols.• Understand some of the application areas where Internet of Things can be applied.• Learn about the middleware for Internet of Things.• Understand the concepts of Web of Things			
Teaching-Learning Process (General Instructions) These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes and make Teaching –Learning more effective <ol style="list-style-type: none">1. At the start of course, the course delivery pattern, prerequisite of the subject will be discussed2. Lecture may be conducted with the aid of multi-media projector, chalk & Talk3. Attendance is compulsory in lectures and laboratory, which may carries five marks in overall evaluation.4. Promoting project based learning may be conducted having a share of 20 marks in the overall internal evaluation.5. Assignment based on course content will be given to the student for each unit/topic and will be evaluated at regular interval. It may carry an importance of ten marks in the overall internal evaluation.6. Surprise tests/Quizzes/Seminar/Tutorial may be conducted and having share of 10 marks in the overall internal evaluation.			
Module-1			
IOT - What is the IoT and why is it important? Elements of an IoT ecosystem, Technology drivers, Business drivers, Trends and implications, Overview of Governance, Privacy and Security Issues.			
Module-2			
IOT PROTOCOLS - Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols – Issues with IoT Standardization – Unified Data Standards – Protocols – IEEE802.15.4–BACNet Protocol– Modbus – KNX – Zigbee– Network layer – APS layer – Security			
Module-3			
IOT ARCHITECTURE - IoT Open source architecture (OIC)- OIC Architecture & Design principles- IoT Devices and deployment models- IoTivity: An Open source IoT stack - Overview- IoTivity stack architecture- Resource model and Abstraction.			
Module-4			
WEB OF THINGS - Web of Things versus Internet of Things – Two Pillars of the Web – Architecture Standardization for WoT– Platform Middleware for WoT – Unified Multitier WoT Architecture – WoT Portals and Business Intelligence.			
Module-5			
IOT APPLICATIONS - IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications. Study of existing IoT platforms /middleware, IoT- A, Hydra etc.			

Course outcome (Course Skill Set)

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

1. Explain the definition and usage of the term “Internet of Things” in different contexts
2. Understand the key components that make up an IoT system
3. Differentiate between the levels of the IoT stack and be familiar with the key technologies and protocols employed at each layer of the stack
4. Apply the knowledge and skills acquired during the course to build and test a complete, working IoT system involving prototyping, programming and data analysis
5. Understand where the IoT concept fits within the broader ICT industry and possible future trends and Appreciate the role of big data, cloud computing and data analytics in a typical IoT system

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) 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:**Text Books**

1. Honbo Zhou, "The Internet of Things in the Cloud: A Middleware Perspective", CRC Press, 2012.
2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), "Architecting the Internet of Things", Springer, 2011.
3. David Easley and Jon Kleinberg, "Networks, Crowds, and Markets: Reasoning About a Highly Connected World", Cambridge University Press, 2010.
4. Olivier Hersent, David Boswarthick, Omar Elloumi, "The Internet of Things – Key applications and Protocols", Wiley, 2012.

References Books:

1. Vijay Madiseti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", 1st Edition, VPT, 2014
2. Francis daCosta, "Rethinking the Internet of Things: A Scalable Approach to Connecting Everything", 1st Edition, Apress Publications, 2013
3. Cuno Pfister, "Getting Started with the Internet of Things", O'Reilly Media, 2011, ISBN: 978-1-4493-9357-1

Web links and Video Lectures (e-Resources):

- Introduction to IoT - https://www.youtube.com/watch?v=WUYAixnwjU4&list=PLE7VH8RC_N3bpVn-e8QzOAHziEgmjQ2qE
- <https://www.coursera.org/learn/beginning-custom-projects-with-raspberry-pi>
- <https://www.edx.org/course/introduction-to-the-internet-of-things-3>

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

1. Familiarization with Arduino/Raspberry Pi and perform necessary software installation.
2. To interface LED/Buzzer with Arduino/Raspberry Pi and write a program to turn ON LED for 1 sec after every 2 seconds.
3. To interface Push button/Digital sensor (IR/LDR) with Arduino/Raspberry Pi and write a program to turn ON LED when push button is pressed or at sensor detection.
4. To interface DHT11 sensor with Arduino/Raspberry Pi and write a program to print temperature and humidity readings.
5. To interface motor using relay with Arduino/Raspberry Pi and write a program to turn ON motor when push button is pressed.
6. To interface OLED with Arduino/Raspberry Pi and write a program to print temperature and humidity readings on it.
7. To interface Bluetooth with Arduino/Raspberry Pi and write a program to send sensor data to smartphone using Bluetooth.
8. To interface Bluetooth with Arduino/Raspberry Pi and write a program to turn LED ON/OFF when '1'/'0' is received from smartphone using Bluetooth.
9. Write a program on Arduino/Raspberry Pi to upload temperature and humidity data to thing speak cloud.
10. Write a program on Arduino/Raspberry Pi to retrieve temperature and humidity data from thing speak cloud.
11. To install MySQL database on Raspberry Pi and perform basic SQL queries.
12. Write a program on Arduino/Raspberry Pi to publish temperature data to MQTT broker.

WASTE HANDLING & MANAGEMENT		Semester	III
Course Code	BME306D	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		
Course objectives: To make students to understand about; 1. Waste generation & effects 2. Solid waste management & challenges 3. Hazordous waste management & challenges 4. Innovative methods in practice to handle waste & its effects 5. Laws governing the waste management			
Teaching-Learning Process (General Instructions) These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes. 1. Class room teaching through chalk & talk, PPT, Appropriate Videos, etc 2. Visit to nearby waste handling sites 3. Segregation of waste & Preparation of compost practical execution 4. Student speeches on their observations 5. Conduction / participation in Waste management idea formulation competition events 6. Case study discussions at least 4 in each topic mentioned			
Module-1: Introduction to waste management			
Importance, methods of logistics, human components, technological components- waste handling equipment and technology, steps in waste management logistics. Waste collection system and organization: Environmental aspects of waste collection, role of public authority and private sector in waste collection, organizing collection of residential waste, fee schemes, public awareness programs.			
Module-2 : Engineering Systems for Solid Waste Management			
Characteristics of solid waste, types of solid waste, Processing and Treatment of Solid Waste; Mechanical Treatment Material Recovery Facility, Recycling and Recovery, Types of Material Recovery Facilities, Biological Treatment & Biological methods for waste processing; Composting & methods. Biomethanation, Biodeisel, Biohydrogen, Mechanical Biological Stabilization, Thermal Treatment Incineration, Residues and its utilisation, co-combustion, Pyrolysis, Gasification, Refuse Derived Fuel, solid recovered fuel. Engineering Disposal of SW: Dumping of solid waste; sanitary land fills – site selection,.			
Module-3 Hazardous Waste Management			
Introduction, Hazardous waste definition, sources, identification and classification, Characteristics, Industrial waste & Plastic Waste; sources, environmental effects, challenges in handling Biomedical waste; Introduction to biomedical wastes, sources, classification, collection, segregation, treatment and disposal, E- waste; characteristics, generation, collection, transport, recycling and disposal, Effects on the society and environment, Transportation and Disposal, recycling and reuse, Nuclear waste; Characteristics, Types, Power reactors, Refinery and fuel fabrication wastes, Health and environmental effects, Decommissioning of Nuclear power reactors Hazardous waste landfills, Site selections.			

	Module-4 Innovations in waste management
	<p>Global and Indian Context, recycling, reuse, energy production, land filling, remediation of hazardous waste contaminated sites.</p> <p>Revenue models, Developing Networks, Entrepreneurship activities,</p> <p>Best practices in India and Abroad- Case studies, Waste management and waste handling entrepreneurs in India and other countries,</p> <p>Case studies of different municipalities waste handling techniques, domestic composting, medium & large scale composting, Centralised composting</p>
	Module-5 Waste Management Laws in India
	<p>The Environmental Protection Act, The Hazardous Wastes (Management, Handling and Transboundary Movement) Rules, 2008, The Plastic Waste (Management and Handling) Rules, 2011, Bio-Medical Waste (Management and Handling) Rules, 1998, The E- Waste (Management and Handling) Rules, 2011, The Batteries (Management and Handling) Rules, 2001. Duties of constitutional bodies and Ministries</p>
Course outcome (Course Skill Set) At the end of the course, the student will be able to: <ol style="list-style-type: none"> 1. Identify & segregate the waste 2. Formulate the appropriate waste segregation, collection & disposal system 3. Generate a report on waste management challenges 4. Select a remedial measure for environmental & living being protection 5. Exercise the constitution laws as a citizen 	

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**).

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

Suggested Learning Resources:**Books**

1. Handbook of Solid Waste Management, Tchobanoglous G and Kreith F, McGraw-Hill Education, 2002, 2nd Edition
2. Hazardous Wastes - Sources, Pathways, Receptors, Richard J. Watts, John Wiley and Sons, 1998, 1st Edition.
3. Strategic Management, Hitt, M.A., Hoskisson, R.E., Ireland, R.D., (2016), Cengage Learning, India.
4. Waste Management Practices: Municipal, Hazardous and Industrial, John Pichtel, CRC Press, 2014, 2nd Edition
5. Handbook of Solid Waste Management, Tchobanoglous G and Kreith F, McGraw-Hill Education, 2002, 2nd Edition

Reference books:

1. Waste Management Practices: Municipal, Hazardous and Industrial, John Pichtel (2014), 2nd Ed., CRC Press, USA.
2. Waste: A Handbook for Management, Letcher, T.M., Vallero, D.A. (2011), 1st Ed, Academic Press, USA.
3. Waste Management Strategy and Action Plan, IGES, UNEP, CCET. (2018), Phnom Penh 2018-2035. Phnom Penh, Cambodia.
4. National Environment Policy, 2006, Ministry of Environment and Forests, Government of India, Approved by the Union Cabinet on 18 May, 2006
5. Innovation and Entrepreneurship, Peter Drucker, (2012), Routledge Publishers, England UK

Web links and Video Lectures (e-Resources):

- <https://nptel.ac.in/content/storage2/courses/105106056/Introduction.pdf>
- <https://nptel.ac.in/courses/105/103/105103205/>
- <http://cpheeo.gov.in/cms/manual-on-municipal-solid-waste-management-2016.php>
- <https://nptel.ac.in/courses/105/103/105103205/>
- <https://nptel.ac.in/courses/120/108/120108005/>
- <https://nptel.ac.in/courses/105/106/105106056/>
- <https://nptel.ac.in/courses/105/105/105105160/>
- <https://nptel.ac.in/courses/103/107/103107125/>
- <https://nptel.ac.in/courses/110/108/110108047/>
- <https://nptel.ac.in/courses/105/106/105106056/>
- <https://nptel.ac.in/courses/105/105/105105184/>
- <https://nptel.ac.in/content/storage2/courses/105106056/Introduction.pdf>
- https://wedocs.unep.org/bitstream/handle/20.500.11822/31379/IWM_Guidelines.pdf?sequence=1&isAllowed=y

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

- Preparation of a model for waste management for a hostel, apartment, institution,
- Speeches by students about best practices followed for domestic waste handling
- Prepare compost using machines
- Visit nearby waste dump yard and prepare a report covering challenges & remedies
- Visit industries and observe large-scale industry waste disposal practices and challenges
- Visit near by hospitals and observe large-scale bio-medical waste disposal practices and challenges
- Display everyday one/ two constitution rules on class notice board
- Poster preparation by students

ADVANCED PYTHON PROGRAMMING		Semester	3
Course Code	BME358A	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	01	Exam Hours	03
Examination type (SEE)	Practical		
Course objectives: <ul style="list-style-type: none">To understand the problem solving approaches.To learn the basic programming constructs in Python.To practice various computing strategies for Python-based solutions to real world problems.To use Python data structures – lists, tuples, dictionaries.To do input/output with files in Python.			
Sl.NO	Experiments		
1	Demonstrate following functions/methods which operates on strings in Python with suitable examples: i) len() ii) strip() iii) rstrip() iv) lstrip() v) find() vi) rfind() vii) index() viii) rindex(),ix) count() x) replace() xi) split() xii) join() xiii) upper() xiv) lower() xv) swapcase() xvi) title() xvii) capitalize() xviii) startswith() xix) endswith()		
2	Implementing programs using Functions. (Factorial, largest number in a list, area of shape).		
3	NESTED LISTS: Write a program to read a 3 X 3 matrix and find the transpose, addition, subtraction, multiplication of two 3 X 3 matrices, check whether two given 3 X 3 matrices are identical or not.		
4	Implementing programs using Strings. (Reverse, palindrome, character count, replacing characters). Real time applications using sets and Dictionaries		
5	Scientific problems using Conditionals and Iterative loops. (Number series and different Patterns).		
6	Numpy Library: Linear Algebra a) Write a python program to find rank, determinant, and trace of an array. b) Write a python program to find eigen values of matrices d) Write a python program to solve a linear matrix equation, or system of linear scalar equations.		
7	Graphics: <ul style="list-style-type: none">Consider turtle object. Write functions to draw triangle, rectangle, polygon, circle and sphere. Use object oriented approach.Design a Python program using the Turtle graphics library to construct a turtle bar chart representing the grades obtained by N students read from a file categorizing them into distinction, first class, second class, third class and failed.		
8	Create a colour images using NumPy in Python.		
	Demonstration Experiments (For CIE)		
9	Write a python program to implement Pandas Series with labels.		
10	Implementing real-time/technical applications using File handling. (copy from one file to another, word count, longest word).		
11	Implementing real-time/technical applications using Exception handling. (divide by zero error, voter's age validity, student mark range validation).		
12	Developing a game activity using Pygame like bouncing ball, car race etc.		

Course outcomes (Course Skill Set):

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

- CO1: Develop algorithmic solutions to simple computational problems.
- CO2: Develop and execute simple Python programs.
- CO3: Use functions to decompose a Python program.
- CO4: Process compound data using Python data structures.
- CO5: Utilize Python packages in developing software 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 Evaluation (CIE):

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

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

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

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

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before

the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.

- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.
- General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)
- Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

- G Venkatesh and Madhavan Mukund, "Computational Thinking: A Primer for Programmers and Data Scientists", 1st Edition, Notion Press, 2021.
- John V Guttag, "Introduction to Computation and Programming Using Python: With Applications to Computational Modeling and Understanding Data", Third Edition, MIT Press, 2021
- Paul Deitel and Harvey Deitel, "Python for Programmers", Pearson Education, 1st Edition, 2021.
- Eric Matthes, "Python Crash Course, A Hands – on Project Based Introduction to Programming", 2nd Edition, No Starch Press, 2019.
- Martin C. Brown, "Python: The Complete Reference", 4th Edition, Mc-Graw Hill, 2018.

INTRODUCTION TO VIRTUAL REALITY		Semester	3rd
Course Code	BME358B	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	0-2-0-0	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	100
Credits	01	Exam Hours	01
Examination nature (SEE)	Theory/practical/Viva-Voce /Term-work/Others		
Course objectives: <ul style="list-style-type: none">Describe how VR systems work and list the applications of VR.Understand the design and implementation of the hardware that enables VR systems to be built.Understand the system of human vision and its implication on perception and rendering.Explain the concepts of motion and tracking in VR systems.Describe the importance of interaction and audio in VR systems.			
Teaching-Learning Process (General Instructions) <p>These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.</p> <ol style="list-style-type: none">Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.Chalk and Talk method for Problem Solving.Adopt flipped classroom teaching method.Adopt collaborative (Group Learning) learning in the class.Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analyzing information.			
Module-1			
Introduction to Virtual Reality : Defining Virtual Reality, History of VR, Human Physiology and Perception, Key Elements of Virtual Reality Experience, Virtual Reality System, Interface to the Virtual World-Input & output- Visual, Aural & Haptic Displays, Applications of Virtual Reality.			
Teaching- Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board		
Module-2			
Representing the Virtual World : Representation of the Virtual World, Visual Representation in VR, Aural Representation in VR and Haptic Representation in VR			
Teaching- Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board		
Module-3			
The Geometry of Virtual Worlds &The Physiology of Human Vision: Geometric Models, Changing Position and Orientation, Axis-Angle Representations of Rotation, Viewing Transformations, Chaining the Transformations, Human Eye, eye movements & implications for VR.			
Teaching- Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board		
Module-4			

Visual Perception & Rendering: Visual Perception - Perception of Depth, Perception of Motion, Perception of Color, Combining Sources of Information Visual Rendering -Ray Tracing and Shading Models, Rasterization, Correcting Optical Distortions, Improving Latency and Frame Rates	
Teaching- Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Module-5	
Motion & Tracking: Motion in Real and Virtual Worlds- Velocities and Accelerations, The Vestibular System, Physics in the Virtual World, Mismatched Motion and Vection Tracking- Tracking 2D & 3D Orientation, Tracking Position and Orientation, Tracking Attached Bodies	
Teaching- Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving./White board
Course outcome (Course Skill Set) At the end of the course the student will be able to: CO1: Describe how VR systems work and list the applications of VR. CO2: Demonstrate the design and implementation of the hardware that enables VR systems to be built. CO3: Understand the system of human vision and its implication on perception and rendering. CO4: Explain the concepts of motion and tracking in VR systems. CO5: Describe the importance of interaction and audio in VR 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 220B2.4, 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 01 mark. The pattern of the question paper is MCQ (multiple choice questions). The time allotted for SEE is **01 hour**. The student has to secure a minimum of 35% of the maximum marks meant for SEE.

Suggested Learning Resources:

Text Books

1. Virtual Reality, Steven M. LaValle, Cambridge University Press, 2016
2. Understanding Virtual Reality: Interface, Application and Design, William R Sherman and Alan B Craig, (The Morgan Kaufmann Series in Computer Graphics)". Morgan Kaufmann Publishers, San Francisco, CA, 2002.
3. Developing Virtual Reality Applications: Foundations of Effective Design, Alan B Craig, William R Sherman and Jeffrey D Will, Morgan Kaufmann, 2009.

Reference Books:

1. Gerard Jounghyun Kim, "Designing Virtual Systems: The Structured Approach", 2005.
2. Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, "3D User Interfaces, Theory and Practice", Addison Wesley, USA, 2005.
3. Oliver Bimber and Ramesh Raskar, "Spatial Augmented Reality: Merging Real and Virtual Worlds", 2005.
4. Burdea, Grigore C and Philippe Coiffet, "Virtual Reality Technology", Wiley Interscience, India, 2003.

Web links and Video Lectures (e-Resources):

- <http://lavalle.pl/vr/book.html>
- <https://nptel.ac.in/courses/106/106/106106138/>
- <https://www.coursera.org/learn/introduction-virtual-reality>.

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

- Course seminars

SPREADSHEET FOR ENGINEERS		Semester	3
Course Code	BME358C	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	15 sessions	Total Marks	100
Credits	1	Exam Hours	03
Examination type (SEE)	Practical		
Course objectives: <ul style="list-style-type: none">• To create different plots and charts• To compute different functions, conditional functions and make regression analysis• To carryout iterative solutions for roots, multiple roots, optimization and non-linear regression analysis• To carryout matrix operations• To Understand VBA and UDF• To understand VBA subroutines and Macros• To carryout numerical integration and solving differential equations using different methods			
Sl.NO	Experiments		
1	Charting: Create an XY scatter graph, XY chart with two Y-Axes, add error bars to your plot, create a combination chart		
2	Functions: Computing Sum, Average, Count, Max and Min, Computing Weighted Average, Trigonometric Functions, Exponential Functions, Using The CONVERT Function to Convert Units		
3	Conditional Functions: Logical Expressions, Boolean Functions, IF Function, Creating a Quadratic Equation Solver, Table VLOOKUP Function, AND, OR and XOR functions.		
4	Regression Analysis: Trendline, Slope and Intercept, Interpolation and Forecast, The LINEST Function, Multilinear Regression, Polynomial Fit Functions, Residuals Plot, Slope and Tangent, Analysis ToolPack.		
5	Iterative Solutions Using Excel: Using Goal Seek in Excel, Using The Solver To Find Roots, Finding Multiple Roots, Optimization Using The Solver, Minimization Analysis, NonLinear Regression Analysis.		
6	Matrix Operations Using Excel: Adding Two Matrices, Multiplying a Matrix by a Scalar, Multiplying Two Matrices, Transposing a Matrix, Inverting a Matrix and Solving System of Linear Equations.		
7	VBA User-Defined Functions (UDF): The Visual Basic Editor (VBE), The IF Structure, The Select Case Structure, The For Next Structure, The Do Loop Structure, Declaring Variables and Data Types, An Array Function The Excel Object Model, For Each Next Structure.		
8	VBA Subroutines or Macros: Recording a Macro, Coding a Macro Finding Roots by Bisection, Using Arrays, Adding a Control and Creating User Forms.		
	Demonstration Experiments (For CIE)		
9	Numerical Integration Using Excel: The Rectangle Rule, The Trapezoid Rule, The Simpson's Rule, Creating a User-Defined Function Using the Simpson's Rule.		
10	Differential Equations: Euler's Method, Modified Euler's Method, The Runge Kutta Method, Solving a Second Order Differential Equation		
Course outcomes (Course Skill Set): At the end of the course the student will be able to: <ul style="list-style-type: none">• Create different plots and charts• Compute different functions, conditional functions and make regression analysis• Carryout iterative solutions for roots, multiple roots, optimization and non-linear regression analysis• Carryout matrix operations			

- Understand VBA and UDF, VBA subroutines and Macros
- Carryout numerical integration and solving differential equations using different methods

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 (CIE):

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

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

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

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

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement

evaluation rubrics shall be decided jointly by examiners.

- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

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

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

The minimum duration of SEE is 03 hours

Suggested Learning Resources:

- Excel Resources - 600+ Self Study Guides, Articles & Tools (wallstreetmojo.com)
- https://www.ictlounge.com/html/year_7/esafety_part7.htm
- McFedries Paul Microsoft Excel 2019 Formulas And Functions Microsoft Press, U.S, 2019 Edition

Tools in Scientific Computing		Semester	3
Course Code	BME358D	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	15 sessions	Total Marks	100
Credits	01	Exam Hours	03
Examination type (SEE)	Theory/ Practical /Viva-Voce /Term-work/Others		
Course objectives:			
1. To learn the fundamentals of problem-solving using MATLAB/MATHCAD and go plot graphs using Origin software			
2. To introduce programming for curve fitting and solving both linear and nonlinear equations.			
3. To understand the concept of approximate methods and recognize their significance in computing.			
Sl.NO	Experiments		
1	Develop a program to find the eigenvalues and eigenvectors of a square matrix		
2	Develop a user-friendly program for the Newton-Raphson method for solving simultaneous nonlinear equations		
3	Develop a user-friendly program to find solution of simultaneous linear equations using matrix methods		
4	Develop a program to find the equation that best fits for the given set of points using any of the curve fitting techniques		
5	Develop a program to compute the area under the given curve described by the function using numerical techniques		
6	Develop a user-friendly program for the thick or thin cylinders subjected to internal and external loads, determine the stresses developed within the cylinder and plot the variation of stresses		
7	Develop a program to find the principal stresses and their associated directions for a given state of stress described by the components of stress in three dimensions (σ_{xx} , σ_{yy} , σ_{zz} , σ_{xy} , σ_{xz} , σ_{yz}),		
8	Develop a user-friendly program for plotting the Mohr's circle for the given 2D stress state and determine the principal stresses and directions of principle stress		
	Demonstration Experiments (For CIE)		
9	Develop a program to find the multiplication and inverse of a square matrix		
10	Develop a program to find and plot the response of spring-mass-dashpot system subjected to harmonic excitation.		
11	Develop a program to find the roots of a quadratic equation using numerical methods		
12	Develop a program to find the solution of differential equation using approximate methods		

Course outcomes (Course Skill Set):

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

1. Understand the fundamentals of programming in scientific computations.
2. Develop programming for curve fitting and solving both linear and nonlinear equations.
3. Apply the concept of approximate methods and recognize their significance in computing.
4. Apply MATLAB/MATCAD/FORTRAN/PYTHON tools, etc., for solving engineering problems

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks 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 (CIE):

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

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

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

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

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.

- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

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

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

The minimum duration of SEE is 03 hours

Suggested Learning Resources:

1. Applied Numerical Methods with MATLAB for Engineers and Scientists, Steven C. Chapra, Edition 3, McGraw-Hill, 2012
2. Numerical methods for engineers, Steven C. Chapra, Raymond P. Canale, 5th fifth edition, 2006, McGraw-Hill Higher Education, Boston, 2006
3. MATLAB and Its Applications in Engineering, Raj Kumar Bansal, et.al 2009, Pearson Education,

APPLIED THERMODYNAMICS		Semester	4
Course Code	BME401	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	2:2:0:0	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		
Course objectives: <ul style="list-style-type: none">• Explain the air standard cycle and combustion in I. C. Engines.• Describe the gas power cycle and vapour power cycles.• Explain the performance of compressor.• Explain the concepts of Refrigeration and Air conditioning.			
Teaching-Learning Process (General Instructions) <p>These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.</p> <ol style="list-style-type: none">1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.2. Chalk and Talk method for Problem Solving.3. Adopt flipped classroom teaching method.4. Adopt collaborative (Group Learning) learning in the class.5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.			
Module-1			
Air standard cycles: Carnot cycle. Otto, Diesel, Dual and cycles, p-v and T -s diagrams, description, efficiencies and mean effective pressures. Comparison of Otto and Diesel cycles.			
I.C.Engines: Classification of IC engines, Combustion of SI engine and CI engine, Detonation and factors affecting detonation, Performance analysis of I.C Engines, Heat balance, Morse test			
Module-2			
Gas power Cycles: Gas turbine (Brayton) cycle; description and analysis. Regenerative, Intercooling and reheating in gas turbine cycles.			
Jet Propulsion cycles: Turbojet, Turboprop, Turbofan, Ram Jet, Rocket, Pulse Jet, Ram Rocket.			
Module-3			
Vapour Power Cycles: Carnot vapour power cycle, drawbacks as a reference cycle. Simple Rankine cycle; description, T-S diagram, analysis for performance. Comparison of Carnot and Rankine cycles. Effects of pressure and temperature on Rankine cycle performance.			
Actual vapour power cycles: Actual vapour power cycles, regenerative vapour power cycle with open and closed feed water heaters. Reheat Rankine cycle.			
Module-4			
Refrigeration Cycles: Vapour compression refrigeration system; description, analysis, refrigerating effect. Capacity, power required, units of refrigeration, COP, Refrigerants and their desirable properties, alternate Refrigerants. Vapour absorption refrigeration system.			
Pscychrometrics and Air-conditioning Systems: Psychometric properties of Air (<i>only for review</i>), Psychometric Chart, Analyzing Air-conditioning Processes; Heating, Cooling, Dehumidification and Humidification, Evaporative Cooling. Adiabatic mixing of two moist air streams.			

Module-5
<p>Reciprocating Compressors: Operation of a single stage reciprocating compressors. Work input through p-v diagram and steady state steady flow analysis. Effect of Clearance and Volumetric efficiency. Adiabatic, Isothermal and Mechanical efficiencies. Multi-stage compressor, saving in work, Optimum intermediate pressure, Inter-cooling, Minimum work for compression.</p> <p>Steam nozzles: Flow of steam through nozzles, Shape of nozzles, effect of friction, Critical pressure ratio, Super saturated flow.</p>
<p>Course outcome (Course Skill Set)</p> <p>At the end of the course, the student will be able to :</p> <ol style="list-style-type: none"> 1. Analyse air standard cycle to evaluate the performance of I C engines. 2. Analyze the gas power cycles to evaluate the overall efficiency of gas turbine plant. 3. Apply thermodynamic concepts to analyze the performance of vapour power cycles. 4. Analyze the vapour compression and vapour absorption systems to improve refrigeration. 5. Determination of various parameters of air compressors and steam nozzles.
<p>Assessment Details (both CIE and SEE)</p> <p>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.</p> <p>Continuous Internal Evaluation:</p> <ul style="list-style-type: none"> • 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. <p>Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.</p> <p>Semester-End Examination:</p> <p>Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours).</p> <ul style="list-style-type: none"> • The question paper will have ten questions. Each question is set for 20 marks. • There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), should have a mix of topics under that module. • The students have to answer 5 full questions, selecting one full question from each module. • Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:**Books (Title of the Book/Name of the author/Name of the publisher/Edition and Year)****Text Books:**

1. Engineering Thermodynamics, P.K. Nag, Tata McGraw Hill, 6th Edition 2018
2. Thermodynamics, Yunus A, Cengel, Michael A Boles, Tata McGraw Hill 7th Edition

Reference Books:

1. Thermodynamics for engineers Kenneth A. Kroosand Merle C. Potter, Cengage Learning 2016
2. Principles of Engineering Thermodynamics, Michael J, Moran,Howard N. Shapiro, Wiley 8th Edition
3. I.C.Engines, M.L.Mathur&Sharma. Dhanpat Rai& sons-India

Web links and Video Lectures (e-Resources):

- <https://www.youtube.com/watch?v=AwbhbN20xl8&list=PLwdnzlV3ogoVJnW1S9GgOKYj5heOzl1dn>
- <https://ciechanow.ski/internal-combustion-engine/>
- <https://www.youtube.com/watch?v=1Vn1PDuPHsY&list=PL4K9r9dYCOoozyQU9kmQFJkTz>

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

- Organise Industrial visits to Thermal power plants and submission of report.
- Visit to a building under construction to explore the design consideration of duct to understand the concept of centralized Air Conditioning.

MACHINING SCIENCE & METROLOGY		Semester	IV
Course Code	BME402	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	03
Examination nature (SEE)	Theory /Viva-Voce /Term-work/Others		

Course objectives:

- To enrich the knowledge pertaining to relative motion and mechanics required for various machine tools.
- To introduce students to different machine tools to produce components having different shapes and sizes.
- To develop the knowledge on mechanics of machining process and effect of various parameters on machining.
- To understand the basic principles of measurements
- To enrich the knowledge pertaining to gauge , comparator and angular measurement.

Teaching-Learning Process (General Instructions)

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

1. Adopt different teaching methods to develop the outcomes through presentations/ video demonstrations/ simulations.
2. Chalk and talk method for problem-solving.
3. Arrange industrial visits to show the live working models other than laboratory topics.
4. Adopt collaborative learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analyzing information.
6. Conduct laboratory demonstrations and practical experiments to enhance experiential skills.

MODULE-1

Introduction to Metal cutting: Orthogonal and oblique cutting. Classification of cutting tools: single, and multipoint; tool signature for single point cutting tool. Mechanics of orthogonal cutting; chip formation, shear angle and its significance, Merchant circle diagram. Numerical problems. Cutting tool materials and applications.

Introduction to basic metal cutting machine tools: Lathe- Parts of lathe machine, accessories of lathe Machine and various operations carried out on lathe. Kinematics of lathe. Turret and Capstan lathe.

MODULE-2

Milling Machines: up milling & down milling, classification of milling machines, constructional features (Column and Knee and vertical milling machine), milling cutter nomenclature, various milling operations, calculation of machining time.

Indexing: Need of indexing Simple, compound and differential indexing calculations. Simple numerical on indexing.

Shaping, Slotting and Planning Machines Tools: Driving mechanisms of Shaper, Slotter and Planer. Operations done on Shaper, Planer & Slotter Difference between shaping and planning operations.

Drilling Machines: Constructional features (Radial & Bench drilling Machines), operations, types of drill & drill bit nomenclature. Calculation of machining time.

Grinding: Grinding operation, classification of grinding processes: cylindrical, surface ¢erless grinding

MODULE-3
<p>Thermal aspects, Tool wear, and Machinability</p> <p>Temperature in Metal Cutting: Heat generation in metal cutting; temperature distribution in metal cutting, effect of cutting speed on temperatures, measurement of cutting temperatures Tool life and tool Wear: progressive tool wear;</p> <p>forms of wear in metal cutting: crater wear, flank wear, tool-life criteria, cutting tool materials: basic requirements of tool materials, major classes of tool materials: high-speed steel, cemented carbide, ceramics, CBN and diamond, tool coatings; the work material and its machinability</p> <p>Cutting fluids: Action of coolants and application of cutting fluids.</p>
MODULE-4
<p>Introduction: Introduction to metrology & measurements, definition, objectives and classification of metrology, standards of length- wave length standard, sub division of standards, numerical problems on length calibration.</p> <p>Line & End Standards: Line and end standard, slip gauges, wringing phenomena, numerical problems on slip gauges.</p> <p>Systems of Limits, Fits & Tolerance: Definition of tolerance, tolerance specification in assembly, principle of interchangeability and selective assembly, limits of size, Indian standards, concepts of limits of size and tolerances, cost v/s tolerances, compound tolerances, accumulation of tolerances, definition of fits, types of fits and their designation.</p>
MODULE-5
<p>Gauges: Classification of gauges, Taylor's principle, design of GO, NO GO gauges, wear allowance on gauges, types of gauges- plain plug gauges, ring gauges, snap gauge, limit gauge, simple problems.</p> <p>Comparators: Introduction to comparators, classification, characteristics, systems of displacement amplification in mechanical comparators, Reed type, Sigma comparator, Zeiss ultra-optimeter, Solex air gauge, ultrasonic gauges, LVDT.</p> <p>Angular Measurements: Bevel protractor, sine bar, angular gauges, numerical on building of angles.</p>

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

Sl.NO	Experiments
1	Preparation of one model on lathe involving - Plain turning, Facing, Knurling, Drilling, Boring, Internal Thread cuts and Eccentric turning.
2	Preparation of One model on lathe involving - Plain turning, Facing, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning.
3	One Job, Cutting of V Groove/ dovetail / Rectangular groove using a shaper.
4	Cutting of Gear Teeth using Milling Machine.
5	Simple operations and One Job on the drilling and grinding machine.
6	Cutting force measurement with dynamometers (Demonstration) for turning, drilling, grinding operations.
7	Analysis of chip formation and chip reduction coefficient in turning of mild steel by HSS tool with different depth of cut, speed, and feed rate.
8	Experiment on anyone advanced machining process
9	Study & Demonstration of power tools like power drill, power hacksaw, portable hand grinding, cordless screw drivers, production air tools, wood cutter, etc., used in Mechanical Engineering.
10	Demonstration/Experimentation of simple programming of CNC machine operations.
11	Demonstration / Experiment on tool wears and tool life on anyone conventional machining process.
12	To study the tool geometry of a single point turning tool (SPTT) in the American Standards Association (ASA) system.

Course outcomes (Course Skill Set):

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

CO1: Analyze various cutting parameters in metal cutting.

CO2: Understand the construction of machines & machine tools and compute the machining time of various operations.

CO3: Understand the concept of Temperature in Metal Cutting, forms of wear in metal cutting and Cutting fluids

CO4: Understand the objectives of metrology, methods of measurement, standards of measurement & various measurement parameters. Explain tolerance, limits of size, fits, geometric and position tolerances, gauges and their design

CO5: Understand the working principle of different types of comparators, gauges, angular Measurements

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**)

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
- The students have to answer 5 full questions, selecting one full question from each module.
- 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. Shaw, M C, (2014), Metal Cutting Principles, Oxford University Press.
2. McGeough, J A, (1988), Advanced Methods of Machining, Springer.
3. Boothroyd, G., and Knight, W. A., Fundamentals of Machining and Machine Tools, CRC Press.
4. Chattopadhyay, A B, (2013), Machining and Machine Tools, Wiley India.
5. Mikell P. Groover, (2019), Fundamentals of Modern Manufacturing: Materials, Processes, and Systems, Wiley Publications.
6. Rao P. N., Manufacturing Technology II, Tata McGraw Hill.
7. Mechanical Measurements Beckwith Marangoni and Lienhard Pearson Education 6th Ed.,
8. Instrumentation, Measurement and Analysis B C Nakra, K K Chaudhry McGraw-Hill 4th Edition
9. Engineering Metrology R.K. Jain Khanna Publishers 2009

Web links and Video Lectures (e-Resources):

1. V. K. Jain, Advanced Machining Processes, NPTEL Course Department of Mechanical Engineering, IIT Kanpur, Link: <http://nptel.ac.in/courses/112104028/>.
2. U. S. Dixit, Mechanics of Machining, NPTEL Course Department of Mechanical Engineering Guwahati, Link: <http://nptel.ac.in/courses/112103248/>.
3. A. B. Chattopadhyay, Manufacturing Processes II, NPTEL Course of Department of Mechanical Engineering, IIT Kharagpur, <https://nptel.ac.in/courses/112/105/112105126/>

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

Visit any one machining center or machining industry and/or

Case study on process parameter influence on anyone advanced machining process and hybrid machining process.

FLUID MECHANICS		Semester	04
Course Code	BME403	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	03
Examination nature (SEE)	Theory		
Course objectives: <ul style="list-style-type: none">To have a working knowledge of the basic properties of fluids and understand the continuum approximation.To Calculate the forces exerted by a fluid at rest on submerged surfaces and understand the force of buoyancy.To understand the flow characteristic and dynamics of flow field for various Engineering applications.To know how velocity changes and energy transfers in fluid flows are related to forces and torques and to understand why designing for minimum loss of energy in fluid flows is so important.To discuss the main properties of laminar and turbulent pipe flow and appreciate their differences and the concept of boundary layer theory.Understand the concept of dynamic similarity and how to apply it to experimental modelling.To appreciate the consequences of compressibility in gas flow and understand the effects of friction and heat transfer on compressible flows.			
Teaching-Learning Process (General Instructions) <p>These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.</p> <ol style="list-style-type: none">1. Power-point Presentation,2. Video demonstration or Simulations3. Chalk and Talk are used for Problem Solving4. Laboratory Demonstrations and Practical Experiments			
MODULE-1			
Basics: Introduction, Properties of fluids-mass density, weight density, specific volume, specific gravity, viscosity, surface tension, capillarity, vapour pressure, compressibility and bulk modulus. Concept of continuum, types of fluids etc,pressure at a point in the static mass of fluid, variation of pressure, Pascal's law,Absolute, gauge, atmospheric and vacuum pressures pressure measurement by simple, differential manometers and mechanical gauges. Fluid Statics: Total pressure and center of pressure for horizontal plane, vertical plane surface and inclined plane surface submerged in static fluid.			
MODULE-2			
Fluid Kinematics: Types of Flow-steady, unsteady, uniform, non-uniform, laminar, turbulent, one, two and three dimensional, compressible, incompressible, rotational, irrotational, stream lines, path lines, streak lines, velocity components, convective and local acceleration, velocity potential, stream function, continuity equation in Cartesian co-ordinates. Rotation, vorticity and circulation, Laplace equation in velocity potential and Poisson equation in stream function, flow net, Problems. Laminar and Turbulent flow: Flow through circular pipe, between parallel plates, Power absorbed in viscous flow in bearings, Poiseuille equation.			
MODULE-3			
Fluid Dynamics: Momentum equation, Impacts of jets- force on fixed and moving vanes, flat and curved. Numericals.Euler's equation, Integration of Euler's equation to obtain Bernoulli's equation,			

Bernoulli's theorem, Application of Bernoulli's theorem such as venture meter, orifice meter, rectangular and triangular notch, pitot tube, orifices etc., related numericals. Loss of head due to friction in pipes , Major and minor losses, pipes in series and parallel.
MODULE-4
Flow over bodies: Development of boundary layer, Lift and Drag, Flow around circular cylinders, spheres, aerofoils and flat plates, Streamlined and bluff bodies, boundary layer separation and its control. Dimensional Analysis: Derived quantities, dimensions of physical quantities, dimensional homogeneity, Rayleigh method, Buckingham Pi-theorem, dimensionless numbers, similitude, types of similitude.
MODULE-5
Compressible flows: Speed of sound, adiabatic and isentropic steady flow, Isentropic flow with area change stagnation and sonic properties, normal and oblique shocks, flow through nozzles. Introduction to CFD: Necessity, limitations, philosophy behind CFD, applications

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

Sl.NO	Experiments
1	Determine the viscosity of oil using Red wood viscometer and Say-bolt viscometer. Can be Demo experiments for CIE
2	Measurement of pressure using different Manometers for high and low pressure measurements (manometers using different manometric fluids).
3	Working principle of different flow meters and their calibration (orifice plate, venture meter, turbine, Rota meter, electromagnetic flow meter) Can be Demo experiments for CIE
4	Determination of head loss in pipes and pipe fittings having different diameters, different materials and different roughness
5	Reynolds apparatus to measure critical Reynolds number for pipe flows
6	Effect of change in cross section and application of the Bernoulli equation
7	Impact of jet on flat and curved plates
8	Measurement of coefficient of pressure distribution on a cylinder at different Reynolds Numbers
9	Effect of change in cross section and application of the Bernoulli equation
10	Working principle of different flow meters for open channel and their calibration
11	Determination of drag and lift co-efficients of standard objects using wind tunnel. Can be Demo experiments for CIE
12	Use any CFD package to study the flow over aerofoil/cylinder Can be Demo experiments for CIE

Course outcomes (Course Skill Set):

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

- CO1: Identify and calculate the key fluid properties used in the analysis of fluid behavior.
- CO2: Understand and apply the principles of pressure, buoyancy and floatation
- CO3: Apply the knowledge of fluid dynamics while addressing problems of mechanical and chemical engineering.
- CO4: Understand the concept of boundary layer in fluid flow and apply dimensional analysis to form dimensionless numbers in terms of input output variables.
- CO5: Understand the basic concept of compressible flow and CFD
- CO 6: Conduct basic experiments of fluid mechanics and understand the experimental uncertainties.

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**)

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

- Fox, R. W., Pitchard, P. J., and McDonald, A. T., (2010), Introduction to Fluid Mechanics, 7th Edition, John Wiley & Sons Inc.
- Cimbala, J. M., Cengel, Y. A. (2010), Fluid Mechanics: Fundamentals and Applications, McGraw-Hill
- Frank M White., (2016), Fluid Mechanics, 8th Edition, McGraw-Hill

Additional References:

- A text book of Fluid Mechanics and Hydraulic Machines, Dr. R K Bansal, Laxmi publishers
- Fundamentals of Fluid Mechanics, Munson, Young, Okiishi & Hebsch, John Wiley Publications, 7th Edition

Web links and Video Lectures (e-Resources):

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

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

- Industrial visits
- Course seminar
- Term project

MECHANICAL MEASUREMENTS AND METROLOGY LAB		Semester	4
Course Code	BME404	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	15 sessions	Total Marks	100
Credits	01	Exam Hours	03
Examination nature (SEE)	Practical		
Course objectives:			
1. To illustrate the theoretical concepts taught in Mechanical Measurements & Metrology through experiments.			
2. To illustrate the use of various measuring tools measuring techniques.			
3. To understand calibration techniques of various measuring devices.			
Sl.NO	Experiments		
	MECHANICAL MEASUREMENTS:		
1	Calibration of Pressure Gauge		
2	Calibration of Thermocouple		
3	Calibration of LVDT		
4	Calibration of Load cell		
5	Determination of modulus of elasticity of a mild steel specimen using strain gauges.		
	METROLOGY:		
6	Measurements using Optical Projector / Toolmaker Microscope.		
7	Measurement of angle using Sine Center / Sine bar / bevel protractor		
8	Measurement of alignment using Autocollimator / Roller set		
	Demonstration Experiments (For CIE)		
9	Measurement of cutting tool forces using a) Lathe tool Dynamometer OR b) Drill tool Dynamometer.		
10	. Measurements of Screw thread Parameters using two wire or Three-wire methods.		
11	Measurements of Surface roughness, Using Tally Surf/Mechanical Comparator		
12	Measurement of gear tooth profile using gear tooth Vernier /Gear tooth micrometer		
Course outcomes (Course Skill Set):			
At the end of the course the student will be able to:			
1. To calibrate pressure gauge, thermocouple, LVDT, load cell, micrometer.			
2. To measure angle using Sine Center/ Sine Bar/ Bevel Protractor, alignment using Autocollimator/ Roller set.			
3. To demonstrate measurements using Optical Projector/Tool maker microscope, Optical flats.			
4. To measure cutting tool forces using Lathe/Drill tool dynamometer.			
5. To measure Screw thread parameters using 2-Wire or 3-Wire method, gear tooth profile using gear tooth vernier/Gear tooth micrometer.			
6. To measure surface roughness using Tally Surf/ Mechanical Comparator.			

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 (CIE):

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

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

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

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

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and

Template for Practical Course and if AEC is a practical Course

scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

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

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

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NON TRADITIONAL MACHINING		Semester	IV
Course Code	BME405A	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination nature (SEE)	Theory/practical/Viva-Voce /Term-work/Others		
Course Objectives: <ul style="list-style-type: none">To learn various concepts related to modern machining processes & their applications.To appreciate the differences between conventional and non-conventional machining processes.To acquire a functional understanding of non-traditional manufacturing equipment.To know about various process parameters and their influence on performance and their applications.To impart knowledge on various types of energy involved in non-traditional machining processes.			
Teaching-Learning Process (General Instructions) <p>These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.</p> <ul style="list-style-type: none">Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Videodemonstrations or Simulations.Chalk and Talk method for Problem Solving.Adopt flipped classroom teaching method.Adopt collaborative (Group Learning) learning in the class.Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such asevaluating, generalizing, and analyzing information.			
Module-1			
Introduction to Non-traditional machining <p>Introduction to Non-traditional machining, Need for Non-traditional machining process, Comparison between traditional and non-traditional machining, general classification Non-traditional machining processes, classification based on nature of energy employed in machining, selection of non-traditional machining processes, Specific advantages, limitations and applications of non-traditional machining processes.</p>			
Module-2			
Ultrasonic Machining (USM): <p>Introduction, Equipment and material process, Effect of process parameters: Effect of amplitude and frequency, Effect of abrasive grain diameter, effect of slurry, tool & work material. Process characteristics: Material removal rate, tool wear, accuracy, surface finish, applications, advantages & limitations of USM.</p> Abrasive Jet Machining (AJM): <p>Introduction, Equipment and process of material removal, process variables: carrier gas, type of abrasive, work material, stand-off distance (SOD). Process characteristics-Material removal rate, Nozzle wear, accuracy & surface finish. Applications, advantages & limitations of AJM.</p>			
Module-3			
Electrochemical machining (ECM): <p>Introduction, Principle of electro chemical machining, ECM equipment, elements of ECM operation, Chemistry of ECM. ECM Process characteristics: Material removal rate, accuracy, surface finish. Process parameters: Current density, Tool feed rate, Gap between tool & work piece, velocity of electrolyte flow, type of electrolyte, its concentration temperature, and choice of electrolytes. ECM Tooling: ECM tooling technique & example, Tool & insulation materials. Applications ECM: Electrochemical grinding and electrochemical honing process. Advantages, disadvantages and application of ECG, ECH.</p> Chemical Machining (CHM): <p>Elements of the process, Resists (maskants), Etchants. Types of chemical machining process-chemical</p>			

blanking process, chemical milling process. Process characteristics of CHM: material removal rate, accuracy, surface finish, advantages, limitations and applications of chemical machining process.
Module-4
<p>Electrical Discharge Machining (EDM): Introduction, mechanism of metal removal, EDM equipment: spark erosion generator (relaxation type), dielectric medium-its functions & desirable properties, electrode feed control system. Flushing types; pressure flushing, suction flushing, side flushing, pulsed flushing. EDM process parameters: Spark frequency, current & spark gap, surface finish, Heat Affected Zone. Advantages, limitations & applications of EDM, Electrical discharge grinding, Traveling wire EDM.</p> <p>Plasma Arc Machining (PAM): Introduction, non-thermal generation of plasma, equipment mechanism of metal removal, Plasma torch, process parameters, process characteristics. Safety precautions. Safety precautions, applications, advantages and limitations.</p>
Module-5
<p>Laser Beam Machining (LBM): Introduction, generation of LASER, Equipment and mechanism of metal removal, LBM parameters and characteristics, Applications, Advantages & limitations.</p> <p>Electron Beam Machining (EBM): Introduction, Principle, equipment and mechanism of metal removal, applications, advantages and limitations.</p>
<p>Course outcome (Course Skill Set) At the end of the course, the student will be able to :</p> <p>C01: Describe non-traditional machining process and compare with Traditional machining process. Recognize the need for Non-traditional machining process.</p> <p>C02: Describe the constructional features, performance parameters, process characteristics, applications, advantages, and limitations of USM, AJM and WJM.</p> <p>C03: Characterize the need of Chemical and electro-chemical machining process along with the constructional features, process parameters, process characteristics, applications, advantages, and limitations.</p> <p>C04: Illustrate the constructional feature of the equipment, process parameters, process characteristics, applications, advantages and limitations EDM & PAM</p>

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 220B2.4, 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. Modern Machining Process by P.C Pandey and H S Shah, McGraw Hill Education India Pvt. Ltd. 2000
2. Wellar, E.J. "Non-Traditional Machining Processes", Society of Manufacturing Engineers Publications, 2nd Edition, Michigan, 1984.
3. Non Traditional Manufacturing Processes, by Gary F Benedict, Taylor & Francis

REFERENCE BOOKS:

1. Production technology, HMT, McGraw Hill Education India Pvt. Ltd. 2001
2. New Technology, Dr. Amitabha Bhattacharyya, The Institute of Engineers (India), 2000
3. Modern Machining process, Aditya, 2002.
4. Non-Conventional Machining, P.K.Mishra, The Institution of Engineers (India) Test book series, Narosa Publishing House – 2005.
5. Metals Handbook: Machining Volume 16, Joseph R. Davis (Editor), American Society of Metals (ASM)
6. Gary F. Benedict, —Nontraditional manufacturing processes||, Marcel Dekker, Inc. 1987.

Web links and Video Lectures (e-Resources):
<ul style="list-style-type: none">• https://nptel.ac.in/courses/112105127
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning <ul style="list-style-type: none">•

ENVIRONMENTAL STUDIES		Semester	IV
Course Code	BME405B	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hr	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		
Course objectives: To impart the knowledge and awareness for the environmental protection for real-time contribution during an execution of engineering practices in the society.			
Teaching-Learning Process (General Instructions) These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes. <ul style="list-style-type: none">• Visit to a local area to document environmental assets/ecosystems- River/forest/grassland/mountain• Construction of Food chain/food web of the visited area• To identify the sources of air/water/soil/noise pollution of any area.			
Module-1			
Introduction to Environmental Studies: Multidisciplinary nature of environmental studies. Scope and importance; Concept of sustainability and sustainable development. Ecosystems: Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. Forest ecosystem, Grassland ecosystem, Desert ecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)			
Module-2			
Natural Resources: Renewable and Non-Renewable Resources: Land resources and land-use change; Land degradation, soil erosion and desertification. Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations. Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (International & Inter-state). Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies.			
Module-3			
Biodiversity and Conservation: Levels of biological diversity: Genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hotspots. India as a mega-biodiversity nation; Endangered and endemic species of India. Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value. Environmental Pollution Environmental Pollution: Types, causes, effects and controls; Air, water, soil and noise pollution. Nuclear hazards and human health risks. Solid waste management, Control measures of urban and industrial waste.			
Module-4			
Environmental Policies and Practices Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture. Environment Laws: Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and Control of Pollution) Act; Wildlife (Protection) Act; Forest Conservation Act.			

<p>International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD).</p> <p>Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.</p>
Module-5
<p>Human Communities and the Environment</p> <p>Human population growth: Impacts on environment, human health and welfare.</p> <p>Resettlement and rehabilitation of project affected persons; case studies.</p> <p>Disaster management: Floods, Earthquake, Cyclones and Landslides.</p> <p>Environmental movements: Chipko, Silent valley, Bishnois of Rajasthan.</p> <p>Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.</p> <p>Environmental communication and public awareness, case studies (e.g., CNG vehicles in cities).</p>
<p>Course outcome (Course Skill Set)</p> <p>At the end of the course, the student will be able to :</p> <p>CO1: Understand the basic concepts of environmental studies and natural resources.</p> <p>CO2: Explain about the various eco-systems of nature.</p> <p>CO3: Discuss different types of environmental pollutions and their control measures.</p> <p>CO4: Explain the acquired knowledge about the various social aspects related to the environment.</p>
<p>Assessment Details (both CIE and SEE)</p> <p>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.</p> <p>Continuous Internal Evaluation:</p> <ul style="list-style-type: none"> 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. <p>Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.</p> <p>Semester-End Examination:</p> <p>Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours).</p> <ul style="list-style-type: none"> The question paper will have ten questions. Each question is set for 20 marks. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), should have a mix of topics under that module. The students have to answer 5 full questions, selecting one full question from each module. Marks scored shall be proportionally reduced to 50 marks

Suggested Learning Resources:**Text Books:**

1. Benny Joseph (2005)., *Environmental Studies*, New Delhi, Tata McGraw Hill Publishing co.Ltd
2. Erach Bharucha (2005)., *Textbook of Environmental Studies for Undergraduate Courses*, Hyderabad, Universities Press.

Reference Books:

1. Anji Reddy .M (2007), *Textbook of Environmental Sciences and Technology*, Hyderabad, BS Publications.
2. Y Anjaneyulu.(2004), *Introduction to Environmental Sciences*, BS Publications.
3. Climate Change: Science and Politics. (2021). Centre Science and Environment, New Delhi.
4. Gadgil, M., & Guha, R. (1993). *This Fissured Land: An Ecological History of India*. Univ. of California Press.
5. Gleeson, B. and Low, N. (eds.) (1999). *Global Ethics and Environment*, London, Routledge.
6. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll. (2006). *Principles of Conservation Biology*. Sunderland: Sinauer Associates.
7. Nandini, N., Sunitha N., & Sucharita Tandon. (2019). *A text book on Environmental Studies (AECC)*. Sapna Book House, Bengaluru.
8. Rosencranz, A., Divan, S., & Noble, M. L. (2001). *Environmental law and policy in India*.

Web links and Video Lectures (e-Resources):

- .www.eco-prayer.org
- www.teriin.org
- www.cpcb.nic.in
- www.indiaenvironmentportal.org.in
- www.sustainabledevelopment.un.org
- www.conserve-energy-future.com

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

- Study of common plants, insects, birds, and basic principles of identification.
- Study of simple ecosystems – pond, river, etc.

MEMS-Micro Electro Mechanical Systems		Semester	IV
Course Code	BME 405C	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory/practical/Viva-Voce /Term-work/Others		
Course objectives: 1. Students are exposed to the MEMS technology & Miniaturization. 2. Students will understand the Process of Micro fabrication Techniques. 3. Students are made to understand the principles of system modelling. 4. Students are made to understand the working principles of Mechanical sensors and actuators. 5. Students are made to understand the working principles of Micro-Opto-Electro Mechanical Systems.			
Teaching-Learning Process (General Instructions) These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes. 1. Power Point Presentation, 2. Chalk and Talk are used for Derivations and Correlations (In-general). 3. Video demonstration or Simulations.			
Module-1			
MEMS: Introduction, Production Engineering, Precision Engineering and Ultra- Precision Engineering, Integrated circuits, Micro Electro Mechanical Systems.			
Module-2			
Micromachining: Introduction, Photo Lithography, Structural and Sacrificial Materials, Etching, Surface Micromachining, Bulk versus Surface Micromachining, Wafer Bonding, LIGA.			
Module-3			
System Modelling: Introduction, Need for Modelling, System types, Basic Modelling Elements In Mechanical System, Basic Modelling Elements In Electrical Systems, Basic Modelling Elements In Fluid Systems and Thermal Systems.			
Module-4			
Mechanical sensors and actuators: Introduction, Principles of Sensing and Actuation, Beam and Cantilever, Micro Plates, Capacitive Effects, Piezo Electric Material as Sensing and Actuating Elements.			
Module-5			
Micro-Opto-Electro Mechanical Systems: Introduction, Fundamental Principles of MOEMS Technology, Review on Properties of Light, Light Modulators, Micro mirrors, Digital Micro mirror Device.			
Course outcome (Course Skill Set): At the end of the course, the student will be able to : 1. Understand the working of MEMS technology & Miniaturization. 2. Explain the Process of Micro fabrication Techniques. 3. Explain the principles of system modelling. 4. Understand the working principles of Mechanical sensors and actuators. 5. Describe the working principles of Micro-Opto-Electro Mechanical 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:

- 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 220B2.4, 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**).

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

Suggested Learning Resources:**Books**

1. MEMS- Nitaigour Premchand Mahalik, TMH 2007.
2. Micro and Smart Systems: G.K.Ananthasuresh, K.J.Vinoy, S.Gopalakrishnan, K.N.Bhat,V.K.Aatre,Wiley India 2010.
3. Design and Development Methodologies, Smart Material Systems and MEMS: V. Varadan, K. J. Vinoy, S. Goplakrishnan, Wiley.
4. MEMS & Microsystems: Design and Manufacture, Tai-Ran Hsu, Tata Mc-Graw-Hill.

Web links and Video Lectures (e-Resources):

- VTU e-Shikshana Program
- VTU EDUSAT Program.

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

- Gaining hands on Knowledge to work on ANSYS Tool
- Simulation of Cantilever Beam For Different Loads On ANSYS Tool.

ROBOTICS AND AUTOMATION		Semester	IV
Course Code	BME405D	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: <ul style="list-style-type: none">• Gain knowledge of Robotics and automation.• Understand the working methodology of robotics and automation.• Write the program for robot for various applications			
Teaching-Learning Process (General Instructions) <p>These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.</p> <ol style="list-style-type: none">1. Through Power Point Presentations and Video demonstrations or Simulations.2. Chalk and Talk method for Problem Solving.3. Encourage collaborative (Group) Learning in the class.4. Ask at least three higher order Thinking questions in the class, which promotes critical thinking.5. Adopt Problem Based Learning (PBL), which fosters students Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information rather than simply recall it.			
Module-1			
Industrial Automation: Definition, Types of automation, List basic Devices in Automated Systems, Distinguish Different Controllers Employed In Automated Systems. Identify Safety in Industrial Automation			
Basic Concepts: Definition and origin of robotics – different types of robotics – various generations of robots – degrees of freedom – Asimov’s laws of robotics			
Module-2			
Fundamentals of Robotics: robot anatomy, work volume, robot drive systems, control systems, precision of movement, end effectors, Introduction to Manipulator kinematics, Robot Dynamics.			
Basic control systems and components: Basic control systems concepts and models, Controllers, control system analysis,			
Module-3			
Robot End Effector: Types of End effectors, Mechanical Grippers, Other types of Grippers, Tools and End effector, The Robot/End effector interface Consideration in Gripper selecting and Design.			
Sensors in Robotics: Transducers and sensors, sensors in robotics, tactile sensors, proximity and range sensors, uses of sensors in robotics.			
Module-4			
Robot Programming: Methods of robot programming, lead-through programming methods, a robot program as a path in space, motion interpolation, wait, signal and delay commands, branching, capabilities and limitations of lead-through methods.			
Module-5			
Material handling and Identification Technologies: Overview of Material Handling Systems, Principles and Design Consideration, Material Transport Systems, Storage Systems, Overview of Automatic Identification Methods.			

Course outcome (Course Skill Set)

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

- CO 1:** Explain various types of Robotics, automation, robotics motion, sensors and control, machine vision, robotic programming and roles of robots in industry.
- CO 2:** Understand the working methodology of robotics and automation, motion and control, machine vision and programming, application of robots in industry.
- CO 3:** Write the program for robot for various applications.
- CO 4:** Describe the different material handling and Identification technologies used in automation

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 220B2.4, 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**).

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

Suggested Learning Resources:**Books**

1. Mikell P. Groover, Mitchel Weiss, Roger N. Nagel, Nicholas G. Odrey and Ashish Dutta, "Industrial Robotics: Technology, Programming and Applications", 2 nd Edition, Tata McGraw Hill, 2012.
2. Roland Siegwart, Illah R. Nourbakhsh, and Davide Scaramuzza, "Introduction to Autonomous Mobile Robots", 2 nd Edition, PHI, 2011

Web links and Video Lectures (e-Resources):

- NPTEL course on Industrial Robotics
- Videos on Industrial Automation

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

- Visit any automated production Industry understand the importance and applications of Robots in Automated Industry

INTRODUCTION TO AI & ML		Semester	IV
Course Code	BME456A	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	15 sessions	Total Marks	100
Credits	01	Exam Hours	03
Examination type (SEE)	PRACTICAL		
Course objectives: <ul style="list-style-type: none">• Make use of Data sets in implementing the machine learning algorithms• Implement the machine learning concepts and algorithms in any suitable language of choice.• Analyse the working of various documents like PDF, Word file			
Sl.NO	Experiments		
1	Implement A* Search algorithm.		
2	Implement AO* Search algorithm.		
3	Write a program to implement Water jug program using AI.		
4	The probability that it is Friday and that a student is absent is 3 %. Since there are 5 school days in a week, the probability that it is Friday is 20 %. What is the probability that a student is absent given that today is Friday? Apply Baye’s rule in python to get the result.		
5	Implement and demonstrate the FIND-S algorithm for finding the most specific hypothesis based on a given set of training data samples. Read the training data from a .CSV file.		
6	For a given set of training data examples stored in a .CSV file, implement and demonstrate the Candidate-Elimination algorithm to output a description of the set of all hypotheses consistent with the training examples.		
7	Build an Artificial Neural Network by implementing the Backpropagation algorithm and test the same using appropriate data sets.		
8	Write a program to construct a Bayesian network considering medical data. Use this model to demonstrate the diagnosis of heart patients using standard Heart Disease Data Set. You can use Java/Python ML library classes/API		
	Demonstration Experiments (For CIE)		
9	Write a program to demonstrate the working of the decision tree based ID3 algorithm. Use an appropriate data set for building the decision tree and apply this knowledge to classify a new sample.		
Course outcomes (Course Skill Set): <ul style="list-style-type: none">• Understand the implementation procedures for the machine learning algorithms• Design Java/Python programs for various Learning algorithms.• Apply appropriate data sets to the Machine Learning algorithms• Identify and apply Machine Learning algorithms to solve real world problems• Examine working of PDF and word file formats			
Assessment Details (both CIE and SEE) <p>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</p>			

Continuous Internal Evaluation (CIE):

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

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

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

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

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

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

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

The minimum duration of SEE is 03 hours

Suggested Learning Resources:

1. Tom M Mitchell, "Machine Learning", 1st Edition, McGraw Hill Education, 2017.
2. Elaine Rich, Kevin K and S B Nair, "Artificial Intelligence", 3rd Edition, McGraw Hill Education, 2017.

Digital Marketing		Semester	IV
Course Code	BME456B	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	01
Examination type (SEE)	Theory		
Course objectives: <ul style="list-style-type: none">To focuses on the importance of digital marketing and its applications and to introduce current and core practices of Digital and Social Media Marketing that will allow learners to analyse, plan, execute and evaluate a digital marketing strategy.			
Teaching-Learning Process (General Instructions) <p>These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.</p> <ul style="list-style-type: none">Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations.Adopt flipped classroom teaching method.Adopt collaborative (Group Learning) learning in the class.			
Module-1			
Introduction to Digital Marketing (DM)-Meaning, Definition, Need of DM, Scope of DM, History of DM, Concept and approaches to DM, Examples of good practices in DM. Email Marketing-Need for Emails, Types of Emails, options in Email advertising, Mobile Marketing.			
Module-2			
Social Media Marketing -Introduction to Blogging. Introduction to Face book, Twitter, Google +, LinkedIn, YouTube, Instagram and Pinterest; their channel advertising and campaigns.			
Module-3			
Acquiring & Engaging Users through Digital Channels: Understanding the relationship between content and branding and its impact on sales, search engine marketing, mobile marketing, video marketing, and social-media marketing.			
Module-4			
Designing Organization for Digital Success: Digital transformation, digital leadership principles, online P.R. and reputation management. ROI of digital strategies, how digital marketing is adding value to business, and evaluating cost effectiveness of digital strategies			
Module-5			
Digital Innovation and Trends: The contemporary digital revolution, digital transformation framework; security and privatization issues with digital marketing, Understanding trends in digital marketing – Indian and global context, online communities and co-creation.			

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

- The question paper will have ten questions. Each question is set for 10 marks.
- 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).
- The students have to answer 5 full questions, selecting one full question from each module.

Suggested Learning Resources:

Books

1. Fundamentals of Digital Marketing by Puneet Singh Bhatia, Pearson
2. Moutsy Maiti: Internet Marketing, Oxford University Press India
3. Vandana, Ahuja; Digital Marketing, Oxford University Press India (November, 2015).
4. Eric Greenberg, and Kates, Alexander; Strategic Digital Marketing: Top Digital Experts
5. Share the Formula for Tangible Returns on Your Marketing Investment; McGraw-Hill
6. Professional (October, 2013).
7. Ryan, Damian; Understanding Digital Marketing: marketing strategies for engaging the
8. digital generation; Kogan Page (3rd Edition, 2014).
9. Tracy L. Tuten & Michael R. Solomon: Social Media Marketing (Sage Publication)

Web links and Video Lectures (e-Resources):

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

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INTRODUCTION TO DATA ANALYTICS		Semester	IV
Course Code	BME456C	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	15 sessions	Total Marks	100
Credits	01	Exam Hours	03
Examination type (SEE)	Practical		
Course objectives: <ul style="list-style-type: none">To understand Numpy, Pandas and Matplot libraryTo understand basics of statisticsTo learn the basic of decision tree algorithm.To understand random forest algorithm and AnovaTo use Python data structures.To use excel in data analytics			
Sl.NO	Experiments		
1	Use Numpy to create single and multi-dimensional array and perform various operations using Python.		
2	Use Pandas to access dataset, cleaning, manipulate data and analyze using Python		
3	Use matplotlib library to plot graph for data visualization using Python		
4	Determine probability, sampling and sampling distribution using Python		
5	Determine frequency distributions, variability, average, and standard deviation using Python		
6	Draw normal curves, correlation, correlation coefficient and scatter plots using Python		
7	Implement and analyze Linear regression in Python (Single variable & Multivariable)		
8	Implement and analyze Logistic regression in Python		
9	Implement and analyze Decision tree algorithm in Python		
10	Implement and analyze Random Forest algorithm in Python		
	Only for CIE		
11	Implementation of two samples T-test and paired two-sample T-test in excel.		
12	Implementation of one-way and two-way ANOVA in excel.		
Course outcomes (Course Skill Set): At the end of the course the student will be able to: <ul style="list-style-type: none">CO1: Analyze data using tools and represent for visualizationCO2: Implement various statistical methods.CO3: Understand and use decision tree and random forest algorithmCO4: Understand and Implement T test and Anova			

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 (CIE):

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

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

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

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

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.

- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.
- General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)
- Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

- McKinney, W. (2012). Python for data analysis: Data wrangling with Pandas, NumPy, and IPython. " O'Reilly Media, Inc."
- Swaroop, C. H. (2003). A Byte of Python. Python Tutorial.
- Ken Black, sixth Editing. Business Statistics for Contemporary Decision Making. "John Wiley & Sons, Inc"
- <https://www.simplilearn.com/tutorials/data-analytics-tutorial/data-analytics-with-python>
- https://www.youtube.com/watch?v=GPVsHOIRBBI&ab_channel=freeCodeCamp.org

Introduction to programming in C++		Semester	IV
Course Code	BME456D	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	15 sessions	Total Marks	100
Credits	01	Exam Hours	03
Examination type (SEE)	Practical		
Course objectives: <ul style="list-style-type: none">To learn object-oriented programming concepts using the C++ language.To apply the principles of data abstraction, inheritance and polymorphism;To use the principles of virtual functions and polymorphismTo learn how to handle formatted I/O and unformatted I/O			
Sl.NO	Experiments		
1	Write a C++ Program to display Names, Roll No., and grades of 3 students who have appeared in the examination. Declare the class of name, Roll No. and grade. Create an array of class objects. Read and display the contents of the array.		
2	Write a C++ program to declare Struct. Initialize and display contents of member variables.		
3	Write a C++ program to declare a class. Declare pointer to class. Initialize and display the contents of the class member.		
4	Given that an EMPLOYEE class contains following members: data members: Employee number, Employee name, Basic, DA, IT, Net Salary and print data members.		
5	Write a C++ program to read the data of N employee and compute Net salary of each employee (DA=52% of Basic and Income Tax (IT) =30% of the gross salary).		
6	Write a C++ to illustrate the concepts of console I/O operations.		
7	Write a C++ program to use scope resolution operator. Display the various values of the same		
8	Write a C++ program to create an array of pointers. Invoke functions using array objects.		
	Demonstration Experiments (For CIE)		
9	Write a C++ program for Vehicle reservation system		
10	Write a C++ program to Create a Modern Periodic Table		
11	Write a C++ program to Develop a Bookshop inventory		
12	Write a C++ program for Credit Card Validation System		
Course outcomes (Course Skill Set): At the end of the course the student will be able to: CO1: Apply Object Oriented Programming concepts in C++ CO2: Write a C++ program by applying knowledge of mathematics, science, and engineering. CO4: Function on multi-disciplinary teams. CO5: Identify, formulate, and solve engineering problems.			

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks 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 (CIE):

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

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

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

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

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.
- General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100

marks and scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

- Change of experiment is allowed only once and 15% of Marks allotted to the procedure part are to be made zero.
- The minimum duration of SEE is 02 hours

Suggested Learning Resources:

1. The C++ Programming Language, 3rd Edition, B. Stroutstrup, Pearson Education.
2. OOP in C++, 3rd Edition, T. Gaddis, J. Walters and G. Muganda, Wiley Dream Tech Press.
3. Object Oriented Programming in C++, 3rd Edition, R. Lafore, Galigotia Publications Pvt Ltd.

Industrial Management & Entrepreneurship		Semester	6
Course Code	BME501	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: <ul style="list-style-type: none">Understand the basic concepts of management, planning, organizing, staffing, directing and controlling.Identify various types of supporting agencies and financing available for an entrepreneurPrepare project report and decide selection of industrial ownership.			
Teaching-Learning Process (General Instructions) <p>These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.</p> <ol style="list-style-type: none">Lecturer method (L) does not mean only traditional lecture method, but different type of teaching methods may be adopted to develop the outcomes.Arrange visits to nearby plants, start -up ecosystem, incubation centers or MSME industries to give information about the industry culture and demand.Show Video/animation films to explain functioning of various machinesEncourage collaborative (Group Learning) Learning in the classAsk at least three HOTS (Higher order Thinking) questions in the class, which promotes critical thinkingAdopt 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.Topics will be introduced in a multiple representation.Show the different ways to solve the same problem and encourage the students to come up with their own creative ways to solve them.Discuss how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.Individual teacher can device the innovative pedagogy to improve the teaching-learning.			
Module-1			
Management: Introduction - Meaning - nature and characteristics of Management, Scope and Functional areas of management - Management as a science, art of profession - Management & Administration - Roles of Management, Levels of Management, Development of Management Thought- early management approaches –Modern management approaches. Planning: Nature, importance and purpose of planning process Objectives - Types of plans (Meaning Only) - Decision making Importance of planning - steps in planning & planning premises - Hierarchy of plans.			
Module-2			
Organizing and Staffing: Nature and purpose of organization Principles of organization - Types of organization - Departmentation Committees Centralization Vs Decentralization of authority and responsibility - Span of control - MBO and MBE (Meaning Only) Nature and importance of staffing--Process of Selection & Recruitment(in brief). Directing & Controlling: Meaning and nature of directing Leadership styles, Motivation Theories, Communication - Meaning and importance - coordination, meaning and importance and Techniques of Co Ordination. Meaning and steps in controlling - Essentials of a sound control system - Methods of establishing control (in brief).			
Module-3			

<p>Entrepreneur: Meaning of Entrepreneur; Evolution of the Concept; Functions of an Entrepreneur, Types of Entrepreneurs, Entrepreneur - an emerging. Class. Concept of Entrepreneurship - Evolution of Entrepreneurship, Development of Entrepreneurship; Stages in entrepreneurial process; Role of entrepreneurs in Economic Development; Entrepreneurship in India; Entrepreneurship – its Barriers.</p>
<p align="center">Module-4</p>
<p>Small Scale Industries: Definition; Characteristics; Need and rationale; Objectives; Scope; role of SSI in Economic Development. Advantages of SSI Steps to start and SSI - Government policy towards SSI; Different Policies of SSI; Government Support for SSI during 5 year plans. Impact of Liberalization, Privatization, Globalization on SSI Effect of WTO/GA TT Supporting Agencies of Government for SSI, Meaning, Nature of support; Objectives; Functions; Types of Help; Ancillary Industry and Tiny Industry</p>
<p align="center">Module-5</p>
<p>Institutional Support: Different Schemes; TECKSOK; KIADB; KSSIDC; KSIMC; DIC Single Window Agency; SISI; NSIC; SIDBI; KSFC.</p> <p>Preparation of Project: Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; Formulation; Guidelines by Planning Commission for Project report; Network Analysis; Errors of Project Report; Project Appraisal. Identification of business opportunities: Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study</p>
<p>Course outcome (Course Skill Set) At the end of the course, the student will be able to :</p> <ol style="list-style-type: none"> 1. Explain about the management and planning. 2. Apply the knowledge on planning, organizing, staffing, directing and controlling. 3. Describe the requirements towards the small-scale industries and project preparation.

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:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 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 assessment methods mentioned in the 22OB4.2, 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 for a total of 50 marks. **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. Principles of Management, P. C.Tripathi,P.N. Reddy, Tata McGraw Hill,
2. Dynamics of Entrepreneurial Development & Management, Vasant Desai, Publishing House.
3. Entrepreneurship Development, Poornima. M.Charantimath, Small Business Enterprises – Pearson, 2006 (2 & 4).
4. Management Fundamentals-Concepts, Application , Skill , RobersLusier –Thomson
5. Entrepreneurship Development, S.S.Khanka, S.Chand& Co
6. Management, Stephen Robbins, Pearson Education/PHI, 17th Edition, 2003

Web links and Video Lectures (e-Resources):

- www.nptel.ac.in
- https://onlinecourses.nptel.ac.in/noc23_mg74/preview
- https://onlinecourses.nptel.ac.in/noc23_mg70/preview
- [https://cleartax.in/s/small-scaleindustriesssi#:~:text=Small%20Scale%20Industries%20\(SSI\)%20are,50%20crore](https://cleartax.in/s/small-scaleindustriesssi#:~:text=Small%20Scale%20Industries%20(SSI)%20are,50%20crore)
- <https://www.startupindia.gov.in/content/sih/en/startup-scheme.html>

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

- At the end of the lecture/presentation, numerical exercises are to be taken up to solve problems related to the topics covered. Additional problems are to be given for practice and also as assignments under each of the topics covered.

TURBOMACHINES		Semester	V
Course Code	BME502	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	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: <ul style="list-style-type: none">Understand typical design of Turbo machine, their working principle, application and thermodynamics process involved.Study the conversion of fluid energy to mechanical energy in Turbo machine with utilization factor and degree of reaction.Analyse various designs of steam turbine and their working principle.Study the various designs of hydraulic turbine based on the working principle.Understand the various aspects in design of power absorbing machine.			
Teaching-Learning Process (General Instructions) <p>These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes.</p> <ul style="list-style-type: none">Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.Arrange visits to show the live working models other than laboratory topics.Adopt collaborative (Group Learning) Learning in the class.Adopt Problem Based Learning (PBL), which foster students' Analytical skills and developsThinking skills such as evaluating, generalizing, and analyzing information.			
MODULE-1			
Introduction: Definition of turbo machine, parts of turbo machines, Comparison with positive displacement machines, Classification, Dimensionless parameters and their significance, Unit and specific quantities, model studies and its numerical. (Note: Since dimensional analysis is covered in Fluid Mechanics subject, the questions on dimensional analysis should not be given. However, dimensionless parameters and model studies may be given more weightage.) Thermodynamics of fluid flow: Application of first and second law of thermodynamics to turbo machines, Efficiencies of turbo machines, Static and Stagnation states, overall isentropic efficiency, stage efficiency (their comparison) and polytropic efficiency for both compression and expansion processes. Reheat factor for expansion process. Simple Numerical on stage efficiency and polytropic efficiency.			
MODULE-2			
Energy exchange in Turbo machines: Euler's turbine equation, Alternate form of Euler's turbine equation, Velocity triangles for different values of degree of reaction, Components of energy transfer, Degree of Reaction, utilization factor, Relation between degree of reaction and Utilization factor, Problems. General Analysis of Turbo machines: Radial flow compressors and pumps – general analysis, Expression for degree of reaction, velocity triangles, Effect of blade discharge angle on energy transfer and degree of reaction, Effect of blade discharge angle on performance, , General analysis of axial flow pumps and compressors, degree of reaction, velocity triangles, Numerical Problems.			
MODULE-3			

Steam Turbines: Classification, Single stage impulse turbine, condition for maximum blade efficiency, stage efficiency, Need and methods of compounding, Multi-stage impulse turbine, expression for maximum utilization factor, Numerical.

Reaction turbine: Parsons's turbine, condition for maximum utilization factor, reaction staging. Numerical.

MODULE-4

Hydraulic Turbines: Classification, various efficiencies. **Pelton Wheel** – Principle of working, velocity triangles, design parameters, maximum efficiency, and numerical.

Francis turbine – Principle of working, velocity triangles, design parameters, and numerical problems

Kaplan and Propeller turbines: Principle of working, velocity triangles, design parameters and Numerical. Theory and types of Draft tubes.

MODULE-5

Centrifugal Pumps: Classification and parts of centrifugal pump, different heads and efficiencies of centrifugal pump, Theoretical head – capacity relationship, Minimum speed for starting the flow, Maximum suction lift, Net positive suction head, Cavitation, Need for priming, Pumps in series and parallel. Problems.

Centrifugal Compressors: Stage velocity triangles, slip factor, power input factor, Stage work, Pressure developed, stage efficiency and surging and problems.

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

SL.NO	Experiments
1	Performance analysis of Pelton Wheel
2	Performance analysis of Francis turbine
3	Performance analysis of Kaplan turbine
4	Performance analysis of centrifugal blowers
5	Performance analysis of centrifugal pump
6	Performance analysis of Axial Fan and Radial Fan

Course outcomes (Course Skill Set):

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

- Apply the Model studies and thermodynamics analysis of turbo machines.
- Analyse the energy transfers in Turbo machine with degree of reaction and utilisation factor.
- Classify, analyse and understand various type of steam turbine.
- Classify, analyse and understand various type of hydraulic turbine.
- Understand the concept of radial power absorbing machine and the problems involved during its operation.

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 220B4.2. 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

1. Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (**duration 03 hours**)
2. The question paper will have ten questions. Each question is set for 20 marks.
3. There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.
4. The students have to answer 5 full questions, selecting one full question from each module.
5. 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:**TEST BOOKS**

1. V. Kadambi and Manohar Prasad, An Introduction to Energy Conversion, Volume III, Turbo machinery, New Age International Publishers, reprint 2008
2. M. S. Govinde Gowda, A Text of Turbo machines, 1st Edn, 2024, Iterative International Publishers (IIP), ISBN: 978-93-6252-884-1.

REFERENCE BOOKS

1. Principals of Turbo machines, D. G. Shepherd, The Macmillan Company (1964).
2. Fluid Mechanics & Thermodynamics of Turbo machines, S. L. Dixon, Elsevier (2005).
3. Turbines, Compressors & Fans, S. M. Yahya, Tata McGraw Hill Co. Ltd., 2nd edition, 2002.
4. B.K Venkanna, Fundamentals of Turbo Machinery, PHI Publishers

Web links and Video Lectures (e-Resources):

- <https://www.tlv.com/global/TI/steam-theory/principal-applications-for-steam.html>
- <https://www.turboindustries.com/>
- <https://www.aeroprobe.com/turbomachinery-industry/>
- <https://www.mr-cfd.com/industries/turbomachinery/>
- <https://youtu.be/GIvV6XWaG-A>
- <https://youtu.be/6FLj3Zpumo>

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

1. Visit to Thermal power plant/Hydroelectric power plant
2. Visit to nearest pump station.
3. Video demonstration of latest trends in turbine manufacturing and pumps manufacturing units.

Theory of Machines		Semester	5
Course Code	BME503	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	4:0:0:0	SEE Marks	50
Total Hours of Pedagogy	52	Total Marks	100
Credits	04	Exam Hours	3
Examination type (SEE)	Theory		
Course objectives: <div>1. To understand the concept of machines, mechanisms and to Analyze a mechanism for displacement, velocity and acceleration at any point in a moving link.</div> <div>2. To understand the force-motion relationship in components subjected to external forces and analysis of standard mechanisms</div> <div>3. To understand the theory of gears and gear trains.</div> <div>4. To understand the undesirable effects of unbalances resulting from prescribed motions in mechanism.</div> <div>5. To understand the principles in mechanisms used for speed control and stability control.</div> <div>6. To compute the natural and damped frequencies of free 1-DOF mechanical systems and to analyse the vibrational motion of 1-DOF mechanical systems under harmonic excitation conditions.</div>			
Teaching-Learning Process (General Instructions) These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes. Course objectives: <div>1. These are sample strategies, which teachers can use to accelerate the attainment of the various course outcomes.</div> <div>2. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.</div> <div>3. Chalk and Talk method for Problem Solving.</div> <div>4. Adopt flipped classroom teaching method.</div> <div>5. Adopt collaborative (Group Learning) learning in the class.</div> <div>6. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.</div>			
Module-1			
Introduction: Mechanisms and machines, Kinematic pairs-types, degree of freedom, Kinematic chains and their classification, Kinematic inversions, Velocity and Acceleration analysis of planar mechanisms Graphical method: Velocity and Acceleration Analysis of Mechanisms Velocity and acceleration analysis of four bar mechanism, slider crank mechanism. Mechanism illustrating Coriolis component of acceleration. Angular velocity and angular acceleration of links, velocity of rubbing. Velocity and Acceleration Analysis of Mechanisms (Analytical Method): Velocity and acceleration analysis of four bar mechanism, slider crank mechanism using complex algebra method.			
Module-2			
Static force analysis: Static equilibrium, analysis of four bar mechanism, slider crank mechanism. Dynamic force analysis: D'Alembert's principle, analysis of four bar and slider crank mechanism. Flywheel: Introduction to Flywheel and calculation of its size for simple machines like punching machine, shearing machine.			

Module-3
<p>Spur Gears: Gear terminology, law of gearing, path of contact, arc of contact, contact ratio of spur gear. Interference in involute gears, methods of avoiding interference, condition and expressions for minimum number of teeth to avoid interference.</p> <p>Gear Trains: Simple gear trains, compound gear trains. Epicyclic gear trains: Algebraic and tabular methods of finding velocity ratio of epicyclic gear trains, torque calculation in epicyclic gear trains. Discussions on applications of gear trains.</p>
Module-4
<p>Balancing of Rotating Masses: Static and Dynamic Balancing, balancing of single rotating mass by balancing masses in same plane and in different planes. Balancing of several rotating masses by balancing masses in same plane and in different planes. Discussions on applications.</p> <p>Balancing of Reciprocating Masses: Inertia Effect of crank and connecting rod, Single cylinder Engine, Balancing in multi cylinder-inline engine (primary and secondary forces). Discussions on applications</p> <p>Governors: Types of Governors; Force Analysis of Porter and Hartnell Governors. Controlling Force, Stability, Sensitiveness, Isochronism, Effort and Power. Discussion on applications.</p>
Module-5
<p>Free vibrations: Basic elements of vibrating system, Types of free vibrations, Longitudinal vibrations- Equilibrium method, D'Alembert's principle, Determination of natural frequency of single degree freedom systems, Damped free vibrations: Under damped, over damped and critically damped systems. Logarithmic decrement.</p> <p>Forced vibrations: Undamped forced vibration of spring mass system, damped forced vibrations, rotating unbalance, Reciprocating unbalance, Vibration isolation, Critical speed. Discussions on applications.</p>
<p>Course outcome (Course Skill Set)</p> <p>At the end of the course, the student will be able to:</p> <ol style="list-style-type: none"> 1. Knowledge of mechanisms and their motion and the inversions of mechanisms 2. Analyse the velocity, acceleration of links and joints of mechanisms. 3. Analyse the mechanisms for static and dynamic equilibrium. 4. Carry out the balancing of rotating and reciprocating masses 5. Analyse different types of governors used in real life situation. 6. Analyze the free and forced vibration phenomenon.
<p>Assessment Details (both CIE and SEE)</p> <p>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.</p> <p>Continuous Internal Evaluation:</p> <ul style="list-style-type: none"> • For the final CIE, average of best two tests for 25 marks and for the Assessment (min. two methods), there are 25 marks. Total CIE is for 50 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 22OB4.2, 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 to a total mark of 50.

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:

Text Books

1. Theory of Machines Kinematics and Dynamics Sadhu Singh Pearson Third edition 2019
2. Mechanism and Machine Theory G. Ambekar PHI 2009 Reference Books

Reference Books

1. Theory of Machines Rattan S.S Tata McGraw-Hill Publishing Company 2014
2. Mechanisms and Machines- Kinematics, Dynamics and Synthesis Michael M Stanisic Cengage Learning 2016
3. Machines and Mechanisms- David H. Myszka, 2012, Prentice Hall,

Web links and Video Lectures (e-Resources):

- <https://archive.nptel.ac.in/courses/112/106/112106270/>
- <https://nptel.ac.in/courses/112105268>
- <https://archive.nptel.ac.in/courses/112/104/112104121/>

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

1. Course Seminar
2. Term project
3. Assignment

CNC PROGRAMMING AND 3-D PRINTING LAB		Semester	5th
Course Code	BME504L	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0-0-2*-0	SEE Marks	50
Credits	01	Total Marks	100
Examination nature (SEE)	Practical	Exam Hours	03 Hrs
* Additional one hour may be considered for Instructions if required			
Course objectives: <ul style="list-style-type: none">• To expose the students to the techniques of CNC programming and cutting tool path generation through CNC simulation software by using G-Codes and M-codes.• To educate the students on the usage of CAM packages.• To expose the students on the usage of 3D Printing Technology• To make the students understand the importance of automation in industries through exposure to FMS,• Robotics, and Hydraulics and Pneumatics.			
Sl.NO	Experiments		
1	Manual CNC part programming using ISO Format G/M codes for 2 turning and 2 milling parts. Selection and assignment of tools, correction of syntax and logical errors, and verification of tool path using CNC program verification software.		
2	CNC part programming using CAM packages : Simulation of Turning simulations to be carried out using simulation packages like: Cadem CAMLab-Pro, Master-CAM.		
3	CNC part programming using CAM packages : Simulation of Drilling simulations to be carried out using simulation packages like: CademCAMLab-Pro, Master-CAM.		
4	CNC part programming using CAM packages : Simulation of Milling simulations to be carried out using simulation packages like: CademCAMLab-Pro, Master-CAM.		
5	Internal and external threading : Write a CNC program to create internal and external threading on a cylindrical block(s).		
6	Simple 3D Printing Model : Creating Simple 3D model (example cube, gear, prism etc) in CAD software and printing the model using any 3D Printer (FDM/SLA/SLS printer)		
7	Assembly Model-1: Creating an 3D CAD model of NUT and Bolt (example size M12x50), print the model using any 3D Printer and Check the assembly		
8	Assembly Model-2: Creating an 3D CAD assembly model containing four or more parts (example Screw jack, plumber block etc) print the model using any 3D Printer and Check the assembly		
	Demonstration Experiments (For CIE)		
9	Robot programming: Using Teach Pendent & Offline programming to perform pick and place, stacking of objects (2 programs).		
10	Pneumatics and Hydraulics, Electro-Pneumatics: 3 typical experiments on Basics of these topics to be conducted.		
11	FMS (Flexible Manufacturing System): Programming of Automatic storage and Retrieval system (ASRS) and linear shuttle conveyor Interfacing CNC lathe, milling with loading unloading arm and ASRS to be carried out on simple components.		
12	Simple strength testing of 3D Printed Parts		

Course outcomes (Course Skill Set):

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

- Explain the knowledge of G-code and M-code for machining operations.
- Perform CNC programming for turning, drilling, milling and threading operation.
- Visualize the 3D models using CAD software's
- Use 3D printing technology
- **Understand robotic programming and FMS**

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks 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 (CIE):

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

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

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

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

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners, one from other institute as external and one from the same institute as internal examiner, are appointed by the university.

- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

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

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

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

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

MECHATRONICS		Semester	6
Course Code	BME515A	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: <ol style="list-style-type: none">1. To acquire a strong foundation in science and focus in mechanical, electronics, control, software, and computer engineering, and a solid command of the newest technologies.2. To understand the evolution and development of Mechatronics as a discipline.3. To substantiate the need for interdisciplinary study in technology education4. To understand the applications of microprocessors in various systems and to know the functions of each element.5. To demonstrate the integration philosophy in view of Mechatronics technology6. To be able to work efficiently in multidisciplinary teams.			
Teaching-Learning Process (General Instructions): <p>These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.</p> <ol style="list-style-type: none">1. Adopt different types of teaching methods to develop the outcomes through PowerPoint Presentations and Video demonstrations or Simulations.2. Chalk and Talk method for Problem Solving.3. Arrange visits to show the live working models other than laboratory topics.4. Adopt collaborative (Group Learning) Learning in the class.5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills and develops thinking skills such as evaluating, generalizing, and analyzing information.			
Module-1			
Introduction: Scope and elements of Mechatronics, Mechatronics design process, measurement system, requirements and types of control systems, feedback principle, Basic elements of feedback control systems, Classification of control system. Examples of Mechatronics Systems such as Automatic Car Park system, Engine management system, Antilock braking system (ABS) control, Automatic washing machine.			
Transducers and sensors: Definition and classification of transducers, Difference between transducer and sensor, Definition and classification of sensors, Principle of working and applications of light sensors, Potentiometers, LVDT, Capacitance sensors, force and pressure sensors, Strain gauges, temperature sensors, proximity switches and Hall Effect sensors.			
Module-2			
Signal Conditioning: Introduction – Hardware – Digital I/O, Analog to digital conversions, resolution, Filtering Noise using passive components – Registers, capacitors, amplifying signals using OP amps. Digital Signal Processing – Digital to Analog conversion, Low pass, high pass, notch filtering. Data acquisition systems DAQS), data loggers, Supervisory control and data acquisition (SCADA), Communication methods.			
Electro Mechanical Drives: Relays and Solenoids – Stepper Motors – DC brushed motors – DC brushless motors – DC servo motors – 4-quadrant servo drives, PWM's – Pulse Width Modulation.			
Module-3			
Microprocessor & Microcontrollers: Introduction, Microprocessor systems, Basic elements of control systems, Microcontrollers, Difference between Microprocessor and Microcontrollers. Microprocessor Architecture: Microprocessor architecture and terminology-CPU, memory and address, I/O and Peripheral devices, ALU, Instruction and Program, Assembler, Data Registers, Program Counter, Flags, Fetch cycle, write cycle, state, bus interrupts. Intel's 8085A Microprocessor.			

Module-4
<p>Programmable Logic Controller: Introduction to PLCs, Basic structure of PLC, Principle of operation, input and output processing, PLC programming language, ladder diagram, ladder diagrams circuits, timer counters, internal relays, master control, jump control, shift registers, data handling, and manipulations, analogue input and output, selection of PLC for application.</p> <p>Application of PLC control: Extending and retracting a pneumatic piston using latches, control of two pneumatic pistons, control of process motor, control of vibrating machine, control of process tank, control of conveyer motor etc.</p>
Module-5
<p>Mechatronics in Computer Numerical Control (CNC) machines: Design of modern CNC machines – Machine Elements: Different types of guide ways, Linear Motion guide ways. Bearings: anti-friction bearings, hydrostatic bearing and hydrodynamic bearing. Re-circulating ball screws. Typical elements of open and closed loop control systems. Adaptive controllers for machine tools.</p> <p>Mechatronics Design process: Stages of design process – Traditional and Mechatronics design concepts – Case studies of Mechatronics systems – Pick and place Robot – Automatic car park barrier.</p>
<p>Course outcome (Course Skill Set)</p> <p>At the end of the course, the student will be able to :</p> <p>C01: Illustrate various components of Mechatronics systems.</p> <p>C02: Assess various control systems used in automation.</p> <p>C03: Design and conduct experiments to evaluate the performance of a Mechatronics system or Component with respect to specifications, as well as to analyse and interpret data.</p> <p>C04: Apply the principles of Mechatronics design to product design.</p> <p>C05: Function effectively as members of multidisciplinary teams.</p>
<p>Assessment Details (both CIE and SEE)</p> <p>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.</p> <p>Continuous Internal Evaluation:</p> <ul style="list-style-type: none"> • The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 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 22OB4.2, 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 for a total of 50 marks. <p>Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.</p> <p>Semester-End Examination:</p> <p>Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the course (duration 03 hours).</p> <ol style="list-style-type: none"> 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. Mechatronics System Design by Devdas Shetty and Richard A Kolk, Second edition, Thomson Learning Publishing
2. Company, Vikas publishing house, 2001.
3. W. Bolton, "Mechatronics" - Addison Wesley Longman Publication, 1999.
4. Shetty and Kolk "Mechatronics System Design"- Cengage Learning, 2010

Web links and Video Lectures (e-Resources):

- <https://nptel.ac.in>

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

- Quiz
- Presentations
- Group Activity

Automation in Manufacturing		Semester	V
Course Code	BME515B	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hr	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		
Course objectives: <ul style="list-style-type: none">• Explain the basics of productions, automation system and manufacturing operations.• Solve the simple problems on mathematical model.• Explain CAPP and MRP system and analyze the AGVS.• Understand the inspection technologies and shop floor control.• Explain the modern trends in additive manufacturing and automated factory			
Teaching-Learning Process (General Instructions) <p>These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.</p> <ul style="list-style-type: none">• Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.• Chalk and Talk method for Problem Solving.• Adopt flipped classroom teaching method.• Adopt collaborative (Group Learning) learning in the class.• Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.			
Module-1			
Introduction: Production system facilities, Manufacturing support systems, Automation in production systems, Automation principles & strategies Manufacturing Operations: Manufacturing operations, Product/production relationship, Production concepts and Mathematical models & costs of manufacturing operations. Problems on mathematical models			
Module-2			
Line Balancing: Methods of line balancing, Numerical problems on largest candidate rule, Kilbridge's and Wester's method, and ranked positional weights method, computerized line balancing methods. Automated Assembly System: Design for automated assembly, types of automated assembly system, Parts feeding devices, Analysis of single and multi station assembly machines.			
Module-3			
Computerized Manufacture Planning and AGVS: Computer aided process planning (CAPP), Retrieval and Generative systems, and benefits of CAPP. Material requirement planning, Inputs to MRP system, working of MRP, Outputs and benefits. Automated Guided Vehicles System: Applications, Guidance and routing, Industrial Robotics: Definition, Robot anatomy, Joints and links, Robot configurations, Robot control systems, Accuracy and repeatability, End effectors, Sensors in robotics. Industrial robot applications: Material handling, Processing, assembly and inspection.			
Module-4			
Inspection Technologies: Automated inspection, coordinate measuring machines construction, Operation & programming, Software, application & benefits, Flexible inspection system, Inspection probes on machine tools, Machine vision, Optical inspection techniques & Non-contact Non-optical inspection technologies. Shop Floor Control and Automatic Identification Techniques: Shop floor control, Factory data collection system, Automatic identification methods, Bar code technology, Automatic data collection systems. An Introduction to QR Code Technology			

Module-5
<p>Additive Manufacturing Systems: Basic principles of additive manufacturing, Slicing CAD models for AM, Advantages and limitations of AM technologies, Recent trends in manufacturing, Hybrid manufacturing. Future of Automated Factory: Trends in manufacturing, the future automated factory, Human workers in future automated factory, Social impact.</p>
<p>Course outcome (Course Skill Set) At the end of the course, the student will be able to : CO1: Explain the basics of productions, automation system and manufacturing operations. Solve the simple problems on mathematical model. CO2: Explain CAPP and MRP system and analyze the AGVS. CO3: Understand the inspection technologies and shop floor control. CO4: Explain the modern trends in additive manufacturing and automated factory.</p>
<p>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.</p> <p>Continuous Internal Evaluation:</p> <ul style="list-style-type: none"> • The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 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 assessment methods mentioned in the 22OB4.2, 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 for a total of 50 marks. <p>Internal Assessment Test question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.</p> <p>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).</p> <ol style="list-style-type: none"> 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
<p>Suggested Learning Resources: Books Text Books:</p> <ol style="list-style-type: none"> 1. Automation, Production Systems and Computer-Integrated Manufacturing, by Mikell P Groover, 3rd Edition, 2009, PHI Learning. 2. Automation, Production Systems and Computer-Integrated Manufacturing, by Mikell P Groover, 1999, Prentice-Hall of India.

3. CAD / CAM Principles and Applications by P N Rao, 3rd Edition, 2015, Tata Mc Graw Hill.
4. Additive Manufacturing Technologies: Rapid Prototyping to Direct Digital Manufacturing, 2nd Ed. (2015), Ian Gibson, David W. Rosen, Brent Stucker 98
5. "Understanding Additive Manufacturing", Andreas Gebhardt, Hanser Publishers, 2011

Reference Books:

1. Systems Approach to Computer-Integrated Design and Manufacturing by Dr. Nanua Singh, Wiley, 1996.
2. CAD/CAM/CIM P. Radhakrishnan, S. Subramanyan, U. Raju, New Age International Publication Revised Third Edition 2007. Delhi.

Web links and Video Lectures (e-Resources):

<http://lavallo.pl/vr/book.html>
<https://nptel.ac.in/courses/106/106/106106138/>
<https://www.coursera.org/learn/introduction-virtual-reality>.

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

- Course seminars

Supply Chain Management & Introduction to SAP		Semester	5 th
Course Code	BME515C	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 nature (SEE)	Theory		
Course objectives: <ul style="list-style-type: none">• To acquaint with key drivers of supply chain performance and their inter-relationships with strategy.• To impart analytical and problem-solving skills necessary to develop solutions for a variety of supply chain management & design problems.• To study the complexity of inter-firm and intra-firm coordination in implementing programs such as e-collaboration, quick response, jointly managed inventories and strategic alliances.• To understand the usage of SAP material management system			
Teaching-Learning Process (General Instructions) <p>These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.</p> <ol style="list-style-type: none">1. Adopt different type of teaching methods to develop the outcomes through Power-Point Presentation and Video demonstration or Simulations.2. Chalk and Talk method for Problem Solving.3. Discuss the case studies and how every concept can be applied to the real world - and when that's possible, it helps improve the students' understanding.4. Adopt collaborative (Group Learning) Learning in the class.5. Adopt Problem Based Learning (PBL), which fosters students Analytical skills, develop thinking skills such as the ability to evaluate, generalize, and analyse information.			
Module-1			
Introduction: Supply Chain – Fundamentals –Evolution- Role in Economy - Importance - Decision Phases –Supplier Manufacturer-Customer chain. - Enablers/ Drivers of Supply Chain Performance. Supply chain strategy -Supply Chain Performance Measures. Strategic Sourcing Outsourcing – Make Vs buy - Identifying core processes - Market Vs Hierarchy - Make Vs buy continuum -Sourcing strategy - Supplier Selection and Contract Negotiation.			
Module-2			
Warehouse Management Stores management -stores systems and procedures-incoming materials control stores accounting and stock verification Obsolete, surplus and scrap-value analysis-material handling transportation and traffic management -operational efficiency-productivity-cost effectiveness-performance measurement. Supply Chain Network Distribution Network Design – Role - Factors Influencing Options, Value Addition – Distribution Strategies - Models for Facility Location and Capacity allocation. Distribution Center Location Models.			
Module-3			
Supply Chain Network optimization models. Impact of uncertainty on Network Design - Network Design, decisions using Decision trees. Planning Demand, -multiple item -multiple location inventory management. Pricing and Revenue Management.			
Module-4			
Current Trends: Supply Chain Integration - Building partnership and trust in Supply chain Value of Information: Bullwhip Effect - Effective forecasting - Coordinating the supply chain. Supply Chain			

restructuring, Supply Chain Mapping - Supply Chain process restructuring, Postpone the point of differentiation – IT in Supply Chain - Agile Supply Chain -Reverse Supply chain. Future of IT in supply chain- EBusiness in supply chain.

Module-5

Introduction to SAP - SAP Material Management, Procurement process, Organization structure, Enterprise structure, Master data management, purchase Info record, source list, procurement cycle, purchase requisition, request for quotation, purchase order, inventory management, invoice verification, service management, transaction code

Course outcome (Course Skill Set)

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

1. Describe the framework and scope of supply chain management.
2. Build and manage a competitive supply chain using strategies, models, techniques and information technology.
3. Plan the demand, inventory and supply and optimize supply chain network.
4. Illustrate the emerging trends and impact of IT on Supply chain.
5. Apply the basics of SAP material management system

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) 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:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 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 assessment methods mentioned in the 22OB4.2, 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 for a total of 50 marks.

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

Web links and Video Lectures (e-Resources):

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

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

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

Energy Engineering		Semester	V
Course Code	BME515D	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40 hours	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		
Course objectives: <ul style="list-style-type: none">Understand energy scenario, energy sources and their utilizationLearn about energy conversion methodsStudy the principles of renewable energy conversion systems.			
Teaching-Learning Process (General Instructions) <p>These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.</p> <ul style="list-style-type: none">Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.Arrange visits to show the live working models other than laboratory topics.Adopt collaborative (Group Learning) Learning in the class.Adopt Problem Based Learning (PBL), which foster students' Analytical skills and develops thinking skills such as evaluating, generalizing, and analyzing information.			
Module-1			
Steam Generators: Coal and ash handling, Generation of steam using forced circulation, high and supercritical pressures, LaMount, Benson, Velox, Loeffler, Schmidt steam generators, Cooling towers and Ponds, Accessories such as Super heaters, De-super heater, Economizers, Air pre heaters.			
Diesel Engine Power System: Applications of Diesel Engines in Power field. Method of starting Diesel engines. Auxiliaries like cooling and lubrication system, filters, centrifuges, Oil heaters, intake and exhaust system, Layout of diesel power plant.			
Module-2			
Solar Energy: Introduction, Solar radiation at the earth's surface, Solar radiation measurements, Flat plate collectors, Focussing collectors, Solar Pond, Solar electric power generation-Solar photo voltaic.			
Biomass Energy: Photosynthesis, photosynthetic oxygen production, energy plantation. Biochemical Route: Biogas production from organic wastes by anaerobic fermentation, Biogas plants-KVIC, Janta, Deenbhandu models, factors affecting bio gas generation. Thermal gasification of biomass, updraft and downdraft			
Module-3			
Geothermal Energy: Forms of geothermal energy, Dry steam, wet steam, hot dry rock and magmatic chamber systems.			
Tidal Energy: Tidal power, Site selection, Single basin and double basin systems, Advantages and disadvantages of tidal energy.			
Wind Energy: Wind energy-Advantages and limitations, wind velocity and wind power, Basic components of wind energy conversion systems, horizontal and vertical axis wind mills, coefficient of performance of a wind mill rotor, Applications of wind energy.			
Module-4			
Hydroelectric plants: Advantages & disadvantages of water power, Hydrographs and flow duration curves numerical, Storage and pondage, General layout of hydel power plants-components such as Penstock, surge tanks, spill way and draft tube and their applications, pumped storage plants, Detailed classification of hydroelectric plants, water hammer.			

Ocean Thermal Energy: Ocean thermal energy conversion, Principle and working of Rankine cycle, Problems associated with OTEC.

Module-5

Nuclear Energy: Principles of release of nuclear energy-Fusion and fission reactions. Nuclear fuels used in the reactors, Chain reaction, Moderation, breeding, Multiplication and thermal utilization factors. General components of a nuclear reactor and materials, Brief description-Pressurized water reactor, Boiling water reactor, Sodium graphite reactor, Fast Breeder reactor, Homogeneous graphite reactor and gas cooled reactor, Radiation hazards, Shielding, Nuclear waste, Radioactive waste disposal.

Course outcome (Course Skill Set)

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

- CO1: Understand the construction and working of steam generators and their accessories.
- CO2: Identify renewable energy sources and their utilization.
- CO3: Understand principles of energy conversion from alternate sources including wind, geothermal, ocean, biomass, nuclear, hydel and tidal.

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:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 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 assessment methods mentioned in the 22OB4.2, 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 for a total of 50 marks.

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:**Test Books:**

1. G.D. Rai, Non conventional energy resources, 5th Edition, Khanna Publishers, New Delhi
2. B H Khan, Non conventional energy resources, 3rd Edition, McGraw Hill Education
3. Principles of Energy conversion, A. W. Culp Jr., McGraw Hill. 1996

REFERENCE BOOKS

1. S.P. Sukhatme, Solar Energy: principles of Thermal Collection and Storage, Tata McGraw-Hill (1984).
2. C. S. Solanki, —Solar Photovoltaic's: Fundamental Applications and Technologies, Prentice Hall of India, 2009.
3. L.L. Freris, Wind Energy Conversion Systems, Prentice Hall, 1990.

Web links and Video Lectures (e-Resources):

- <https://www.tlv.com/global/TI/steam-theory/principal-applications-for-steam.html>
- <https://youtu.be/IdPTuwKEfmA>
- <https://youtu.be/6FMLm5WCadI>
- https://youtu.be/utjf7US_cKA
- https://youtu.be/Z1ur09_SLVo
- https://youtu.be/Z1ur09_SLVo
- <https://youtu.be/AMXxXoHtM-o>

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

1. Visit to conventional energy source power plant (thermal power plant/nuclear power plant/diesel engine power plant)
2. Visit to Non-conventional energy source power plant (solar power plant/wind power plant/tidal power plant/OTEC power plant, etc)
3. Video demonstration of latest trends in renewable energy sources.

HEAT TRANSFER		Semester	6 th
Course Code	BME601	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:2:0	SEE Marks	50
Total Hours of Pedagogy	40 hours Theory + 8-10 Lab slots	Total Marks	100
Credits	04	Exam Hours	03
Examination nature (SEE)	Theory		
Course objectives: Student will be able to learn <ul style="list-style-type: none">Principles of heat transfer.Steady and transient heat transfer, obtain the differential equation of heat conduction in various coordinate system.Physical mechanism of convection and visualize the development of velocity and thermal boundary layers during flow over a surface.Radiation heat transfer mechanismThe mechanisms of boiling and condensation and understand performance parameters of heat exchangers.			
Teaching-Learning Process (General Instructions) These are sample Strategies; that teachers can use to accelerate the attainment of the various course outcomes. <ol style="list-style-type: none">Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.Chalk and Talk method for Problem Solving.Adopt flipped classroom teaching method.Adopt collaborative (Group Learning) learning in the class.Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.			
MODULE-1			
Introductory Concepts and definition: Review of basics of Modes of Heat Transfer. Conduction-Basic Equations: General form of one-dimensional heat conduction equation. Boundary conditions of first, second and third kinds; One dimensional Steady state conduction with and without heat generation: Steady state conduction in slab, cylinder and sphere with engineering applications. Steady state conduction: Overall heat transfer coefficient for a composite medium; thermal contact resistance; critical thickness of insulation, Discussion on engineering applications.			
MODULE-2			
Extended surfaces; Steady state conduction in fins of uniform cross section long fin, fin with insulated tip and fin with convection at the tip; fin efficiency & effectiveness, Discussion on engineering applications. One dimensional Transient conduction: Conduction in solids with negligible internal temperature gradients (lumped system analysis) Use of transient temperature charts (Heisler's charts) for Transient conduction in slab, long cylinder and sphere; Discussion on engineering applications.			
MODULE-3			

Numerical Analysis of Heat Conduction: Introduction, one-dimensional steady conduction and one Dimensional unsteady conduction, boundary conditions, and solution methods.

Radiation Heat transfer: Review of basic laws of thermal radiation, Intensity of radiation and solid angle; Concept of thermal radiation resistance, Radiation network, view factor, Radiation heat exchange between two parallel infinite black surfaces, between two parallel infinite gray surfaces; Effect of radiation shield; Discussion on engineering applications.

MODULE-4

Concepts and Basic Relations in Boundary layers: Flow over a flat plate -Velocity boundary layer, Thermal boundary layer; Prandtl number; general expression for local heat transfer coefficient; Average heat transfer coefficient.

Forced Convection: Physical significance of Dimensionless numbers. Use of various Correlations for hydro dynamically and thermally developed flows; Use of correlations for flow over a flat plate, cylinder, sphere and flow inside the duct.

Free or Natural Convection: Physical significance of dimensionless numbers. Use of correlations for free convection from or to vertical, horizontal and inclined flat plates, vertical and inclined cylinder.

MODULE-5

Boiling and Condensation; Pool boiling regimes. Basics of Film and dropwise condensation, Use of correlations for film and dropwise condensation on tubes.

Heat Exchangers: Classification of heat exchangers; Overall heat transfer coefficient, Fouling, Scaling factors; LMTD and NTU methods of analysis of heat exchangers.

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

Sl.NO	Experiments
1	Determination of Thermal Conductivity of a Metal Rod.
2	Determination of Overall Heat Transfer Coefficient of a Composite wall.
3	Determination of Effectiveness on a Metallic fin.
4	Determination of Heat Transfer Coefficient in free Convection
5	Determination of Heat Transfer Coefficient in a Forced Convention
6	Determination of Emissivity of a Surface and Determination of Stefan Boltzmann Constant.
7	Determination of LMDT and Effectiveness in a Parallel Flow and Counter Flow Heat Exchangers.
8	Experiments on Boiling of Liquid and Condensation of Vapour.
9	Experiment on Transient Conduction Heat Transfer.
10	Use of CFD for demonstrating heat transfer mechanism considering practical applications,
11	Minimum two exercises
12	Using one dimensional transient conduction, experimentally demonstrate estimation of thermal conductivity and thermal diffusivity

Course outcomes (Course Skill Set):

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

- Determine temperature distribution in steady-state heat conduction.
- Analyse the forced and free convective heat transfer.
- Analyse the radiation Heat transfer. Analyse the heat transfer through extended surfaces and

transient heat conduction.

- Design of heat exchangers using LMTD, NTU methods and analyse the boiling and condensation.

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 must 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:**(Title of the Book/Name of the author/Name of the publisher/Edition and Year)****Text Books:**

1. Principals of heat transfer Frank Kreith, Raj M. Manglik, Mark S. Bohn Cengage learning Seventh Edition 2011.
2. Heat transfer, a practical approach Yunus A. Cengel Tata Mc Graw Hill Fifth edition

Reference Books:

1. Heat and mass transfer Kurt C, Rolle Cengage learning second edition
2. Heat Transfer A Basic Approach M. Necati Ozisik McGraw Hill, New York 2005
3. Fundamentals of Heat and Mass Transfer Incropera, F. P. and De Witt, D. P John Wiley and Sons, New York 5th Edition 2006
4. Heat Transfer Holman, J. P. Tata McGraw Hill, New York 9th Edition 2008

Web links and Video Lectures (e-Resources):

- https://www.youtube.com/watch?v=rxTK_SvSmvs&list=PL1gyM10tgL1hK9666oGndGIWDQdpQzkY9
- https://www.kochheattransfer.com/products/twisted-tube-bundle-technology?gad=1&gclid=Cj0KCQjwmtGjBhDhARIsAEqfDEdG22TY7OH8PBzHX1Yo_DKQcheV46aZxtDRvDIhCe1Gfpr5obDMLoaArSXEALw_wcB
- <https://www.hightemp-furnaces.com/>

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

- Organize a visit to automobile service station and write a report for cooling systems in automobile.
- Apply knowledge of plane wall transient conduction to determine the temperature distribution throughout the pizza as a function of time.

MACHINE DESIGN		Semester	6 th
Course Code	BME602	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3-2-0-0	SEE Marks	50
Total Hours of Pedagogy	52	Total Marks	100
Credits	04	Exam Hours	3
Examination type (SEE)	Theory		
Course objectives: The student will be able: <ol style="list-style-type: none">1. To explain the principles involved in design of machine elements, subjected to different kinds of forces, from the considerations of strength, rigidity.2. To understand and interpret different failure modes and application of appropriate criteria for design of machine elements.3. Develop the capability to design elements like shafts, couplings and welded joints, screwed joints.4. To learn transmission elements like gears, belts, pulleys, bearings from the manufacturers' catalogue.5. To produce assembly and working drawings of various mechanical systems involving machine elements like clutches and brakes.			
Teaching-Learning Process (General Instructions) These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes. <ol style="list-style-type: none">1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.2. Chalk and Talk method for Problem Solving.3. Adopt flipped classroom teaching method.4. Adopt collaborative (Group Learning) learning in the class.5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.			
Module-1			
Introduction and Review: Review of engineering materials and their properties and manufacturing processes; use of codes and standards, selection of preferred sizes. Review of axial, bending, shear and torsion loading on machine components, combined loading. Design for static strength: Factor of safety and service factor. Failure mode: definition and types., Failure of brittle and ductile materials; even and uneven materials; Stress concentration, stress concentration factor, Theories of failure: maximum normal stress theory, maximum shear stress theory, distortion energy theory, strain energy theory, Columba –Mohr theory and modified Mohr's theory Fatigue loading: Introduction to fatigue failure, Mechanism of fatigue failure, types of fatigue loading, S-N Diagram, Low cycle fatigue, High cycle fatigue, Endurance limit.			
Module-2			
Design of shafts: Torsion of shafts, solid and hollow shaft design with steady loading based on strength and rigidity, ASME and BIS codes for power transmission shafting, design of shafts subjected to combined bending, torsion and axial loading, Discussion on engineering applications. Design of keys and couplings: Keys: Types of keys and their applications, design considerations in parallel and tapered sunk keys, Design of square and rectangular sunk keys. Couplings: Rigid and flexible coupling-types and applications, design of Flange coupling, and Bush and Pin type coupling.			
Module-3			

Riveted joints: Types of rivets, rivet materials, Caulking and fullering, analysis of riveted joints, joint efficiency, failures of riveted joints, boiler joints, riveted brackets, Discussion on engineering applications.

Welded joints: Types, strength of butt and fillet welds, eccentrically loaded welded joints, Discussion on engineering applications.

Spur Gears: Definitions, stresses in gear tooth: Lewis equation and form factor, design for strength, dynamic load and wear.

Module-4

Helical Gears: Definitions, transverse and normal module, formative number of teeth, design based on strength, dynamic load and wear.

Bevel Gears: Definitions, formative number of teeth, design based on strength, dynamic load and wear.

Worm Gears: Definitions, types of worm and worm gears, and materials for worm and worm wheel. Design based on strength, dynamic, wear loads and efficiency of worm gear drives.

Module-5

Design of Clutches and Brakes: Design of single plate, multi-plate based on uniform pressure and uniform wear theories. Design of band brakes, block brakes

Lubrication and Bearings: Lubricants and their properties, bearing materials and properties; mechanisms of lubrication, hydrodynamic lubrication, pressure development in oil film, bearing modulus, coefficient of friction, minimum oil film thickness, heat generated, and heat dissipated.

Course outcome (Course Skill Set)

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

1. Apply codes and standards in the design of machine elements and select an element based on the Manufacturer's catalogue.
2. Analyse the performance and failure modes of mechanical components subjected to combined loading and fatigue loading using the concepts of theories of failure.
3. Demonstrate the application of engineering design tools to the design of machine components like shafts, keys, couplings, welded and riveted joints, brakes and clutches
4. Design different types of gears and simple gear boxes for relevant applications.
5. Apply design concepts of hydrodynamic bearings for different applications using the manufacturers, catalogue.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) 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:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 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 assessment methods mentioned in the 220B4.2, 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 for a total of 50 marks.

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:

Text Books

- 1 Shigley's Mechanical Engineering Design Richard G. Budynas, and J. Keith Nisbett McGraw-Hill Education 10th Edition, 2015
- 2 Fundamentals of Machine Component Design Juvinall R.C, and Marshek K.M John Wiley & Sons Third Edition 2007 Wiley student edition
- 3 Design of Machine Elements V. B. Bhandari Tata Mcgraw Hill 4th Ed 2016.

Web links and Video Lectures (e-Resources):

1. https://en.wikipedia.org/wiki/Machine_element
2. www.nptel.ac.in
3. <https://cosmolearning.org>
4. www.vtu.ac.in
5. <http://nevonprojects.com/mini-projects-for-mechanical-engineering/>

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

- Term Projects
- Course seminar

Design lab		Semester	6 th
Course Code	BME606L	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0-0-2	SEE Marks	50
Credits	01	Exam Hours	3
Examination type (SEE)	Practical		
Course objectives: The students will be able <ul style="list-style-type: none">To understand the concepts of natural frequency, logarithmic decrement, damping and damping ratio.To understand the techniques of balancing of rotating masses and influence of gyroscopic couple.To verify the concept of the critical speed of a rotating shaft.To illustrate the concept of stress concentration using Photo elasticity.To appreciate the equilibrium speed, sensitiveness, power and effort of a Governor.To illustrate the principles of pressure development in an oil film of a hydrodynamic journal bearing.To visualize different mechanisms and cam motionsModern computing techniques are preferred to be used wherever possible			
Sl.NO	Experiments		
1	Determination of natural frequency, logarithmic decrement, damping ratio and damping coefficient in a single degree of freedom vibrating systems (longitudinal and torsional)		
2	Balancing of rotating masses		
3	Determination of critical speed of a rotating shaft		
4	Determination of equilibrium speed, sensitiveness, power and effort of Porter/Proell /Hartnell Governor.		
5	Determination of Pressure distribution in Journal bearing		
6	Study of different types of cams, types of followers and typical follower motions. Obtain cam profile for any two types of follower motions and types of followers		
7			
8	Determination of Fringe constant of Photo-elastic material using. a) Circular disc subjected to diametral compression. b) Pure bending specimen (four-point bending).		
	Demonstration Experiments (For CIE)		
9	Study the principle of working of a Gyroscope and demonstrate the Effect of gyroscopic Couple on plane disc		
10	Demonstration and study of operation of different Mechanisms and their Inversions: Slider crank chain, Double slider crank chain and its inversions, Quick return motion mechanisms- Peaucellier's mechanism. Geneva wheel mechanism, Ratchet and Pawl mechanism, toggle mechanism, pantograph, Ackerman steering gear mechanism		
11			
12	Demonstration of stress concentration using Photo-elasticity for simple components like plate with a hole under tension or bending, circular disk with circular hole under compression		
Course outcomes (Course Skill Set): At the end of the course the student will be able to: <ul style="list-style-type: none">Compute the natural frequency of the free and forced vibration of single degree freedom systems, critical speed of shafts.			

- Carry out balancing of rotating masses and gyroscope phenomenon.
- Analyse the governor characteristics.
- Determine stresses in disk, beams and plates using photo elastic bench.
- Determination of Pressure distribution in Journal bearing
- Analyse the stress and strains using strain gauges in compression and bending test
- To realize different mechanisms and cam motions

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks 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 (CIE):

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

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

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

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

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners, one from other institute as external and one from the same institute as internal examiner, are appointed by the university.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics

shall be decided jointly by examiners.

- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

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

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

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

- Theory of Machines, Rattan S.S , Tata McGraw-Hill Publishing Company, 2014 2. Experimental Stress analysis, M. M. Frotch, McGraw-Hill

TOTAL QUALITY MANAGEMENT		Semester	6 th
Course Code	BME613A	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/practical/Viva-Voce /Term-work/Others		
Course objectives: <ul style="list-style-type: none">Understand various approaches to TQMUnderstand the characteristics of quality leader and his role.Develop feedback and suggestion systems for quality management.Enhance the knowledge in Tools and Techniques of quality management●			
Teaching-Learning Process (General Instructions) <p>These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.</p> <ul style="list-style-type: none">Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.Chalk and Talk method for Problem Solving.Adopt flipped classroom teaching method.Adopt collaborative (Group Learning) learning in the class.Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skillssuch as evaluating, generalizing, and analysing information.			
Module-1			
Principles and Practice: <ul style="list-style-type: none">Definition, basic approach, gurus of TQM, TQM Framework, awareness, defining quality, historical review, obstacles, benefits of TQM.Quality Management Systems: Introduction, benefits of ISO registration, ISO 9000 series of standards, ISO 9001 requirements.			
Module-2			
Leadership: <ul style="list-style-type: none">Definition, characteristics of quality leaders, leadership concept, characteristics of effective people, ethics, the Deming philosophy,Role of TQM leaders, implementation, core values, concepts and framework, strategic planning communication, decision making,			
Module-3			
Customer Satisfaction and Customer Involvement: <ul style="list-style-type: none">Customer Satisfaction: customer and customer perception of quality, feedback, using customer complaints, service quality, translating needs into requirements, customer retention, case studies.Employee Involvement – Motivation, employee surveys, empowerment, teams, suggestion system, recognition and reward, gain sharing, performance appraisal, unions and employee involvement, case studies.			
Module-4			
Continuous Process Improvement: <ul style="list-style-type: none">The Juran trilogy, improvement strategies, types of problems, the PDSA Cycle, problem-solving methods, Kaizen, reengineering, six sigma, case studies.Statistical Process Control: Pareto diagram, process flow diagram, cause and effect diagram, check sheets, histograms, statistical fundamentals, Control charts, state of control, out of control process, control charts for variables, control charts for attributes, scatter diagrams, case studies.			

Module-5

Total Productive Maintenance (TPM):

- Definition, Types of Maintenance, Steps in introduction of TPM in an organization, Pillars of TPM – 5S, Jishu Hozen, Quality Maintenance, Planned Maintenance.
- Quality by Design (QbD): Definition, Key components of QbD, Role of QbD in Pharmaceutical Industry, Benefits and Challenges of QbD. Environmental Management Systems (EMS): Definition, Basic EMS, EMS under ISO 14001, Costs and Benefits of EMS.

Course outcome (Course Skill Set)

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

- CO1: Explain the various approaches of TQM
- CO2: Infer the customer perception of quality
- CO3: Analyse customer needs and perceptions to design feedback systems.
- CO4: Apply statistical tools for continuous improvement of systems
- CO5: Apply the tools and technique for effective implementation of TQM.

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:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 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 assessment methods mentioned in the 22OB4.2, 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 for a total of 50 marks.

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. Total Quality Management Dale H. Besterfield Pearson Education India, Edition 03. ISBN: 8129702606,

2. Total Quality Management for Engineers M. Zairi Wood head Publishing ISBN:185573024
3. Managing for Quality and Performance Excellence James R. Evans and William M Lindsay Cengage Learning. 9th edition
4. Four revolutions in management Shoji Shiba, Alan Graham, David Walden Oregon 1990
5. Organizational Excellence through TQM H. Lal New age Publications 200864 Engineering Optimization Methods and Applications A Ravindran, K, M. Ragsdell Willey India Private Limited 2nd Edition,2006
6. Introduction to Operations Research- Concepts and Cases F.S. Hillier. G.J. Lieberman Tata McGraw Hill 9th Edition, 2010

Web links and Video Lectures (e-Resources):

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

- Case studies Quiz
- Topic Seminar presentation
- Assignments

REFRIGERATION AND AIR CONDITIONING		Semester	VI
Course Code	BME613B	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		
Course Learning Objectives: <ol style="list-style-type: none">1. Study the basic definition, ASHRAE Nomenclature for refrigerating systems.2. Understand the working principles and applications of different types of refrigeration systems.3. Study the working of air conditioning systems and their applications.4. Identify the performance parameters and their relations of an air conditioning system.			
Teaching-Learning Process (General Instructions) <p>These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.</p> <ol style="list-style-type: none">1. Classroom Teaching using Pedagogical methods.2. Using ICT tools3. Video of different refrigeration systems and air conditioning systems.4. Visiting industries for understanding different air conditioning systems and also the refrigerator manufacturing units.			
Module-1			
Introduction to Refrigeration –Basic Definitions, ASHRAE Nomenclature, Air Refrigeration Cycles-reversed Carnot cycle, Bell-Coleman cycle analysis, Air Refrigeration systems-merits and demerits and applications; Aircraft refrigeration cycles, Joule Thompson coefficient and Inversion Temperature, Linde, Claude and Stirling cycles for liquefaction of air.			
Industrial Refrigeration -Chemical and process industries, Dairy plants, Petroleum refineries, Food processing and food chain, Miscellaneous			
Module-2			
Vapour Compression Refrigeration System(VCRS): Comparison of Vapour Compression Cycle and Gas cycle, Vapour Compression Refrigeration system Working and analysis, Limitations, Superheat horn and throttling loss for various refrigerants, efficiency, Modifications to standard cycle – liquid suction heat exchangers, Grindlay cycle and Lorenz cycle, Optimum suction condition for optimum COP – Ewing’s construction and Gosney’s method. Actual cycles with pressure drops, Complete Vapour Compression Refrigeration System, Multi-Pressure, Uti-evaporator systems or Compound Vapour Compression Refrigeration Systems – Methods like Flash Gas removal, Flash inter cooling and water Inter cooling.			
Module-3			
Vapour Absorption Refrigeration Systems: Absorbent – Refrigerant combinations, Water-Ammonia Systems, Practical problems, Lithium- Bromide System, Contrast between the two systems, Modified Version of Aqua-Ammonia System with Rectifier and Analyzer Assembly. Practical problems – crystallization and air leakage, Commercial systems.			
Other types of Refrigeration systems: Brief Discussion on (i) Steam-Jet refrigeration system and (ii) Thermoelectric refrigeration, pulse tube refrigeration, thermoacoustic refrigeration systems			
Module-4			

Refrigerants: Primary and secondary refrigerants, Designation of Refrigerants, Desirable properties of refrigerants including solubility in water and lubricating oil, material compatibility, toxicity, flammability, leak detection, cost, environment and performance issues Thermodynamic properties of refrigerants, Synthetic and natural refrigerants, Comparison between different refrigerants vis a vis applications, Special issues and practical implications Refrigerant mixtures – zeotropic and azeotropic mixtures.

Refrigeration systems Equipment: Compressors, Condensers, Expansion Devices and Evaporators, A brief look at other components of the system.

Module-5

Air-Conditioning: Introduction to Air-Conditioning, Basic Definition, Classification, power rating, Mathematical Analysis of Air-Conditioning Loads, Related Aspects, Different Air-Conditioning Systems-Central – Station Air-Conditioning System, Unitary Air-Conditioning System, Window Air-Conditioner and Packaged Air-Conditioner, Components related to Air-Conditioning Systems.

Transport air conditioning Systems: Air conditioning systems for automobiles (cars, buses etc.), Air conditioning systems for trains, Air conditioning systems for ships

Course outcome (Course Skill Set)

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

C01: Understand the principles, nomenclature and applications of refrigeration systems.

C02: Explain vapour compression refrigeration system and identify methods for performance improvement

C03: Illustrate the working principles of air, vapour absorption, thermoelectric and steam-jet and thermoacoustic refrigeration systems.

C04: Estimate the performance of air-conditioning systems using the principles of psychrometry.

C05: Compute and Interpret cooling and heating loads in an air-conditioning system.

C06: Identify suitable refrigerant for various refrigerating 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:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 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 assessment methods mentioned in the 220B4.2, 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 for a total of 50 marks.

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:**Text Books**

1. Roy J. Dossat, Principles of Refrigeration, Wiley Limited
2. Arora C.P., Refrigeration and Air-conditioning, Tata Mc Graw -Hill, New Delhi, 2ndEdition, 2001.
3. Stoecker W.F., and Jones J.W., Refrigeration and Air-conditioning, Mc Graw - Hill, New Delhi 2nd edition, 1982.

Reference Books:

1. Dossat, Principles of Refrigeration Pearson-2006.
2. McQuiston, Heating, Ventilation and Air Conditioning, Wiley Students edition, 5th edition, 2000.
3. Refrigeration and Air-Conditioning' by Manohar prasad
4. S C Arora & S Domkundwar, Refrigeration and Air-Conditioning Dhanpat Rai Publication

Web links:

<http://nptel.ac.in/courses/112105128/#>

MEMS & MICROSYSTEM TECHNOLOGY		Semester	VI
Course Code	BME613C	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3-0-0-0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory/practical/Viva-Voce /Term-work/Others		
Course objectives: <ol style="list-style-type: none">1. Students are exposed to the MEMS technology & Miniaturization.2. Students are taught the Process of Micro fabrication Techniques.3. Students are made to understand the Operation of Microsystems.4. Students are made to understand the Operation Electronics Circuits for Micro and Smart Systems.5. Students are made to understand the Implementation of Controllers for MEMS & Case Studies of Integrated Microsystems.			
Teaching-Learning Process (General Instructions) <p>These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.</p> <ol style="list-style-type: none">1. Power Point Presentation,2. Chalk and Talk are used for Derivations and Correlations (In-general).3. Video demonstration or Simulations,			
Module-1			
<u>Introduction to Micro and Smart systems:</u> Miniaturization, Microsystems versus MEMS, Micro-fabrication, Smart Materials, Structures & Systems, Integrated Microsystems, Application of Smart Materials & Microsystems.			
Module-2			
<u>Micro and Smart Devices and Systems: Principles and Materials:</u> Definitions and salient features of sensors, actuators, and systems, Sensors: silicon capacitive accelerometer, piezoresistive pressure sensor, Portable blood analyser, conductometric gas sensor. Actuators: Micro mirror Array for Video Projection, Piezo-electric based inkjet print head, electrostatic comb-drive, Magnetic micro relay.			
Module-3			
<u>Micromachining Technologies:</u> Silicon as a Material for Micromachining, Silicon wafer preparation, thin-film deposition techniques, Lithography, Etching, Silicon micromachining: surface micromachining bulk micromachining. Specialized Materials for Microsystems.			
Module-4			
<u>Electronics Circuits for Micro and Smart Systems.</u> Semiconductor devices: Diode, Schottky diode, Tunnel diode ,MOSFET,CMOS circuits ,Electronics Amplifiers ,Op-Amp based circuits .			
Module-5			
<u>Implementation of Controllers for MEMS & Case Studies of Integrated Microsystems.</u> Design Methodology, PID controller, Circuit Implementation, Digital controller, Microcontroller & PLC. Case Studies of Integrated Microsystems: BEL pressure sensor, design considerations, performance parameters, Smart Structure in vibration control.			

Course outcome (Course Skill Set)

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

1. Demonstrate the working methodology of smart materials, Microsystems, electronic circuitry in MEMS devices.
2. Illustrate the process of silicon wafer preparation, thin film deposition techniques, lithography, etching, bulk & surface micromachining involved in MEMS fabrication.
3. Examine the behaviour of piezoresistive & piezoelectric materials required to fabricate pressure sensor & vibration control structures.
4. Measure the performance of pressure sensor & vibration control structure in real time 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 Evaluation:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 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 assessment methods mentioned in the 22OB4.2, 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 for a total of 50 marks.

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. Micro and Smart Systems: G.K.Ananthasuresh, K.J.Vinoy, S.Gopalakrishnan, K.N.Bhat, V.K.Aatre,Wiley India 2010.
2. Design and Development Methodologies, Smart Material Systems and MEMS: V. Varadan,K. J. Vinoy, S. Gopalakrishnan, Wiley.
3. MEMS- Nitaigour Premchand Mahalik, TMH 2007.

4. MEMS & Microsystems: Design and Manufacture, Tai-Ran Hsu, Tata Mc-Graw-Hill
Web links and Video Lectures (e-Resources):
<ul style="list-style-type: none">• VTU e-Shikshana Program• VTU EDUSAT Program.
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning <ul style="list-style-type: none">• Conduct Analysis of Stress and Strain on Cantilever beam structure on Ansys Tool.• Prepare Models to exhibit FCC Structures and create patterns on sheets of paper to demonstrate different Micromachining Fabrication Processes.

Design for Manufacturing and Assembly		Semester	VI
Course Code	BME613D	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	42	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		
Course objectives: <ol style="list-style-type: none">1. Understand the concepts of Geometric dimensioning and Tolerances in Engineering drawing2. Analyse the process capabilities and datum features in various components3. Evaluate the design considerations of casting, injection moulding, die casting and powder metallurgical components4. Estimate the assembly limits, machining sequence and process parameters			
Teaching-Learning Process (General Instructions) <p>These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.</p> <ol style="list-style-type: none">1. Classroom Teaching2. Disassemble a machine and reassemble appreciate the fitting tolerance3. Case studies to discuss on material selection and tolerances4. Video of different manufacturing process5. Videos of different assembly			
Module-1 : Introduction to Design for Manufacturing			
Introduction: History of DFM, Design philosophy steps in Design process - General Design rules for manufacturability - basic principles of designing for economical production - creativity in design. evaluation method, Process capability. Materials: Selection of Materials for design Developments in Material technology - criteria for material selection			
Module-2: Components design for Manufacturing			
Component Design-I: Machining Consideration: Design features to facilitate machining: drills, milling cutters, keyways, Doweling procedures, counter sunk screws, Reduction of machined area, simplification by separation, simplification by amalgamation, Design for machinability, Design for economy, Design for clampability, Design for accessibility, Design for assembly. Component Design-II: Casting Consideration: Redesign of castings based on parting line considerations, Minimizing core requirements, machined holes, redesign of cast members to obviate cores. Identification of uneconomical design, Modifying the design, group technology, Computer Applications for DFMA			
Module-3: Assembly			
Assemble advantages: Development of the assemble process, choice of assemble method assemble advantages social effects of automation. Automatic assembly transfer systems: Continuous transfer, intermittent transfer, indexing mechanisms, and operator - paced free – transfer machine GD&T – Symbols, Three datum concept of dimensioning, Straightness, concentricity, Run-out, Location Tolerance, Assembly of parts having concentric cylinders, Control of feature location by true position, Body of revolution, Roundness, Profile dimensioning, Tapers, Shaft of two diameters. Examples.			
Module-4 : Manual Assembly			

Design of manual assembly: Design for assembly fits in the design process, general design guidelines for manual assembly, development of the systematic DFA methodology, assembly efficiency, classification system for manual handling, classification system for manual insertion and fastening, effect of part symmetry on handling time, effect of part thickness and size on handling time, effect of weight on handling time, parts requiring two hands for manipulation, effects of combinations of factors, effect of symmetry effect of chamfer design on insertion operations, estimation of insertion time

Module-5 : Design for Environment

Design for the Environment: Introduction, Environmental objectives, Global issues, Regional and local issues, Basic DFE methods, Design guide lines, Example application, Lifecycle assessment, Basic method, Environmentally responsible product assessment, Weighted sum assessment method, Lifecycle assessment method, Techniques to reduce environmental impact, Design to minimize material usage, Design for disassembly, Design for recyclability, Design for remanufacture, Design for energy efficiency, Design to regulations and standard.

Course outcome (Course Skill Set)

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

1. Apply the concepts of Geometrical dimensioning, selection of materials and tolerance for engineering products
2. Analyse the design principles related to various manufacturing processes and assembly method
3. Develop the appropriate material and machining sequence for manufacturing processes
4. Select a suitable manufacturing system considering environmental factors

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:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 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 assessment methods mentioned in the 220B4.2, 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 for a total of 50 marks.

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:

Text Books

1. Designing for Manufacture, Peck H, Pitman Publications, 1983
2. Engineering Design: A Materials and processing Approach, Dieter, G.E. McGraw Hill Co.Ltd 2000
3. Engineering Metrology, R K Jain, Khanna Publications, 2000.

Reference Books:

1. ASM Hand book, Vol.20. Material selection & Design
2. Handbook of Products Design for Manufacturing: A Practical Guide to Low-cost Production Bralla, James G. McGraw Hill, New York, 1986.
3. Product Design for Manufacture and Assembly, Geoffery Boothroyd et al, Mercel Dekker Inc. New York.

PROJECT MANAGEMENT		Sem	6 th
Course Code	BME654A	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Course Learning Objectives: <ul style="list-style-type: none"> To understand how to break down a complex project into manageable segments and use of effective project management tools and techniques to arrive at solution and ensure that the project meets its deliverables and is completed within budget and on schedule. To impart knowledge on various components, phases, and attributes of a project. To prepare students to plan, develop, lead, manage, and successfully implement and deliver projects within their chosen practice area. 			
MODULE-1			
Introduction: Definition of project, characteristics of projects, understand projects, types of projects, scalability of project tools, project roles Project Selection and Prioritization – Strategic planning process, Strategic analysis, strategic objectives, portfolio alignment – identifying potential projects, methods of selecting projects, financial mode / scoring models to select projects, prioritizing projects, securing and negotiating projects.			
MODULE-2			
Planning Projects: Defining the project scope, Project scope checklist, Project priorities, Work Breakdown Structure (WBS), Integrating WBS with organisation, coding the WBS for the information system. Scheduling Projects: Purpose of a project schedule, historical development, how project schedules are limited and created, develop project schedules, uncertainty in project schedules, Gantt chart.			
MODULE-3			
Resourcing Projects: Abilities needed when resourcing projects, estimate resource needs, creating staffing management plan, project team composition issues, Budgeting Projects: Cost planning, cost estimating, cost budgeting, establishing cost control. Project Risk Planning: Risk Management Planning, risk identification, risk analysis, risk response planning, Project Quality Planning and Project Kick off: Development of quality concepts, project quality management plan, project quality tools, kicks off project, baseline and communicate project management plan, using Microsoft Project for project baselines.			
MODULE-4			
Performing Projects: Project supply chain management: - Plan purchasing and acquisitions, plan contracting, contact types, project partnering and collaborations, project supply chain management. Project Progress and Results: Project Balanced Scorecard Approach, Internal project, customer, financial issues, Finishing the project: Terminate project early, finish projects on time, secure customer feedback and approval, knowledge management, perform administrative and contract closure.			
MODULE 5			
Network Analysis: Introduction, network construction - rules, Fulkerson's rule for numbering the events, AON and AOA diagrams; Critical path method (CPM) to find the expected completion time of a project, floats; PERT for finding expected duration of an activity and project, determining the probability of completing a project, predicting the completion time of project; crashing of simple projects.			
Course outcomes (Course Skill Set): At the end of the course the student will be able to: CO1: Understand the selection, prioritization and initiation of individual projects and strategic role of project management.			

CO2: Understand the work breakdown structure by integrating it with organization.
 CO3: Understand the scheduling and uncertainty in projects.
 CO4: Understand risk management planning using project quality tools.
 CO5: Understand the activities like purchasing, acquisitions, contracting, partnering and elaborations related to performing projects.
 CO6: Determine project progress and results through balanced scorecard approach
 CO7: Draw the network diagram to calculate the duration of the project and reduce it using crashing.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) 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:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 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 assessment methods mentioned in the 22OB4.2, 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 for a total of 50 marks.

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. Project Management, Timothy J Kloppenborg, Cengage Learning, Edition 2009.
2. Project Management, A systems approach to planning scheduling and controlling by Harold kerzner, CBS publication.
3. Project Management by S Choudhury, Mc Graw Hill Education (India) Pvt. Ltd. New Delhi, 2016

Reference Books:

1. Project Management, Pennington Lawrence, Mc Graw hill
2. Project Management, A Moder Joseph and Phillips New York Van Nostrand, Reinhold.
3. Project Management, Bhavesh M. Patal, Vikas publishing House,

Renewable Energy Power Plants		Semester	6 th
Course Code	BME654B	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03
Examination type (SEE)	Theory		
Course objectives: <ul style="list-style-type: none">• To explore society’s present needs and future energy demands.• To introduce the concepts of solar energy• To introduce the concepts and applications of Wind energy, Biomass energy, geothermal energy and Ocean energy as alternative energy sources.• To get exposed to energy conservation methods.			
Teaching-Learning Process (General Instructions) <p>These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.</p> <ol style="list-style-type: none">1. Use pie chart showing distribution of renewable energy sources2. Use wind turbine models3. Use sun path diagrams			
Module-1			
Introduction to Renewable Energy: Overview of global energy demand and the need for renewable energy, Comparison of renewable and non-renewable energy sources, Environmental benefits and challenges of renewable energy. Solar Radiation: Extra-Terrestrial radiation, spectral distribution of extra-terrestrial radiation, solar constant, solar radiation at the earth’s surface, beam, diffuse and global radiation			
Module-2			
Solar Power Plants: <p>Measurement of Solar Radiation: Pyrometer, shading ring pyrheliometer, sunshine recorder, schematic diagrams and principle of working. Solar Thermal Conversion: Collection and storage, thermal collection devices.</p> <p>Fundamentals of solar energy and photovoltaic (PV) technology, Types of solar power plants: grid-tied, off-grid, and hybrid systems, Design considerations for solar power plants: site selection, orientation, and shading analysis, PV system components and their functionalities, Operation, maintenance, and performance monitoring of solar power plants</p>			
Module-3			
Wind Power Plants: <p>Basics of wind energy and wind turbine technology, Types of wind turbines: horizontal axis and vertical axis; Wind resource assessment and site selection for wind power plants, Wind farm layout optimization and wake effects, Grid integration and power system considerations for wind power plants</p> <p>Geothermal Energy Conversion: Principle of working, types of geothermal station with schematic diagram, geothermal plants in the world, problems associated with geothermal conversion, scope of geothermal energy.</p>			
Module-4			
Tidal Power: Tides and waves as energy suppliers and their mechanics; fundamental characteristics of tidal power, harnessing tidal energy, advantages and limitations.			
Ocean Thermal Energy Conversion: Principle of working, OTEC power stations in the world, problems associated with OTEC.			

Module-5

Biomass Power Plants: Biomass as a renewable energy source: types and characteristics, Conversion technologies: combustion, gasification, and anaerobic digestion, biomass feedstock selection and availability, Environmental impacts and sustainability of biomass power plants, Integration of biomass power plants with other energy systems

Hydrogen Energy: Properties of Hydrogen with respect to its utilization as a renewable form of energy, sources of hydrogen, production of hydrogen, electrolysis of water, thermal decomposition of water, chemical production bio-chemical production.

Course outcome (Course Skill Set)

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

1. Understand the need of renewable energy resources, historical and latest developments.
2. Describe the use of solar energy and the various components used in the energy production
3. Appreciate the need of Wind Energy and the various components used in energy generation and the classifications.
4. Acquire the knowledge of fuel cells, wave power, tidal power and geothermal principles and Applications.
5. Understand the concept of Biomass energy resources and their classification, types of biogas Plants 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 Evaluation:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 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 assessment methods mentioned in the 220B4.2, 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 for a total of 50 marks.

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. Nonconventional Energy sources, G D Rai, Khanna Publication, Fourth Edition,
2. Energy Technology, S.Rao and Dr. B.B. Parulekar, Khanna Publication. Solar energy, Subhas P Sukhatme, TataMcGrawHill, 2ndEdition,1996
3. Principles of Energy conversion, A.W.Culp Jr. McGraw Hill, 1996
4. 4. Non-Convention Energy Resources, ShobhNath Singh, Pearson, 2018

Web links and Video Lectures (e-Resources):

- <https://www.investopedia.com/terms/i/internet-energy>
- E-book URL: <https://www.pdfdrive.com/non-conventional-energy-sources-e10086374.html>
- E-book URL: <https://www.pdfdrive.com/non-conventional-energy-systems-nptel-d17376903.html>
- E-book URL: <https://www.pdfdrive.com/renewable-energy-sources-and-their-applications-e33423592.html>
- E-book URL: <https://www.pdfdrive.com/lecture-notes-on-renewable-energy-sources-e34339149>.
- html https://onlinecourses.nptel.ac.in/noc18_ge09/preview

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

- Visit nearest power plants and know the principles of power production
- Seminar/poster presentation of all Renewable power plants
- Assignments
- quiz

Introduction to MECHATRONICS		Semester	6 th
Course Code	BME654C	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. To acquire a strong foundation in science and focus in mechanical, electronics, control, software, and computer engineering, and a solid command of the newest technologies. 2. To understand the evolution and development of Mechatronics as a discipline. 3. To substantiate the need for interdisciplinary study in technology education 4. To understand the applications of microprocessors in various systems and to know the functions of each element. 5. To demonstrate the integration philosophy in view of Mechatronics technology 6. To be able to work efficiently in multidisciplinary teams.			
Teaching-Learning Process (General Instructions): These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes. 1. Adopt different types of teaching methods to develop the outcomes through PowerPoint Presentations and Video demonstrations or Simulations. 2. Chalk and Talk method for Problem Solving. 3. Arrange visits to show the live working models other than laboratory topics. 4. Adopt collaborative (Group Learning) Learning in the class. 5. Adopt Problem Based Learning (PBL), which fosters students' Analytical skills and develops thinking skills such as evaluating, generalizing, and analyzing information.			
Module-1			
Introduction: Scope and elements of Mechatronics, Mechatronics design process, measurement system, requirements and types of control systems, feedback principle, Basic elements of feedback control systems, Classification of control system. Examples of Mechatronics Systems such as Automatic Car Park system, Engine management system, Antilock braking system (ABS) control, Automatic washing machine. Transducers and sensors: Definition and classification of transducers, Difference between transducer and sensor, Definition and classification of sensors, Principle of working and applications of light sensors, Potentiometers, LVDT, Capacitance sensors, force and pressure sensors, Strain gauges, temperature sensors, proximity switches and Hall Effect sensors.			
Module-2			
Signal Conditioning: Introduction – Hardware – Digital I/O, Analog to digital conversions, resolution, Filtering Noise using passive components – Registers, capacitors, amplifying signals using OP amps. Digital Signal Processing – Digital to Analog conversion, Low pass, high pass, notch filtering. Data acquisition systems DAQS), data loggers, Supervisory control and data acquisition (SCADA), Communication methods. Electro Mechanical Drives: Relays and Solenoids – Stepper Motors – DC brushed motors – DC brushless motors – DC servo motors – 4-quadrant servo drives, PWM's – Pulse Width Modulation.			
Module-3			
Microprocessor & Microcontrollers: Introduction, Microprocessor systems, Basic elements of control systems, Microcontrollers, Difference between Microprocessor and Microcontrollers. Microprocessor Architecture: Microprocessor architecture and terminology-CPU, memory and address, I/O and Peripheral devices, ALU, Instruction and Program, Assembler, Data Registers, Program Counter, Flags, Fetch cycle, write cycle, state, bus interrupts. Intel's 8085A Microprocessor.			
Module-4			
Programmable Logic Controller: Introduction to PLCs, Basic structure of PLC, Principle of operation, input and output processing, PLC programming language, ladder diagram, ladder diagrams circuits, timer counters, internal relays, master control, jump control, shift registers, data			

handling, and manipulations, analogue input and output, selection of PLC for application.

Application of PLC control: Extending and retracting a pneumatic piston using latches, control of two pneumatic pistons, control of process motor, control of vibrating machine, control of process tank, control of conveyer motor etc.

Module-5

Mechatronics in Computer Numerical Control (CNC) machines: Design of modern CNC machines – Machine Elements: Different types of guide ways, Linear Motion guide ways. Bearings: anti-friction bearings, hydrostatic bearing and hydrodynamic bearing. Re-circulating ball screws. Typical elements of open and closed loop control systems. Adaptive controllers for machine tools.

Mechatronics Design process: Stages of design process – Traditional and Mechatronics design concepts – Case studies of Mechatronics systems – Pick and place Robot – Automatic car park barrier.

Course outcome (Course Skill Set)

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

CO1: Illustrate various components of Mechatronics systems.

CO2: Assess various control systems used in automation.

CO3: Design and conduct experiments to evaluate the performance of a Mechatronics system or Component with respect to specifications, as well as to analyse and interpret data.

CO4: Apply the principles of Mechatronics design to product design.

CO5: Function effectively as members of multidisciplinary teams.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) 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 22OB4.2, 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. Mechatronics System Design by Devdas Shetty and Richard A Kolk, Second edition, Thomson Learning Publishing
2. Company, Vikas publishing house, 2001.
3. W. Bolton, "Mechatronics" - Addison Wesley Longman Publication, 1999.
4. Shetty and Kolk "Mechatronics System Design" - Cengage Learning, 2010

Web links and Video Lectures (e-Resources):

- <https://nptel.ac.in>

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

- Quiz
- Presentations
- Group Activity

MODERN MOBILITY		Semester	VI
Course Code	BME654D	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 nature (SEE)	Theory/practical/Viva-Voce /Term-work/Others		
Course objectives: <ul style="list-style-type: none">To understand the different chassis design & main components of automobileTo understand the working of transmission and control system employed in automobilesTo understand the automotive pollution and alternative automotive technologies under trailTo understand the upcoming electric vehicle technology			
Teaching-Learning Process (General Instructions) <p>These are sample Strategies; which teachers can use to accelerate the attainment of the various course outcomes.</p> <ul style="list-style-type: none">Explain clearly through Power Point presentationsshowing live Videos for working of componentsDemonstration of live working of components through cut section modelsInspecting live vehiclesVisiting nearby service centresExpert Talks			
Module-1 Mobility Systems			
History of Automobile, Classification of Automobile w.r.t Usage, Chassis, Body, Power Sources, capacity, main components of Internal Combustion Engines and their Functions, Modern Fuel supply system, Cooling System, Lubrication System & Ignition System, Engine Management System.			
Module-2 Power Transmission			
Clutches; Plate Clutches, Cone Clutch, Centrifugal Clutch, Fluid Flywheel Gear Box; Gear Shifting mechanism, synchromesh Gear box, Torque converter, Automatic Manual Transmission (AMT), Automatic Transmission (AT), Continuously Variable Transmission (CVT), Infinitely Variable Transmission (IVT)& IMT, Working of Differential. Types Of Tyres- Radial & Conventional, Tubeless Tyres, Tubed Tyres- Puncture patching			
Module-3 Direction Control & Braking			
Steering system- mechanisms & Linkages, Steering gear boxes- Rack & pinion, worm & wheel construction & working, power Steering construction & working, steering geometry, Wheel balancing Braking System- Mechanism and Linkages; Mechanical Brakes, Hydraulic Brakes, Power Brakes, Parking brakes, ABS Suspension – layout & working of Hydraulic& Air suspension, independent suspension			
Module-4 Exhaust Emission & Alternate Sources			
Exhaust gas pollutants and their effects on environment, Emission norms, IC engine fuel types, extraction& availability, BIOFUELS – Production and impact. Ethanol engines, CNG vehicles- operation, advantages			

& disadvantages, overview of Hydrogen - fuel cell vehicles, advantages & disadvantages, IC engine/ electric hybrid vehicles overview, layout, transmission & control system, solar powered vehicles- wind powered vehicles, super capacitors, supply rails

Module-5 Electrical Vehicles

Electric vehicles principle and components- layout of two & 4-wheeler, Motors used in Electric vehicles –types- overview of construction and working, power transmission & control system in Electric vehicles. Batteries – construction & working principle of Lead acid, nickel based, sodium based, Lithium & Metal Air batteries. Battery charging types and requirements

Course outcome (Course Skill Set)

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

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

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50) 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 of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

Continuous Internal Evaluation:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 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 assessment methods mentioned in the 22OB4.2, 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 for a total of 50 marks.

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**

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

Web links and Video Lectures (e-Resources):

- <https://archive.nptel.ac.in/courses/107/106/107106088/>
- https://onlinecourses.nptel.ac.in/noc20_de06/preview
- <https://www.digimat.in/nptel/courses/video/107106088/L01.html>
- <https://nptel.ac.in/courses/107106088>
- https://www.youtube.com/watch?v=LZ82iANWBL0&list=PLbMVogVj5nJTW50jj9_gvJmdwFWHaqR5J

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

- Operate the cut section models of complete vehicle chassis and observe the working of all components
- Dismantle & Assemble the Automotive Engine, Gear Box, Clutch, brakes
- Prepare the posters of automobile chassis & display
- Visit nearby automobile showrooms/ service station
- Prepare a comparison statement of different automobiles using specification provided by respective manufacturers
- Visit auto expo

Basics of Matlab		Semester	6 th
Course Code	BME657A	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2*:0	SEE Marks	50
Total Hours of Pedagogy	12-14 sessions	Total Marks	100
Credits	01	Exam Hours	03
Examination nature (SEE)	Practical		
* Additional one hour may be considered for instructions, if required			
Course objectives: <ul style="list-style-type: none">To know about fundamentals of MATLAB tool.To provide an overview to program curve fitting & solve Linear and Nonlinear Equations.To understand the concept and importance of Fourier transforms.To gain knowledge about MATLAB Simulink & solve engineering problems.			
Sl.NO	Experiments		
1	Introduction to MATLAB Programming: Basics of MATLAB Programming, array operations in MATLAB, loops and execution of control, working with files: Scripts and functions, plotting and programming output, examples.		
2			
3	Numerical Methods and their applications: Curve Fitting: Straight line fit, Polynomial fit.		
4			
5	Numerical Integration and Differentiation: Trapezoidal method, Simpson method.		
6			
7	Linear and Nonlinear Equations: Eigen values, Eigen vectors, Solution of linear algebraic equations using Gauss Elimination and LU decomposition, Solution of nonlinear equation in single variable using Gauss-Siedal and Newton-Raphson method.		
8			
9	Ordinary Differential Equations: Introduction to ODE's, Euler's method, second order RungeKutta method, MATLAB ode45 algorithm in single variable and multivariable. Transforms: Discrete Fourier Transforms,		
10			
11	Application of MATLAB to analyse problems in basic engineering mechanics, mechanical vibrations, control system, statistics and dynamics of different circuits.		
12	MATLAB Simulink: Introduction to MATLAB Simulink, Simulink libraries, development of basic models in Simscape Power Systems		
Course outcomes (Course Skill Set): At the end of the course the student will be able to: <ul style="list-style-type: none">Implement loops, branching, control instruction and functions in MATLAB programming environment.Programming for curve fitting, numerical differentiation and integration, solution of linear equations in MATLAB and solve engineering problems.Understand implementation of ODE using ode 45 and execute Solutions of nonlinear equations and DFT in MATLAB.Simulate MATLAB Simulink examples.			
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 (CIE):

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

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

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

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

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

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

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

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

Text Books:

1. Agam Kumar Tyagi, "**MATLAB and Simulink for Engineers**", OXFORD Higher Education.
2. Dr. Shailendra Jain, "**Modelling & Simulation using MATLAB – Simulink**", Wiley – India.

Reference Books:

1. Won Y.Tang, Wemun Cao, Tae-Sang Ching and John Morris, "**Applied Numerical Methods Using MATLAB**", A John Wiley & Sons.
2. Steven T. Karris, "**Introduction to Simulink with Engineering Applications**", Orchard Publications.

Fundamental of Virtual Reality ARP Development		Semester	VI
Course Code	BME657B	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	1:0:0:0	SEE Marks	50
Total Hours of Pedagogy	15 Hrs	Total Marks	100
Credits	01	Exam Hours	1
Examination type (SEE)	Theory		
Course objectives: <ul style="list-style-type: none">• Describe how VR systems work and list the applications of VR.• Understand the design and implementation of the hardware that enables VR systems to be built.• Understand the system of human vision and its implication on perception and rendering.• Explain the concepts of motion and tracking in VR systems.• Describe the importance of interaction and audio in VR systems.			
Teaching-Learning Process (General Instructions) <p>These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.</p> <ul style="list-style-type: none">• Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.• Chalk and Talk method for Problem Solving.• Adopt flipped classroom teaching method.• Adopt collaborative (Group Learning) learning in the class.• Adopt Problem Based Learning (PBL), which fosters students’ analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.			
Module-1			
Introduction to Virtual Reality: Defining Virtual Reality, History of VR, Human Physiology and Perception, Key Elements of Virtual Reality Experience, Virtual Reality System, Interface to the Virtual World-Input & output- Visual, Aural & Haptic Displays, Applications of Virtual Reality.			
Module-2			
Representing the Virtual World : Representation of the Virtual World, Visual Representation in VR, Aural Representation in VR and Haptic Representation in VR			
Module-3			
The Geometry of Virtual Worlds &The Physiology of Human Vision: Geometric Models, Changing Position and Orientation, Axis-Angle Representations of Rotation, Viewing Transformations, Chaining the Transformations, Human Eye, eye movements & implications for VR.			
Module-4			
Visual Perception & Rendering: Visual Perception - Perception of Depth, Perception of Motion, Perception of Color, Combining Sources of Information Visual Rendering -Ray Tracing and Shading Models, Rasterization, Correcting Optical Distortions, Improving Latency and Frame Rates.			
Module-5			
Motion & Tracking: Motion in Real and Virtual Worlds- Velocities and Accelerations, The Vestibular System, Physics in the Virtual World, Mismatched Motion and Vection Tracking- Tracking 2D & 3D Orientation, Tracking Position and Orientation, Tracking Attached Bodies			

Course outcome (Course Skill Set)

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

CO1: Describe how VR systems work and list the applications of VR.

CO2: Understand the design and implementation of the hardware that enables VR systems to be built.

CO3: Understand the system of human vision and its implication on perception and rendering.

CO4: Explain the concepts of motion and tracking in VR systems.

CO5: Describe the importance of interaction and audio in VR 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)

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 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 assessment methods mentioned in the 22OB4.2, 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 for a total of 50 marks..

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****Text Books**

1. Virtual Reality, Steven M. LaValle, Cambridge University Press, 2016
2. Understanding Virtual Reality: Interface, Application and Design, William R Sherman and Alan B Craig, (The Morgan Kaufmann Series in Computer Graphics)". Morgan Kaufmann Publishers, San Francisco, CA, 2002
3. Developing Virtual Reality Applications: Foundations of Effective Design, Alan B Craig, William R Sherman and Jeffrey D Will, Morgan Kaufmann, 2009.

Reference Books:

1. Gerard Jounghyun Kim, "Designing Virtual Systems: The Structured Approach", 2005.
2. Doug A Bowman, Ernest Kuijff, Joseph J LaViola, Jr and Ivan Poupyrev, "3D User Interfaces, Theory and Practice", Addison Wesley, USA, 2005.
3. Oliver Bimber and Ramesh Raskar, "Spatial Augmented Reality: Merging Real and Virtual Worlds", 2005.
4. Burdea, Grigore C and Philippe Coiffet, "Virtual Reality Technology", Wiley Interscience, India, 2003.

Web links and Video Lectures (e-Resources):

<http://lavallo.pl/vr/book.html>
<https://nptel.ac.in/courses/106/106/106106138/>
<https://www.coursera.org/learn/introduction-virtual-reality>.

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

- Course Seminars

Simulation and Analysis using Ansys workbench		Semester	6 th
Course Code	BME657C	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2:0	SEE Marks	50
Total Hours of Pedagogy	12 sessions	Total Marks	100
Credits	01	Exam hours	3
Examination nature (SEE)	Practical		
Course objectives:			
<div>1. General understanding of the user interface, as related to geometry import, meshing, application of loads and supports, and postprocessing</div> <div>2. Procedure for performing FEA simulations, including linear static, modal, and harmonic structural analyses and nonlinear steady-state thermal analyses</div> <div>3. Utilizing parameters for ‘what-if’ scenarios</div> <div>4. To launch the individual software components and used to transfer data between them.</div> <div>5. To see at-a-glance how a model has been built, and determine which files were used for a particular simulation (pairing geometry files to solver runs)</div> <div>6. To perform parametric analyses (without the user needing to manually launch each application in turn) and makes it easy to simulate Multiphysics scenarios like fluid-structure interaction.</div>			
SLNO	Experiments		
1	Bars of constant cross section area, tapered cross section area and stepped bar.		
2	Trusses		
3	Beams and (Simply supported, cantilever, beams with UDL, and beams with varying load etc.)		
4	Frames		
5	Stress analysis of a rectangular plate with a circular hole, axisymmetric problems.		
6	Thermal Analysis -2D problem with conduction and convection boundary conditions		
7	Fluid flow Analysis -Potential distribution in the 2 -D bodies		
8	Magnetostatic: – Perform various magnetic field analyses.		
	Demonstration Experiments (For CIE)		
9	Electrical: – Simulate electrical devices such as motors, solenoids,		
10	Fixed -fixed beam for natural frequency determination		
11	Bar subjected to forcing function		
12	Fixed -fixed beam subjected to forcing function		
Course outcomes (Course Skill Set):			
At the end of the course the student will be able to			
<div>1. Covers fundamentals and practical knowledge of finite element modelling and simulation</div> <div>2. Uses ANSYS Workbench as the FEA environment Describes simulation case studies demonstrated in a step-by-step fashion Includes a web-based geometry input CAD files for ANSYS Workbench examples Covers the analyses of trusses, beams, frames, plane stress and plane strain problems, plates and shells, three-dimensional design components, and assembly structures</div> <div>3. APPLY basics of Theory of Elasticity to continuum problems.</div> <div>4. FORMULATE finite elements like bar, truss and beam elements for linear static structural analysis. FORMULATE 2D and axisymmetric finite elements.</div> <div>5. Develop finite element equations for 1D heat transfer elements and solve numericals.</div> <div>6. Apply finite element simulation tool to solve practical problems (Lab and Self-study).</div>			

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 (CIE):

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

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

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

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

Semester End Evaluation (SEE):

- SEE marks for the practical course are 50 Marks.
- SEE shall be conducted jointly by the two examiners of the same institute, examiners are appointed by the Head of the Institute.
- The examination schedule and names of examiners are informed to the university before the conduction of the examination. These practical examinations are to be conducted between the schedule mentioned in the academic calendar of the University.
- All laboratory experiments are to be included for practical examination.
- (Rubrics) Breakup of marks and the instructions printed on the cover page of the answer script to be strictly adhered to by the examiners. **OR** based on the course requirement evaluation rubrics shall be decided jointly by examiners.
- Students can pick one question (experiment) from the questions lot prepared by the examiners jointly.
- Evaluation of test write-up/ conduction procedure and result/viva will be conducted jointly by examiners.

General rubrics suggested for SEE are mentioned here, writeup-20%, Conduction procedure and result in -60%, Viva-voce 20% of maximum marks. SEE for practical shall be evaluated for 100 marks and

scored marks shall be scaled down to 50 marks (however, based on course type, rubrics shall be decided by the examiners)

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

The minimum duration of SEE is 02 hours

Suggested Learning Resources:

1. www.ansys.com
2. www.mece.ualberta.ca/tutorials/ansys
3. <http://mae.uta.edu/~lawrence/>
4. <http://expertfea.com/tutorials.html>

Introduction Augmented Reality		Semester	6 th
Course Code	BME657D	CIE Marks	50
Teaching Hours/Week (L: T:P: S)	0:2:0:0	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	100
Credits	01	Exam Hours	01
Examination nature (SEE)	Theory		
Course objectives: <ul style="list-style-type: none">• Describe how AR systems work and list the applications of AR.• Understand and analyse the hardware requirement of AR.• Use computer vision concepts for AR and describe AR techniques• Analyse and understand the working of various state of the art AR devices• Acquire knowledge of mixed reality			
Teaching-Learning Process (General Instructions) <p>These are sample Strategies, which teachers can use to accelerate the attainment of the various course outcomes.</p> <ul style="list-style-type: none">• Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.• Chalk and Talk method for Problem Solving.• Adopt flipped classroom teaching method.• Adopt collaborative (Group Learning) learning in the class.• Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.			
Module-1			
Introduction to Augmented Reality (A.R): Defining augmented reality, history of augmented reality, The Relationship between Augmented Reality and Other Technologies-Media, Technologies, Other Ideas Related to the Spectrum between Real and Virtual Worlds, applications of augmented reality			
Augmented Reality Concepts: Concepts Related to Augmented Reality, Ingredients of an Augmented Reality Experience.			
Module-2			
Augmented Reality Hardware: Augmented Reality Hardware – Displays – Audio Displays, Haptic Displays, Visual Displays, Other sensory displays, Visual Perception, Requirements and Characteristics, Spatial Display Model. Processors – Role of Processors, Processor System Architecture, Processor Specifications. Tracking & Sensors - Tracking, Calibration, and Registration, Characteristics of Tracking Technology, Stationary Tracking Systems, Mobile Sensors, Optical Tracking, Sensor Fusion.			
Module-3			
Computer Vision for Augmented Reality & A.R. Software: Computer Vision for Augmented Reality - Marker Tracking, Multiple-Camera Infrared Tracking, Natural Feature Tracking by Detection, Simultaneous Localization and Mapping, Outdoor Tracking Augmented Reality Software - Introduction, Major Software Components for Augmented Reality Systems, Software used to Create Content for the Augmented Reality Application.			
Module-4			
AR Techniques- Marker based & Marker less tracking: Marker-based approach- Introduction to marker-based tracking, types of markers, marker camera pose and identification, visual tracking, mathematical representation of matrix multiplication			

Marker types- Template markers, 2D barcode markers, imperceptible markers. Marker-less approach- Localization based augmentation, real world examples Tracking methods- Visual tracking, feature based tracking, hybrid tracking, and initialization and recovery.

Module-5

AR Devices & Components: AR Components – Scene Generator, Tracking system, monitoring system, display, Game scene

AR Devices – Optical See-through HMD, Virtual retinal systems, Monitor bases systems, Projection displays, and Video see-through systems

Course outcome (Course Skill Set)

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

- C01** : Describe how AR systems work and list the applications of AR.
- C02** : Understand and analyse the hardware requirement of AR.
- C03** : Apply computer vision concepts for AR and describe AR techniques
- C04** : Analyse and understand the working of various state of the art AR devices
- C05** : Explain the knowledge acquired on mixed reality

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:

- The CIE is the sum of Average of Two Internal Assessment Tests each of 25 marks and Any two Assessment methods for 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 assessment methods mentioned in the 22OB4.2, 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 for a total of 50 marks.

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

Suggested Learning Resources:**Books**

1. Allan Fowler-AR Game Development||, 1st Edition, A press Publications, 2018, ISBN 978-1484236178
2. Augmented Reality: Principles & Practice by Schmalstieg / Hollerer, Pearson Education India; First edition (12 October 2016),ISBN-10: 9332578494

Reference Books:

1. Designing for Mixed Reality, Kharis O'Connell Published by O'Reilly Media, Inc., 2016, ISBN: 9781491962381
2. Sanni Siltanen- Theory and applications of marker-based augmented reality. Julkaisija – Utgivare Publisher. 2012. ISBN 978-951-38-7449-0

Web links and Video Lectures (e-Resources):

- <https://www.vttresearch.com/sites/default/files/pdf/science/2012/S3.pdf>
- <https://docs.microsoft.com/en-us/windows/mixed-reality/>
- <https://docs.microsoft.com/en-us/archive/msdn-magazine/2016/november/hololensintroduction-to-the-hololens>

MOOC Courses:

- <https://www.coursera.org/learn/ar>
- <https://www.udemy.com/share/101XPi/>

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

- Course seminar
- Term project



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