04.08.23

AIRCRAFT MATERIALS AND PROCESSES		Semester	III
Course Code	**BAE301**	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: This course will enable students to

- Acquire knowledge of different aerospace materials & their properties.
- Understand the Heat Treatment processes of aircraft metals and alloys
- Characteristics and Applications of Aluminium alloys, Ceramics, Composites and Material Testing.

Teaching-Learning Process (General Instructions)

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

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

Module-1

Mechanical Behavior of Engineering Materials: Introduction to aerospace materials and their classification, Linear and non-linear elastic properties- Stress and Strain Curves-Yielding and strain Hardening, Toughness-Modules of resilience-Bauchinger's effect-Effect of notches-Testing and flaw detection of materials and components, knowledge of various material testing machines.

Module-2

Non-ferrous materials in aircraft construction: Aluminium and its alloys: Types and identification. Properties -Castings-Heat treatment processes –Surface treatments.

Magnesium and its alloys: Cast and Wrought alloys-Aircraft application, features specification, fabrication problems, Special treatments.

Titanium and its alloys: Applications, machining, forming, welding and heat treatment, Copper Alloys.

Wood and fabric in aircraft construction and specifications- Glues Use of glass, plastics & rubber in aircraft, Introduction to glass & carbon composite.

Module-3

Ferrous materials in aircraft construction: Steels: Plain and low carbon steels, various low alloy steels, aircraft steel specifications, corrosion and heat resistant steels, structural applications.

Maraging Steels: Properties and Applications.

Super Alloys: Use -Nickel base- Cobalt base- Iron base -Forging and Casting of Super alloys-Welding, Heat treatment.

Module-4

Ceramics and Composites: Introduction, modern ceramic materials, cermets, glass ceramic, production of semi-fabricated forms, Carbon/Carbon composites, Fabrication processes and its aerospace applications involved in metal matrix composites, polymer composites.

Module-5

Material Testing: Corrosion, its detection and prevention. Protective finishes. Testing: Destructive and non - destructive testing techniques. Crack detection, inspection of parts by hot oil and chalk, dye-penetrate, fluorescent and magnetic particles, X-ray, ultrasonic, eddy current and acoustic emission methods.

Course outcome (Course Skill Set)

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

1. Apply the knowledge about the mechanical behaviour of different aircraft & aerospace materials.
2. Explain the applications of Aluminium alloys, Ceramics and Composites Materials.
3. Evaluate the importance of high temperature materials and their characterization.

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

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

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

Semester-End Examination:

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

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

Suggested Learning Resources:

Books

1. Titterton GF, Aircraft Material and Processes, English Book Store, New Delhi, 5th edition,1998, ISBN-13: 978-8175980136
2. H Buhl, Advanced Aerospace Materials, Springer, Berlin 1992, ISBN-13: 978-3540558880.

Reference Books

1. Balram Gupta, Aerospace material Vol.1,2,3,4 ARDB, S Chand & Co , 2009, ISBN-13: 978-8121922005.
2. Parker ER, Materials for Missiles and Space, McGraw-Hill Inc., US, 1963.
3. Hill ET, The Materials of Aircraft Construction, Pitman London.
4. CG Krishnadas Nair, Hand book of Aircraft materials, Interline publishers, Bangalore, 1993
5. King and Butler, Principles of Engineering Inspection, Clever Humes Press.

Web links and Video Lectures (e-Resources):

- https://www.soaneemrana.org/onewebmedia/AIRCRAFT%20MATERIALS%20AND%20PROCESSES%20BY%20GEORGE%20F.%20TITTERTON.pdf
- https://nptel.ac.in/courses/101104010

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

- Experimentation – gathering knowledge through experience through lab.
- Exploration – gathering knowledge and attaining skills through active investigation.
- Expression – encouraging students to express their views through visual presentations.

ELEMENTS OF AERONAUTICS		Semester	3
Course Code	**BAE302**	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: This course will enable students to

- To know the history and basic principle of aviation.
- To understand the foundation of flight, aircraft structures, material aircraft propulsion.
- To develop an understanding stability of an aircraft along with its different systems.

Teaching-Learning Process (General Instructions)

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

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

MODULE-1

Introduction to Aircrafts

History of aviation; Atmosphere and its properties; Classification of aircrafts; Basic components of an aircraft; aircraft axis system; aircraft motions; control surfaces and high lift devices; conventional design configurations; principle of operation of each major part; Helicopters, their parts and functions.

Aircraft Structures and Materials:

Introduction; structural members; general types of construction; monocoque, semi-monocoque and geodesic structures; typical wing and fuselage structure; metallic and non-metallic materials for aircraft application.

MODULE-2

Basic principles of flight – significance of speed of sound; airspeed and groundspeed; standard atmosphere; Bernoulli's theorem and its application for generation of lift and measurement of airspeed; forces over wing section, airfoil nomenclature, pressure distribution over a wing section. Lift and drag components – generation of lift and drag; lift curve, drag curve, types of drag, factors affecting lift and drag; center of pressure and its significance; aerodynamic center, aspect ratio, Mach number and supersonic flight effects; simple problems on lift and drag.

MODULE-3

Aircraft Propulsion:

Aircraft power plants, classification based on power plant and location and principle of operation. Turboprop, turbojet and turbofan engines; ramjets and scramjets; performance characteristics. Aircraft power plants – basic principles of piston, turboprop and jet engines; Brayton cycle and its application to gas turbine engines; use of propellers and jets for production of thrust; comparative merits and limitations of different types of propulsion engines; principle of thrust augmentation.

MODULE-4

Aircraft Stability:

Forces on an aircraft in flight; static and dynamic stability; longitudinal, lateral and roll stability; necessary conditions for longitudinal stability; basics of aircraft control systems. Effect of flaps and slats on lift, control tabs, stalling, gliding, landing, turning, aircraft maneuvers; stalling, gliding, turning. Simple problems on these. Performance of aircraft – power curves, maximum and minimum speeds for horizontal flight at a given altitude; effect of changes in engine power and altitude on performance; correct and incorrect angles of bank; aerobatics, inverted maneuvers, maneuverability. Simple problems.

MODULE-5

Introduction to Aircraft Systems:

Aircraft systems (Mechanical) – hydraulic and pneumatic systems and their applications; environment control system; fuel system, oxygen system.

Aircraft systems (Electrical) – flight control system, cockpit instrumentation and displays; communication systems; navigation systems; power generation systems – engine driven alternators, auxiliary power Module,

ram air turbine; power conversion, distribution and management.

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Create a paper plane model and calculate the Range and Endurance of the same.
2	Sketching the detailed configuration of Aircraft(Fighter or Commercial)
3	Fabrication on types of wing configuration-Foam or Balsa wood
4	Fabrication of glider using balsa wood (unpowered)
5	Calculate the CG of the modelled Glider & Assessing the aerodynamic performance parameter i.e. Range & Endurance
6	Flight testing on the gliders (belly landing)
7	Design & Fabrication of Ornithopter
8	Design & Fabrication of Lighter Than Air Concepts (Para Gliding)
	Demonstration Experiments (For CIE)
9	**Visualization on the concept of landing**
10	**Sugar candy solid propellant**
11	**Design & Fabrication of powered gliders**
12	**Case Study on Aircraft Crash Investigation**

Course outcomes (Course Skill Set):

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

- Appreciate and apply the basic principle of aviation.
- Apply the concepts of fundaments of flight, basics of aircraft structures, aircraft propulsion and aircraft materials during the development of an aircraft.
- Comprehend the complexities involved during development of flight vehicles.

Assessment Details (both CIE and SEE)

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

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. **John D. Anderson**, "Introduction to Flight", McGraw-Hill Education, 8th edition, 2015, ISBN: 978-0078027673.
2. **Lalit Gupta and O P Sharma**, Fundamentals of Flight Vol-I to Vol-IV, Himalayan Books. 2006, ISBN: 9788170020752

Reference Books

1. **A.C. Kermode**, "Flight without formulae", Pearson Education India, 1989. ISBN: 9788131713891.
2. **Nelson R.C.,** "Flight stability and automatic control", McGraw-Hill International Editions, 1998. ISBN 9780071158381.
3. **Ian Moir, Allan Seabridge,** "Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration", John Wiley & Sons, 2011, ISBN: 978111965006.

Web links and Video Lectures (e-Resources):

- **https://www.digimat.in/nptel/courses/video/101104061/L01.html**

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

- Experimentation – gathering knowledge through experience through lab.
- Exploration – gathering knowledge and attaining skills through active investigation.
- Expression – encouraging students to express their views through visual presentations.

FLUID MECHANICS		Semester	3
Course Code	**BAE303/BAS303**	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/Practical**		

Course objectives: This course will enable students to

- Understand the basic fluid properties.
- Understand the governing laws of fluid flow.
- Acquire the knowledge of types of fluid flows.

Teaching-Learning Process (General Instructions)

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

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

MODULE-1

Basic Considerations:

Introduction, Dimensions- Modules and physical quantities, Continuum view of gases and liquids, Pressure and Temperature scales, Physical properties of fluids.

Fluid Statics:

Pressure distribution in a static fluid, Pressure and its measurement, hydrostatic forces on plane and curved surfaces, buoyancy, illustration by examples.

MODULE-2

Fluids in motion:

Methods of describing fluid motion, types of fluid flow, continuity equation in 3 dimensions, velocity potential function and stream function. Types of motion, Source sink, doublet, plotting of stream lines and potential lines Numerical problems.

Fluid Kinematics:

Kinematics of fluid motion and the constitutive equations, Integral (global) form of conservation equations (mass, momentum, energy) and applications, Differential form of conservation equations (continuity, Navier-Stokes equations, energy equation).

MODULE-3

Fluid Dynamics:

Equations of motion: Euler's and Bernoulli's equation of motion for ideal and real fluids. Momentum equation, Fluid flow measurements. Numerical problems.

Dimensional analysis and similarity:

Dimensional homogeneity, methods of dimensional analysis, model analysis, types of similarity and similitude. Dimensionless numbers. Model laws. Numerical problems.

MODULE-4

Flow past Immersed bodies:

Introduction to boundary layer, boundary layer thickness, Karman's integral momentum theory, drag on a flat plate for laminar and turbulent flow, Drag on immersed bodies. Expression for drag and lift. Kutta –Joukowsky theorem; Fundamentals of aerofoil theory, Numerical problems.

MODULE-5

Compressible flow and Boundary Layers theory:

Steady, one-dimensional gas dynamics, Propagation of pressure waves in a compressible medium, velocity of sound, Mach number, Mach cone, Stagnation properties, Bernoulli's equation for isentropic flow, normal shock waves. Numerical Problem; Laminar and turbulent boundary layers.

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Calibration of Venturimeter.
2	Determination of discharge of a given Pipe Flow using Venturimeter/Orifice meter.
3	Determination of Coefficient of discharge for a small orifice by a constant head method.
4	Determination of Coefficient of discharge for a small orifice by a variable head method.
5	Determination of Viscosity of a Fluid.
6	Calibration of contracted Rectangular Notch.
7	Verification of Bernoulli's equation.
8	Pipe friction apparatus with loss of head on pipe fittings.
9	Determination of Coefficient of loss of head in a sudden contraction and friction factor.
10	Estimation of Major loss/Minor losses for a given flow system.
11	Determination of state of flow in a closed conduit using Reynolds Experiment.
12	Impact of Jet over a flat surface.

Course outcomes (Course Skill Set):

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

- Evaluate the effect of fluid properties.
- Apply the governing laws of fluid flow.
- Classify different types of fluid flows.

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 scoredby 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. Bansal, R.K, "Fluid Mechanics and Hydraulics Machines", Laxmi Publications (P) Ltd., New Delhi 2015,ISBN-13: 978-8131808153.
2. Radhakrishnan. E, "Fluid Mechanics", Prentice-Hall of India Pvt. Ltd, 2010, ISBN 13: 9788120331839.

Reference Books

1. Yunus A. Cengel& John M Cimbala, Fluid Mechanics and Applications, McGraw Hill Education; 3rd edition, 2013, ISBN-13: 978-0073380322.
2. Ramamritham. S "Hydraulic Fluid Mechanics and Fluid Machines", Dhanpat Rai&Sons, Delhi, 1988, ISBN 13: 9788187433804.
3. Kumar. K.L., "Engineering Fluid Mechanics" (VII Ed.) Eurasia Publishing House (P) Ltd., New Delhi, 1995, ISBN 13: 9788121901000.
4. Streeter. V. L., and Wylie, E.B., "Fluid Mechanics", McGraw Hill, 1983, ISBN 13: 9780070665781

Web links and Video Lectures (e-Resources):

- **https://home.iitk.ac.in/~nikhilk/Book.pdf**
- **https://nptel.ac.in/courses/112104118**
- **https://nptel.ac.in/courses/105101082**

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

- Experimentation – gathering knowledge through experience through lab.
- Exploration – gathering knowledge and attaining skills through active investigation.
- Expression – encouraging students to express their views through visual presentations.

MECHANICS OF MATERIALS		Semester	3
Course Code	**BAE304**	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: This course will enable students to

- Comprehend the basic concepts of strength of materials.
- Acquire the knowledge of stress, strain under different loadings.
- Understand the different failure theory.

Teaching-Learning Process (General Instructions)

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

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

Module-1

Basics of linear elasticity: The concept of stress& strain, state of stress & Strain at a point, Equilibrium equations, The state of plane stress and plane strain. Compatibility equations, Constitutive Laws (Hooke's Law), Stress-strain curves for brittle and ductile materials, Allowable stress, Material selection for structural performance.

Simple & Compound Stresses: Extension / Shortening of a bar, bars with cross sections varying in steps, bars with continuously varying cross sections. Elongation due to self-weight. Volumetric strain, expression for volumetric strain, elastic constants, simple shear stress, shear strain, temperature stresses, Introduction to Plane stress, stresses on inclined sections, principal stresses & strains, Analytical & graphical method (Mohr's Circle) to find principal stresses & strains.

Module-2

Bending Moment and Shear Force in Beams: Introduction, Types of beams, loads and reactions, shear forces and bending moments, rate of loading, sign conventions, relationship between shear force and bending moments. Shear force and bending moment diagrams for different beams subjected to concentrated loads, uniformly distributed load, (UDL) uniformly varying load (UVL) and couple for different types of beams.

Euler-Bernoulli beam theory: The Euler-Bernoulli assumptions, Implications of the Euler-Bernoulli assumptions, the Euler-Bernoulli Beam theory derivation, Bending stress equation, Moment carrying capacity of a section. Shearing stresses in beams, shear stress across rectangular, circular, symmetrical I and T sections (Only Numerical).

Module-3

Deflection of Beams: Introduction, Differential equation for deflection. Equations for deflection, slope and bending moment. Double integration method for cantilever and simply supported beams for point load, UDL, UVL and Couple. Macaulay's method.

Torsion of Circular Shafts and Elastic Stability of Columns: Introduction. Pure torsion, assumptions, derivation of torsional equations, polar modulus, torsional rigidity / stiffness of shafts. Power transmitted by solid and hollow circular shafts.

Module-4

Virtual work principles: Introduction, Equilibrium and work fundamentals, Principle of virtual work, Principle of virtual work applied to mechanical systems, Principle of virtual work applied to truss structures, Principle of virtual work applied to beams. Principle of complementary virtual work, internal virtual work in beams and solids.

Energy methods: Conservative forces, Principle of minimum total potential energy, Strain energy in springs, Strain energy in beams, Strain energy in solids, Applications to trusses, Development of a finite element formulation for trusses, Principle of minimum complementary, Energy theorems, Reciprocity theorems, Saint-

Venant's principle.

Module-5

Mechanical Properties of materials:
Fracture: Type I, Type II and Type III.

Creep: Description of the phenomenon with examples. Three stages of creep, creep properties, stress relaxation.
Fatigue: Types of fatigue loading with examples, Mechanism of fatigue, fatigue properties, fatigue testing and S-N diagram.

Course outcome (Course Skill Set)

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

1. Apply the basic concepts of strength of materials.
2. Compute stress, strain under different loadings.
3. Distinguish the different failure theories.

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

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

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

Semester-End Examination:

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

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

Suggested Learning Resources:
Books
Text Books

1. S.S. Bhavaikatii, "*Strength of Materials*", Vikas Publications House, New Delhi, 2012, ISBN-13: 978-8125927914.
2. S. Ramamrutham, R Narayanan, "*Strength of Materials"*, Dhanapath Rai Publishing Company, New Delhi,

2012, ISBN 13: 9789384378264

Reference Books

1. T.H.G Megson "*Introduction to Aircraft Structural Analysis*", Butterworth-Heinemann Publications, 2007, ISBN 13: 9781856179324
2. Beer .F.P. and Johnston .R, "*Mechanics of Materials*", McGraw Hill Publishers, 2006, ISBN-13:978-0073380285.
3. Timoshenko and Young "*Elements of Strength of Materials*', East-West Press, 1976, ISBN 10: 8176710199.
4. O.A. Bauchau and J.I. Craig "*Structural Analysis*" Springer Dordrecht Heidelberg London New York,ISBN 978-90-481-2515-9, e-ISBN 978-90-481-2516-6

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/105106172

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

- Experimentation – gathering knowledge through experience through lab.
- Exploration – gathering knowledge and attaining skills through active investigation.
- Expression – encouraging students to express their views through visual presentations.

Computer Aided Aircraft Drawing		Semester	3
Course Code	**BAEL305/BASL305**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2	SEE Marks	50
Credits	01	Exam Hours	100
Examination type (SEE)	Practical/Viva-Voce		

Course objectives: This course will enable students to

- Understand and interpret drawings of machine and aircraft components
- Prepare assembly drawings either manually or by using standard CAD packages.
- Familiarize with standard components and their assembly of an aircraft.

Sl.NO	Experiments
1	**Sections of Solids:** Sections of Pyramids, Prisms, Cubes, Tetrahedrons, Cones and Cylinders resting only on their bases (No problems on axis inclinations, spheres and hollow solids). True shape of sections.
2	**Orthographic Views:** Conversion of pictorial views into orthographic projections of simple machine parts with or without section. (Bureau of Indian Standards conventions are to be followed for the drawings) Hidden line conventions. Precedence of lines.
3	**Thread Forms:** Thread terminology, sectional views of threads. ISO Metric (Internal & External) BSW (Internal & External) square and Acme. Sellers thread, American Standard thread.
4	**Fasteners:** Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut. Flanged nut, slotted nut, taper and split pin for locking, counter sunk head screw, grub screw, Allen screw.
5	**Keys & Joints:** Parallel key, Taper key, Feather key, Gibhead key and Woodruff key.
6	**Riveted Joints:** Single and double riveted lap joints, butt joints with single/double cover straps (Chain and Zigzag, using snap head rivets). Cotter joint (socket and spigot), knuckle joint (pin joint) for two rods.
7	**Couplings:** Split Muff coupling, protected type flanged coupling, pin (bush) type flexible coupling, Oldham's coupling and universal coupling (Hooks' Joint)
8	Design of propeller and hub assembly.
9	Design of Landing Gear Assembly.
	Demonstration Experiments (For CIE)
10	Design of UAV
11	Design of fuselage.
12	Design of wing.

Course outcomes (Course Skill Set):

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

- Distinguish drawings of machine and aircraft components
- Identify assembly drawings either manually or by using standard CAD packages.
- Practise with standard components and their assembly of an aircraft.

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:

- https://transport.itu.edu.tr/docs/librariesprovider99/dersnotlari/dersnotlarires112e/not/cadd-1.pdf?sfvrsn=4

Introduction to Drone Technologies		Semester	3
Course Code	**BAE306A/ BAS306A**	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: This course will enable students to

- Comprehend the basic evolution of Drones / UAV systems.
- Acquire the knowledge of basic aerodynamics, performance, stability and control.
- Understand the propulsion, loads and structures.
- Understand Regulations and Certification aspects

Teaching-Learning Process (General Instructions)

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

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

Module-1

Basics: Introduction, History, UV types: UGV, UAV, USV, UUWV, Drones in India, Future scope.
Introduction to nano drones and Swarm Drones
Principles, Newton's Laws, Degrees of Freedom, Stick Movements, Flight Modes, Basic Manoeuvres, Take-off, Pitch, Roll, Yaw, Landing.

Module-2

Components and Systems: Basic components, Micro controllers, microprocessors, Sensors, Pre-Flight Checks, Flight Planning, Transmitter, Receiver.
Introduction to Arduino Sensors, Program Structures, Flight Controllers, Telemetry, Mission Planning, Camera, Binding, etc

Module-3

Air Worthiness:DGCA Rules and Regulations, Pilot Licensing requirements, NPNT Compliance. Certifications.

Module-4

Basics of Structures: Configurations, Payload Configurations, Design Considerations.

Basics of Propulsion: Batteries, Hybrid Propulsions, IC Engines, Mini Turbines, Solar,

Module-5

Tuning, Testing, Manufacturing Constraints, Simulator Training, Applications
CASE Studies:
Construction and testing of a basic drone.

Course outcome (Course Skill Set)

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

1. Apply the basic concepts of UAV systems.
2. Explain the basic aerodynamics, performance, stability and control required for UAV.
3. Select the propulsion system and materials for structures.
4. Understand Regulatory and Certification aspects
5. Understand basic flight with experimentation

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

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

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

Semester-End Examination:

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

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

Suggested Learning Resources:

Books

1. Introduction to UAV Systems Paul Gerin, Fahlstrom, Thomas James Wiley Publication 4th Edition,2012
2. Unmanned Aerial Vehicles: DOD's Acquisition Efforts Alpha Editions.
3. Handbook of Unmanned Aerial Vehicles Valavanis, K., Vachtsevano S, George J Springer

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc22_ae15/preview
- https://onlinecourses.nptel.ac.in/noc22_ae16/preview

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

- Experimentation – gathering knowledge through experience through lab.
- Exploration – gathering knowledge and attaining skills through active investigation.
- Expression – encouraging students to express their views through visual presentations.

Mechanism and Machine Theory		Semester	3
Course Code	**BAE306B/ BAS306B**	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: This course will enable students to

- Understand the theory of mechanisms including velocity, acceleration and static force analysis.
- Acquire knowledge of spur gears, gear train, balancing of rotating and reciprocating masses.
- Understand the concept of governors and gyroscope.

Teaching-Learning Process (General Instructions)

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

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

Module-1

Introduction to Mechanisms:

Types of constrained motion, Link and its types, joints and its types, kinematic pair and its types, degrees of freedom, Grubler's criterion, Types of kinematic chains and inversions:

Inversions of Four bar chain: Beam engine, coupling rod of a locomotive, Watt's indicator mechanism. Inversions of Single Slider Crank Chain: Pendulum pump or Bull engine, Oscillating cylinder engine, Rotary internal combustion engine, Crank and slotted lever quick return motion mechanism, Whitworth quick return motion mechanism. Inversions of Double Slider Crank Chain: Elliptical trammels, Scotch yoke mechanism, Oldham's coupling. Straight line motion mechanisms: Peaucellier's mechanism and Robert's mechanism. Intermittent Motion mechanisms: Geneva wheel mechanism and Ratchet and Pawl mechanism, Ackerman steering gear mechanism.

Module-2

Velocity, Acceleration and static force analysis of Mechanisms (Graphical Methods):

Velocity and acceleration analysis of Four Bar mechanism, slider crank mechanism and Simple Mechanisms by vector polygons.

Static force analysis: Introduction: Static equilibrium, Equilibrium of two and three force members. Members with two forces and torque. Free body diagrams, principle of virtual work. Static force analysis of four bar mechanism and slider-crank mechanism with and without friction.

Module-3

Spur Gears and Gear Trains

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.

Gear Trains: Simple gear trains, Compound gear trains, Reverted gear trains, Epicyclic gear trains, Analysis of epicyclic gear train (Algebraic and tabular methods), torques in epicyclic trains.

Module-4

Balancing of Rotating and Reciprocating Masses

Balancing of Rotating Masses: Balancing of Several Masses Rotating in the Same Plane, Balancing of Several Masses Rotating in Different Planes (only Graphical Methods).

Balancing of Reciprocating Masses: Primary and Secondary Unbalanced Forces of Reciprocating Masses, Partial Balancing of Unbalanced Primary Force in a Reciprocating Engine, Balancing of Primary and secondary Forces of Multi-cylinder In-line Engines, Balancing of Radial Engines (only Graphical Methods)

Module-5

Governors and Gyroscope

Governors: Types of governors; force analysis of Porter and Hartnell governors, Controlling force, stability, sensitiveness, isochronism, effort and power of Porter and Hartnell governors.

Gyroscopes: Vectorial representation of angular motion, gyroscopic couple, effect of gyroscopic couple on plane disc and aeroplane

Course outcome (Course Skill Set)

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

1. Apply the theory of velocity, acceleration and static force analysis to design of mechanisms.
2. Design spur gears, gear train, balancing of rotating and reciprocating masses.
3. Apply governors and gyroscope.

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

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

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

Semester-End Examination:

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

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

Suggested Learning Resources:

Books

1. **Rattan S.S,** ‘‘Theory of Machines”, Tata McGraw-Hill Publishing Company Ltd., New Delhi, and 3rd edition -2009, ISBN: 007014477X, 9780070144774.
2. **J.J. Uicker, G.R. Pennock, J.E. Shigley.**“Theory of Machines & Mechanisms”, OXFORD 3rd Ed. 2009, ISBN-13: 978-0195371239

Reference Books

1. **R. S. Khurmi, J.K. Gupta,**“Theory of Machines”, Eurasia Publishing House, 2008, ISBN 13: 9788121925242.
2. **Robert L Norton,**“Design of Machinery” by McGraw Hill, 2001, ISBN-13: 978-0077421717.
3. **Ambekar,** “Mechanism and Machine theory”, PHI Learning Pvt. Ltd., 2007, ISBN 13: 9788120331341.

Web links and Video Lectures (e-Resources):
• https://nptel.ac.in/courses/112105268
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning • Experimentation – gathering knowledge through experience through lab. • Exploration – gathering knowledge and attaining skills through active investigation. • Expression – encouraging students to express their views through visual presentations.

Aircraft Maintenance, Repair and Overhaul		Semester	3
Course Code	**BAE306C**	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: This course will enable students to

- Comprehend the fundamentals of maintenance and certification.
- Acquire the knowledge of inspection of various systems &documentation for maintenance.
- Understand the Aircraft Maintenance, safety and trouble shooting.

Teaching-Learning Process (General Instructions)

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

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

Module-1

Welding In Aircraft Structural Components

Equipment's used in welding shop and their maintenance – Ensuring qualitywelds – Welding jigs and fixtures – Soldering and brazing.

Sheet Metal Repair And Maintenance

Inspection of damage – Classification – Repair or replacement – Sheet metal inspection – N.D.T. Testing – Riveted repair design, Damage investigation – reverse technology.

Module-2(08 hours)

Plastics and Composites in Aircraft

Review of types of plastics used in airplanes – Maintenance and repair of plastic components – Repair of cracks, holes etc., various repair schemes – Scopes.

Inspection and Repair of Composite Components:

Inspection and Repair of composite components – Special precautions –Autoclaves.

Module-3

Aircraft Jacking, Assembly And Rigging

Airplane jacking and weighing and C.G. Location. Balancing of control surfaces – Inspection maintenance. Helicopter flight controls. Tracking and balancing of main rotor.

Review of Hydraulic and Pneumatic System

Trouble shooting and maintenance practices – Service and inspection. –Inspection and maintenance of landing gear systems. – Inspection and maintenance of air-conditioning and pressurisation system, water and waste system. Installation and maintenance of Instruments – handling – Testing – Inspection.

Module-4

Inspection And Maintenance Of Auxiliary Systems:

Inspection and maintenance of auxiliary systems – Fire protection systems – Ice protection system – Rain removal system – Position and warning system –Auxiliary Power Units (APUs)

Safety Practices

Hazardous materials storage and handling, Aircraft furnishing practices – Equipment's. Trouble shooting - Theory and practices.

Module-5

Documentation for Maintenance

Manufacturers documentation, Airplane maintenance manual, Fault insulation manual, Illustrated parts catalogue, structural repair manual, wiring diagram manual, Master minimum equipment, Federal Aviation regulation (FAR), Advisory circulars, Airworthiness direction ATA document standards, Technical policies and procedure manuals (TPPM)

Fundamentals of Maintenance & Certification

Types of maintenance, Redesign, Failure rate pattern, Other maintenance considerations.

Aviation industry certification requirements, Type certificate (FAA form 8110.9), Airworthiness certificate (FAA form 8100-2), Aviation maintenance certifications, General, Airframe, Power plant, Avionics courses.

Course outcome (Course Skill Set)

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

1. Maintain the aircraft maintenance manual and logbook.
2. Do the quality control and calibration.
3. Incorporate the safety regulations and rules.

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

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

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

Semester-End Examination:

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

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

Suggested Learning Resources:

Books

1. **Kroes, Watkins, Delp,** "Aircraft Maintenance and Repair",McGraw-Hill, New York, 2013.
2. **Harry A Kinnison, Tariq Siddiqui,** Aviation Maintenance Management, McGraw Hill education (India) Private Ltd 2013.

Reference Books

1. **Larry Reithmaier**" Aircraft Repair Manual" Palmar Books, Marquette, 1992.
2. **Brimm. DJ, Bogges, HE**, Aircraft Maintenance, Pitman publishing corp, London, 1952.

Web links and Video Lectures (e-Resources):

- https://onlinecourses.nptel.ac.in/noc20_ae03/preview

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

- Experimentation – gathering knowledge through experience through lab.
- Exploration – gathering knowledge and attaining skills through active investigation.
- Expression – encouraging students to express their views through visual presentations.

IOT CONCEPTS AND ALGORITHMS		Semester	3
Course Code	**BAE306D/BAS306D**	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:

- To apprise students with basic knowledge of IoT that paves a platform to understand physical and logical design of IOT.
- To introduce the technologies behind Internet of Things (IoT).
- To explain the students how to code for an IoT application using Arduino/Raspberry Pi open platform.
- To understand and apply the algorithm analysis techniques on searching and sorting Algorithms
- To critically analyze the efficiency of graph algorithms

Teaching-Learning Process (General Instructions)

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

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

Module-1

Introduction to Internet of Things: Evolution of Internet of Things – Enabling Technologies – IoT Architectures: oneM2M, IoT World Forum (IoTWF) and Alternative IoT Models – Simplified IoT Architecture and Core IoT Functional Stack – Fog, Edge and Cloud in IoT.

Components in Internet of Things: Functional Blocks of an IoT Ecosystem – Sensors, Actuators, and Smart Objects – Control Units - Communication modules (Bluetooth, Zigbee, Wifi, GPS, GSM Modules)

Module-2

Protocols and Technologies Behind IoT: IOT Protocols - IPv6, 6LoWPAN, MQTT, CoAP - RFID, Wireless Sensor Networks, Big Data Analytics, Cloud Computing, Embedded Systems.

Module-3

Open Platforms and Programming: IOT deployment for Raspberry Pi /Arduino platform-Architecture – Programming – Interfacing – Accessing GPIO Pins – Sending and Receiving Signals Using GPIO Pins – Connecting to the Cloud.

Module-4

Introduction to Algorithms: Algorithm analysis: Time and space complexity - Asymptotic Notations and its properties Best case, Worst case and average case analysis – Recurrence relation: substitution method - Lower bounds – searching: linear search, binary search and Interpolation Search, Pattern search: The naïve string- matching algorithm - Rabin-Karp algorithm - Knuth-Morris-Pratt algorithm. Sorting: Insertion sort – heap sort

Module-5

Graph Algorithms: Graph algorithms: Representations of graphs - Graph traversal: DFS – BFS - applications - Connectivity, strong connectivity, bi-connectivity - Minimum spanning tree: Kruskal's and Prim's algorithm- Shortest path: Bellman-Ford algorithm - Dijkstra's algorithm - Floyd-Warshall algorithm Network flow: Flow networks - Ford-Fulkerson method – Matching: Maximum bipartite matching

Course outcome (Course Skill Set)

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

1. Explain the concept of IoT.
2. Design portable IoT using Arduino/Raspberry Pi /open platform.
3. Apply data analytics and use cloud offerings related to IoT.
4. Analyze the efficiency of algorithms using various frameworks.

5. Apply graph algorithms to solve problems and analyze their efficiency.

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

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

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

Semester-End Examination:

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

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

Suggested Learning Resources:

Books

1. Robert Barton, Patrick Grossetete, David Hanes, Jerome Henry, Gonzalo Salgueiro, "IoT Fundamentals: Networking Technologies, Protocols, and Use Cases for the Internet of Things", CISCO Press, 2017
2. Samuel Greengard, The Internet of Things, The MIT Press, 2015
3. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest and Clifford Stein, "Introduction to Algorithms", 3rd Edition, Prentice Hall of India, 2009.
4. Ellis Horowitz, Sartaj Sahni, Sanguthevar Rajasekaran "Computer Algorithms/C++" Orient Blackswan, 2nd Edition, 2019.

REFERENCES:

1. Perry Lea, "Internet of things for architects", Packt, 2018
2. Olivier Hersent, David Boswarthick, Omar Elloumi , "The Internet of Things – Key applications and Protocols", Wiley, 2012.
3. IOT (Internet of Things) Programming: A Simple and Fast Way of Learning, IOT Kindle Edition.
4. Anany Levitin, "Introduction to the Design and Analysis of Algorithms", 3rd Edition, Pearson Education, 2012.
5. Alfred V. Aho, John E. Hopcroft and Jeffrey D. Ullman, "Data Structures and Algorithms", Reprint Edition, Pearson Education, 2006.

Web links and Video Lectures (e-Resources):
• https://www.arduino.cc/https://www.ibm.com/smarterplanet/us/en/?ca=v_smarterplanet.
Activity Based Learning (Suggested Activities in Class)/ Practical Based learning • Experimentation – gathering knowledge through experience through lab. • Exploration – gathering knowledge and attaining skills through active investigation. • Expression – encouraging students to express their views through visual presentations.

Development of Soft Skills for Engineers		Semester	3
Course Code	**BAE358A/BAS358A**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	01	Exam Hours	1
Examination type (SEE)	Theory		

Course objectives: This course will enable students to

1. Understand the significance of soft skills for engineers
2. Acquire verbal and non-verbal communication skills
3. Get the essence of personal and professional leadership skills

Teaching-Learning Process (General Instructions)

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

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

Module-1

Foundations of everyday leadership, Emotional intelligence, Leadership and collaborative abilities, Listening skills, Research and analytical skills

Module-2

Verbal and non-verbal communication, Stress Management and Tolerance, Email Writing, Public speaking and presentation

Module-3

Negotiation skills, and diffusing project conflict, managing project risks and changes, scope , time and cost management, Strategic Planning

Module-4

Creativity and vision, Problem-solving, writing code and cross-functional skill, digital product management

Module-5

Adaptability and staying positive, Applications of everyday leadership, Teamwork and people skills

Course outcome (Course Skill Set)

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

1. Apply soft skills for engineering profession.
2. Practise both verbal and non-verbal communication skills effectively.
3. Use personal and professional leadership skills

Assessment Details (both CIE and SEE)

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

Continuous internal Examination (CIE)

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

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

Semester End Examinations (SEE)

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

OR

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

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

Suggested Learning Resources:

Books

1. Fast-Tracking Your Career: Soft Skills for Engineering and IT Professionals 1st Edition by Wushow Chou (Author)
2. Soft Skills 3rd Edition: Personality Development for Life Success Paperback – 30 October 2021 by Prashant Sharma (Author)

Web links and Video Lectures (e-Resources):

- https://www.ktit.pf.ukf.sk/images/clanky/Dokumenty/Desire/Softskillsforengineers.pdf.

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

- Experimentation – gathering knowledge through experience through lab.
- Exploration – gathering knowledge and attaining skills through active investigation.
- Expression – encouraging students to express their views through visual presentations.

Ethics, Technology and Engineering		Semester	3
Course Code	**BAE358B/BAS358B**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	01	Exam Hours	1
Examination type (SEE)	Theory		

Course objectives: This course will enable students to

- Learn ethical values in engineering
- Understand how ethics are followed in technology and engineering.
- Share the ethical practices

Teaching-Learning Process (General Instructions)

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

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

Module-1

Moral sensibility: the ability to recognize social and ethical issues in engineering

Module-2

Moral analysis skills: the ability to analyse moral problems in terms of facts, values, stakeholders and their interests;

Module-3

Moral creativity: the ability to think out different options for action in the light of (conflicting) moral values and the relevant facts;

Module-4

Moral judgement skills: the ability to give a moral judgement on the basis of different ethical theories or frameworks including professional ethics and common sense morality;

Module-5

Moral decision-making skills: the ability to reflect on different ethical theories and frameworks and to make a decision based on that reflection.

Course outcome (Course Skill Set)

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

1. Develop Ethical values in engineering and Technology
2. Adopt ethical practices
3. Assimilate the ethics in Engineering and Technology

Assessment Details (both CIE and SEE)

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

Continuous internal Examination (CIE)

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

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

Semester End Examinations (SEE)

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

OR

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

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

Suggested Learning Resources:

Books

1. Ethics, Technology and Engineering , An Introduction- Wiley-Blackwell (an imprint of John Wiley & Sons Ltd)
2. Ethics in Engineering | 4th Edition Paperback – 1 July 2017by Mike W. Martin (Author)

Web links and Video Lectures (e-Resources):

- https://cdn.prexams.com/6229/BOOK.pdf
- https://www.coursera.org/learn/ethics-technology-engineering

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

- Experimentation – gathering knowledge through experience through lab.
- Exploration – gathering knowledge and attaining skills through active investigation.
- Expression – encouraging students to express their views through visual presentations.

DIGITALIZATION IN AERONAUTICS		Semester	3
Course Code	**BAE358C**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	01	Exam Hours	1
Examination type (SEE)	Theory		

Course objectives: The course will enable the students to

- To become familiar with digitalization in Aeronautics
- To understand the importance of digitalization
- To accelerate the learning of digitalization in Aeronautics

Teaching-Learning Process (General Instructions)

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

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

Module-1

Digitalisation and the Future of the Aerospace Industry, Digitization in Production, Human Factors 4.0: Requirements and challenges for humans, teams and organizations

Module-2

Managing Maintenance, Repair and Overhaul for Civil Aircraft, The psycho-social implications of digitalization, Collaborative Aircraft Design

Module-3

The Significance of Testing concerning Maintenance of Aircraft, Maintenance in the Age of Digitalisation

Module-4

Digital Avionics Networks, Mil-STD, Modeling and Simulation of Aerospace Systems, Digital Models

Module-5

Efficient Order Reduction of Parametric Models, Parametric Model Order Reduction for Structural Analysis

Course outcome (Course Skill Set)

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

1. Apply digitalization in Aeronautics
2. Implement digitalization in collaborative design, maintenance, repair and overhaul
3. Enhance the productivity thru digitalization in Aeronautics

Assessment Details (both CIE and SEE)

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

Continuous internal Examination (CIE)

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

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

Semester End Examinations (SEE)

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

OR

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

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

Suggested Learning Resources:

Books

1. Aerospace and Digitalization: A Transformation Through Key Industry 4.0 Technologies (Springer Briefs in Applied Sciences and Technology) 1st ed. 2021 Edition by Diego Carou (Author)
2. Digitalisation in Aeronautics and Space by coursera
3. Mastering The Digital World : A Guide To Understanding, Using And Exploiting Digital Media by Peter Cope

Web links and Video Lectures (e-Resources):

1. https://www.lll.tum.de/certificate/digitalisation-in-aeronautics-and-space/
2. https://www.repository.cam.ac.uk/bitstream/handle/1810/278896/CDBB_REP_002_Lamb_Final.pdf

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

- Experimentation – gathering knowledge through experience through lab.
- Exploration – gathering knowledge and attaining skills through active investigation.
- Expression – encouraging students to express their views through visual presentations.

CODING LITERACY		Semester	3
Course Code	**BAE358D/BAS358D**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	01	Exam Hours	
Examination type (SEE)	Theory		

Course objectives: The course will enable the students to

- Become literate on foundation of codes
- Be familiar to the concepts of code development and operation
- Understand any code's structural components

Teaching-Learning Process (General Instructions)

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

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

Module-1

Introduction, How Computer Programming Is Changing Writing, Why is coding literacy important? devices and software , digital environments, rules of code.

Module-2

Core coding concepts including statement, variable, flow control, and functions through digital media, such as graphics, animation, and sound, and interaction.

Module-3

Coding versus programming, develop a code, read a code, run a code, find high-level logic, use/know tools, know the language/conventions, Read best practices/design patterns

Module-4

Code Review, Simple Codes using Java script, MATLAB, R and Python

Module-5

Critical thinking and evaluation, functional skills, Advanced communication, collaboration, cultural and social understanding, Capstone project using codes

Course outcome (Course Skill Set)

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

1. Develop literacy so as to understand any code
2. Start using the concepts of code and develop it
3. Share the literacy with others

Assessment Details (both CIE and SEE)

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

Continuous internal Examination (CIE)

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

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

Semester End Examinations (SEE)

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

OR

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

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

Suggested Learning Resources:

Books

1. Coding Literacy: How Computer Programming Is Changing Writing (Software Studies) by Annette Vee (Author)
2. The Pragmatic Programmer: From Journeyman to Master (2nd Edition) by Andrew Hunt and David Thomas
3. Computer Programming JavaScript, Python, HTML, SQL, CSS: The step by step guide for beginners to intermediate by Willam Alvin Newton (Author), Steven Webber (Author)

Web links and Video Lectures (e-Resources):

- https://static.realpython.com/python-basics-sample-chapters.pdf
- http://www.uop.edu.pk/ocontents/A%20Guide%20to%20MATALB.pdf
- https://matfuvit.github.io/UVIT/predavanja/literatura/TutorialsPoint%20JavaScript.pdf
- https://cran.r-project.org/doc/contrib/Paradis-rdebuts_en.pdf

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

- Experimentation – gathering knowledge through experience through lab.
- Exploration – gathering knowledge and attaining skills through active investigation.
- Expression – encouraging students to express their views through visual presentations.

Aero Engineering Thermodynamics		Semester	4
Course Code	**BAE401**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40hrs	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives: This course will enable students to

- Understand various concepts and definitions of thermodynamics.
- Comprehend the I-law and II-law of thermodynamics.
- Acquire the knowledge of various types of gas cycles.

Teaching-Learning Process (General Instructions)

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

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

Module-1

Fundamental Concepts & Definitions:

Thermodynamics definition and scope, Microscopic and Macroscopic approaches. Some practical applications of engineering thermodynamic Systems, Characteristics of system boundary and control surface, examples. Thermodynamic properties; definition and Modules, intensive and extensive properties. Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic processes; Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium. Zeroth law of thermodynamics, Temperature; concepts, scales, fixed points and measurements.

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

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, pure substance; definition, two-property rule, Specific heat at constant volume, enthalpy, specific heat at constant pressure. Extension of the First law to control volume; steady state-steady flow energy equation, important applications,

Module-3

Second Law of Thermodynamics:

Devices converting heat to work; (a) in a thermodynamic cycle, (b) in a mechanical cycle. Thermal reservoir. Direct heat engine; schematic representation and efficiency. Devices converting work to heat in a thermodynamic cycle; reversed heat engine, schematic representation, coefficients of performance. 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; Reversible and Irreversible processes; factors that make a process irreversible, reversible heat engine, Carnot cycle, Carnot principles.

Entropy: Clasius inequality; Statement, proof, application to a reversible cycle. Entropy; definition, a property, change of entropy, principle of increase in entropy, calculation of entropy using Tds relations. Available and unavailable energy.

Module-4

Pure Substances & Ideal Gases: Mixture of ideal gases and real gases, ideal gas equation, compressibility factor use of charts. P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, Saturated liquid, mixture of saturated liquid and vapour, saturated vapour and superheated vapour states of pure substance with water as example. Enthalpy of change of phase (Latent heat). Dryness fraction (quality), T-S and H-S diagrams, representation of various processes on these diagrams.

Thermodynamic relations

Maxwell's equations, Tds relations, ratio of heat capacities, evaluation of thermodynamic properties from an equation of state.

Module-5

Gas Power Cycles: Efficiency of air standard cycles, Carnot, Otto, Diesel cycles, P-V & T-S diagram, calculation of efficiency.

Vapour power cycle: Simple Rankine cycle, Analysis and performance of Rankine Cycle, Ideal and practical regenerative Rankine cycles – Reheat and Regenerative Cycles, Binary vapour cycle.

Course outcome (Course Skill Set)

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

1. Apply the concepts and definitions of thermodynamics.
2. Differentiate thermodynamic work and heat and apply I law and II law of thermodynamics to different process.
3. Apply the principles of various gas cycles.

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

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

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

Semester-End Examination:

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

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

Suggested Learning Resources:

Books

1. P K Nag, "Basic and Applied Thermodynamics", 2nd Ed., Tata McGraw Hill Pub. 2002, ISBN 13: 9780070151314
2. Yunus A. Cenegal and Michael A. Boles, "Thermodynamics: An Engineering Approach", Tata McGraw Hill publications, 2002, ISBN 13: 9780071072540

Reference Books

1. Michael Moran, J., and Howard Shapiro, N., "Fundamentals of Engineering Thermodynamics", 4thEdition, John
Wiley & Sons, New York, 2010.
2. Rayner Joel, "Basic Engineering Thermodynamics", 5th Edition, Addison Wesley, New York, 2016.
3. Holman, J. P., "Thermodynamics", 4th Edition Tata McGraw Hill, New Delhi, 2015.
4. Rathakrishnan. E, "Fundamentals of Engineering Thermodynamics", Prentice – Hall, India, 2005.

Web links and Video Lectures (e-Resources):

- https://www.edx.org/course/thermodynamics-iitbombayx-me209-1x-1
- https://www.coursera.org/learn/thermodynamics-intro
- https://onlinecourses.nptel.ac.in/noc18_ch03/preview

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

- Experimentation – gathering knowledge through experience through lab.
- Exploration – gathering knowledge and attaining skills through active investigation.
- Expression – encouraging students to express their views through visual presentations.

AERODYNAMICS		Semester	4
Course Code	**BAE402/ BAS402**	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:

- Understand the basics of fluid mechanics as a prerequisite to Aerodynamics
- Acquire knowledge on typical airfoil characteristics and two-dimensional flows over airfoil and study the incompressible over finite wings
- Understand the concept of compressible flow and acquire the knowledge of shocks & wave formation

Teaching-Learning Process (General Instructions)

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

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

MODULE-1

Two Dimensional Flows & Incompressible Flow Over Airfoil

Uniform flow, Source flow, Sink flow, Combination of a uniform flow with source and sink. Doublet flow. Non-lifting flow over a circular cylinder. Vortex flow. Lifting flow over a circular cylinder. Kutta-Joukowski theorem and generation of Lift, D-Alembert's paradox, Numericals.

Incompressible flow over airfoils: Kelvin's circulation theorem and the starting vortex, vortex sheet, Kutta condition, Classical thin airfoil theory for symmetric and cambered airfoils. Numericals.

MODULE-2

Incompressible Flow Over Finite Wings

Biot-Savart law and Helmholtz's theorems, Vortex filament: Infinite and semi-infinite vortex filament, Induced velocity. Prandtl's classical lifting line theory: Downwash and induced drag. Elliptical and modified elliptical lift distribution. Lift distribution on wings. Limitations of Prandtl's lifting line theory. Extended lifting line theory-lifting surface theory, vortex lattice method for wings. Lift, drag and moment characteristics of complete airplane.

MODULE-3

Applications of Finite Wing Theory & High Lift Systems

Simplified horse-shoe vortex model, formation flight, influence of downwash on tail plane, ground effects. Swept wings: Introduction to sweep effects, swept wings, pressure coefficient, typical aerodynamic characteristics, Subsonic and Supersonic leading edges. Introduction to high-lift systems, flaps, leading-edge slats and typical high – lift characteristics. Critical Mach numbers, Lift and drag divergence, shock induced separation, Effects of thickness, camber and aspect ratio of wings, Transonic area rule, Tip effects. Introduction to Source panel & vortex lattice method.

MODULE-4

Basics of Compressible Flow

Basics of thermodynamics-definition and basic relation, Energy Equation- For flow and non-flow process, adiabatic energy equation, stagnation pressure, temperature, density, reference velocities, Bernoulli's equation, Effect of Mach number on Compressibility, Isentropic flow with variable area-Area ratio as a function of Mach number, Impulse function, Mass flow rate, Flow through nozzles and diffusers

MODULE-5

Normal, Oblique Shocks and Expansion Waves

Governing Equations of Normal Shock Wave. Prandtl relation and Rankine - Hugoniot equation. Oblique shocks and corresponding relations. Shock polar & Hodograph plane. Supersonic flow over a wedge. Supersonic compression and supersonic expansion. Detached shocks. Mach reflection. Intersection of waves of same and opposite families.

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Calibration of a subsonic wind tunnel: test section static pressure and total head distributions.
2	Smoke flow visualization studies on a two-dimensional circular cylinder at low speeds.
3	Smoke flow visualization studies on a two dimensional airfoil at different angles of incidence at low speeds.
4	Smoke flow visualization studies on a two dimensional multi element airfoil with flaps and slats at different angles of incidence at low speeds.
5	Tuft flow visualization on a wing model at different angles of incidence at low speeds: identify zones of attached and separated flows.
6	Surface pressure distributions on a two-dimensional smooth and rough circular cylinder at low speeds and calculation of pressure drag.
7	Surface pressure distributions on a two-dimensional symmetric airfoil.
8	Surface pressure distributions on a two-dimensional cambered airfoil at different angles of incidence and calculation of lift and pressure drag.
9	Calculation of total drag of a two-dimensional circular cylinder and cambered airfoil at low speeds using pitot-static probe wake survey.
10	Measurement of a typical boundary layer velocity profile on the tunnel wall (at low speeds) using a pitot probe and calculation of boundary layer displacement and momentum thickness.
11	Calculation of aerodynamic coefficients and forces acting on a model aircraft at various AOA and speeds using wind tunnel balance (With and Without Yaw).
12	Pressure measurements on airfoil for a case of reverse flow.

Course outcomes (Course Skill Set):

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

- Evaluate typical airfoil characteristics and two-dimensional flows over airfoil
- Compute and analyse the incompressible flow over finite wings
- Apply finite wing theory and design high lift systems from the aerodynamics view point
- Calculate the lift and drag &apply the flow visualization techniques.
- Estimate the pressure distribution over the bodies.

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. Anderson J.D, "Fundamental of Aerodynamics", 5th edition, McGraw-Hill International Edition, New York (2011), ISBN-13: 978-0073398105.

2. Yahya, S.M., "Fundamentals of Compressible flow", Wiley Eastern, 2003

Reference Books

1. Clancy L. J. "Aerodynamics", Sterling book house, New Delhi. (2006), ISBN 13: 9780582988804

2. Louis M. Milne-Thomson, "Theoretical Aerodynamics", Imported Edition, Dover Publications, USA (2011), ISBN 9780486619804.

3. Radhakrishnan, E., "Gas Dynamics", Prentice Hall of India.1995 edition**.**

4. E. L. Houghton, P.W. Carpenter, "Aerodynamics for Engineering Students", 5th edition, Elsevier, New York. (2010), ISBN-13: 978-0080966328

Web links and Video Lectures (e-Resources):

- https://www.mooc-list.com/course/16101x-introduction-aerodynamics-edx
- http://nptel.ac.in/syllabus/101105059/
- http://nptel.ac.in/courses/112105171/1
- http://nptel.ac.in/courses/112104118/

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

- Experimentation – gathering knowledge through experience through lab.
- Exploration – gathering knowledge and attaining skills through active investigation.
- Expression – encouraging students to express their views through visual presentations.

AIRCRAFT PROPULSION		Semester	4
Course Code	**BAE403**	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: This course will enable students to

- Understand the basic principle and theory of aircraft propulsion.
- Understand the purpose of a centrifugal, axial compressors, axial and radial turbines.
- Acquire knowledge of importance of nozzles & inlets and combustion chamber.

Teaching-Learning Process (General Instructions)

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

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

MODULE-1

Introduction: Review of thermodynamic principles, Principles of aircraft propulsion, Types of power plants, Working principles of internal combustion engine, Two – stroke and four – stroke piston engines, Gas- turbine engines, Cycle analysis of reciprocating engines and jet engines, advantages and disadvantages.

MODULE-2

Propeller Theories & Jet propulsion:

Propeller Theories: Types of propeller, Propeller thrust: momentum theory, Blade element theories, propeller blade design, propeller selection.

Jet Propulsion: Illustration of working of gas turbine engine – The thrust equation – Factors affecting thrust – Effect of pressure, velocity and temperature changes of air entering compressor – Methods of thrust augmentation – Characteristics of turboprop, turbofan and turbojet – Performance characteristics.

MODULE-3

Inlets & Nozzles

Internal flow and Stall in Subsonic inlets, Boundary layer separation. Major features of external flow near a subsonic inlet. Relation between minimum area ratio and eternal deceleration ratio. Diffuser performance**.**

Supersonic inlets: Supersonic inlets, starting problem in supersonic inlets, Shock swallowing by area variation, External deceleration. Modes of inlet operation.

Nozzles: Theory of flow in isentropic nozzles, Convergent nozzles and nozzle choking, Nozzle throat conditions. Nozzle efficiency, Losses in nozzles. Over-expanded and under-expanded nozzles, Ejector and variable area nozzles, Thrust reversal.

MODULE-4

Gas Turbine Engine Compressors

Centrifugal compressors: Principle of operation of centrifugal compressors. Work done and pressure rise - Velocity diagrams, Diffuser vane design considerations. performance characteristics. Concept of Pre-whirl, Rotating stall.

Axial flow compressors: Elementary theory of axial flow compressor, Velocity triangles, Degree of reaction, three-dimensional flow. Air angle distribution for free vortex and constant reaction designs, Compressor blade design. Axial compressor performance characteristics.

MODULE-5
Combustion chambers and Turbines Classification of combustion chambers, important factors affecting combustion chamber design, Combustion process, Combustion chamber performance Effect of operating variables on performance – Flame tube cooling – Flame stabilization – Use of flame holders **Axial Flow Turbines:** Introduction, Turbine stage, Multi-staging of turbine, Exit flow conditions, Turbine cooling, Heat transfer in turbine cooling. **Radial turbine:** Introduction, Thermodynamics of radial turbines, Losses and efficiency.

PRACTICAL COMPONENT OF IPCC

Sl.NO	Experiments
1	Study of an aircraft piston engine. (Includes study of assembly of sub systems, various components, their functions and operating principles)
2	Study of an aircraft jet engine (Includes study of assembly of sub systems, various components, their functions and operating principles)
3	Study of free and forced convective heat transfer over a flat plate.
4	Cascade testing of a model of axial compressor and turbine blade row.
5	Study of performance of a propeller.
6	Determination of heat of combustion of aviation fuel.
7	Study of free and wall jet.
8	Measurement of burning velocity of a premixed flame
9	Study of the flame lift up and fall back phenomenon for varied Air/Fuel ratio.
10	Measurement of nozzle flow.
11	Performance studies on a scaled jet engine.
12	Study of Fuel injection characteristics.

Course outcomes (Course Skill Set):

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

- Apply the basic principle and theory of aircraft propulsion.
- Explain the functions of centrifugal, axial compressors, axial and radial turbines
- Analyse the performance of nozzles & inlets and combustion chamber.
- Analyse the cascade testing of axial compressor and axial turbine blade row.
- Evaluate the performance of a jet engine.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 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 scoredby 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. Bhaskar Roy, "Aircraft propulsion", Elsevier (2011), ISBN-13: 9788131214213.

2. V. Ganesan, "Gas Turbines", Tata McGraw-Hill, 2010, New Delhi, India, ISBN: 0070681929.

Reference Books

1. Hill, P.G. & Peterson, C.R., "Mechanics & Thermodynamics of Propulsion" Addison – Wesley Longman INC, 1999, ISBN-13: 978-0201146592.

2. Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H., "Gas Turbine Theory", Longman, 1989, ISBN 13: 9780582236325.

3. Irwin E. Treager, "Gas Turbine Engine Technology" GLENCOE Aviation Technology Series, 7th Edition, Tata

McGraw Hill Publishing Co. Ltd. Print 2003, ISBN-13: 978-0028018287.
4. S. M. Yahya, "Fundamentals of Compressible Flow with Aircraft and Rocket propulsion", 4th Edition, New Age International Publications, New Delhi 2014, ISBN 13: 9788122426687.

Web links and Video Lectures (e-Resources):

- http://nptel.ac.in/courses/101106033/
- http://nptel.ac.in/courses/101101001/
- http://nptel.ac.in/courses/101101002/
- http://nptel.ac.in/courses/101104019/

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

- Experimentation – gathering knowledge through experience through lab.
- Exploration – gathering knowledge and attaining skills through active investigation.
- Expression – encouraging students to express their views through visual presentations.

AIRCRAFT MATERIAL TESTING & PROCESSING LAB		Semester	4
Course Code	**BAEL404**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2	SEE Marks	50
Credits	01	Exam Hours	100
Examination type (SEE)	Practical		

Course objectives:

- Understand the formation, properties and significance of the alloys through different experiments.
- Understand the types, advantages and applications of various NDT methods.
- Prepare physical models using different manufacturing processes.

Sl.NO	Experiments
1	Tensile, shear and compression tests of metallic and non-metallic specimens using Universal Testing Machine
2	Izod and Charpy Tests on M.S, C.I Specimen.
3	Brinell, Rockwell and Vickers's Hardness test.
4	Torsion Testing
5	Dye penetration testing. To study the defects of Cast and Welded specimens
6	Machining by plain turning, taper turning, step turning, eccentric turning & knurling
7	Machining by internal and external thread cutting
8	Machining by drilling and boring operation
	Demonstration Experiments (For CIE)
9	Ultrasonic flaw detection
10	Heat treatment: Annealing, normalizing, hardening and tempering of steel.
11	Magnetic crack detection
12	Additive Manufacturing

Course outcomes (Course Skill Set):

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

- Differentiate the formation, properties and significance of the alloys through different experiments.
- Differentiate the types, advantages and applications of various NDT methods.
- Practice general-purpose machine tools and manufacturing 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

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:

- https://ecourses.ou.edu/cgi-bin/ebook.cgi?topic=me
- 2 https://www.coursera.org/learn/mechanics-1
- https://www.edx.org/course/materials-science-engineering-misisx-mse1x
- https://www.mooc-list.com/tags/materials-science

ADDITIVE MANUFACTURING		Semester	4
Course Code	**BAE405A**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:1:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives:

- To know the principle methods, areas of usage, possibilities and limitations of the Additive Manufacturing technologies.
- To be familiar with the characteristics of the different materials those are used in Additive Manufacturing
- To know the principles of polymerization and powder metallurgy process, extrusion-based system printing processes, sheet lamination processes, beam deposition processes, direct write technologies and Direct Digital Manufacturing.
- To be familiar with application of additive manufacturing in Aeronautical and Aerospace field

Teaching-Learning Process (General Instructions)

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

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

Module-1

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

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

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

Module-2

Photo polymerization processes: Stereo lithography (SL), Materials, SL resin curing process, Micro-stereo lithography, Process Benefits and Drawbacks, Applications of Photo polymerization Processes. Powder bed fusion processes: Introduction, Selective laser Sintering (SLS), Materials, Powder fusion mechanism, SLS Metal and ceramic part creation, Electron Beam melting (EBM), Process Benefits and

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

Module-3

Printing Processes: evolution of printing as an additive manufacturing process, research achievements in printing deposition, technical challenges of printing, printing process modeling, material modification methods, three-dimensional printing, advantages of binder printing sheet Lamination Processes: Materials, Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications.

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

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

Module-4

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

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

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

Module-5
The use of multiple materials in additive manufacturing: Introduction, multiple material approaches, discrete multiple material processes, porous multiple material processes, blended multiple material processes, commercial applications using multiple materials, future directions. AM Applications: Functional models, Pattern for investment and vacuum casting, Medical models, art models, Engineering analysis models, Rapid tooling, new materials development, Bi-metallic parts, Remanufacturing. Application: Examples for Aerospace and defence, Direct digital manufacturing: Align Technology, siemens and phonak, DDM drivers, manufacturing vs. prototyping, life- cycle costing, future of direct digital manufacturing.
Course outcome (Course Skill Set) At the end of the course, the student will be able to : 1: Demonstrate the knowledge of the broad range of AM processes, devices, capabilities and materials that are available. 2: Demonstrate the knowledge of the broad range of AM processes, devices, capabilities and materials that are available. 3: Understand the various software tools, processes and techniques that enable advanced/additive manufacturing. 4: Apply the concepts of additive manufacturing to design and create components that satisfy product development/prototyping requirements, using advanced/additive manufacturing devices and processes. 6: Understand characterization techniques in additive manufacturing. 7: Understand the latest trends and business opportunities in additive manufacturing
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). The student is declared as a pass in the course if he/she 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:** • There are 25 marks for the CIE's Assignment component and 25 for the Internal Assessment Test component. • Each test shall be conducted for 25 marks. The first test will be administered after 40-50% of the coverage of the syllabus, and the second test will be administered after 85-90% of the coverage of the syllabus. The average of the two tests shall be scaled down to 25 marks • 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 schedule for assignments shall be planned properly by the course teacher. The teacher should not conduct two assignments at the end of the semester if two assignments are planned. Each assignment shall be conducted for 25 marks. (If two assignments are conducted then the sum of the two assignments shall be scaled down to 25 marks) • The final CIE marks of the course out of 50 will be the sum of the scale-down marks of tests and assignment/s 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:

Text Books

1. Additive Manufacturing Technologies Rapid Prototyping to Direct Digital Manufacturing. Gibson l D. W. Rosen l B. Stucker, Springer New York Heidelberg Dordrecht, London, ISBN: 978-1- 4419-1119-3 e-ISBN: 978- 1-4419- 1120-9 DOI 10.1007/978 -1-4419- 1120-9

Reference Books:

1. "Rapid Prototyping: Principles & Applications Chua Chee Kai, Leong Kah Fai World Scientific 2003 Edition.
2. Rapid Prototyping: Theory & Practice Ali K. Kamrani, Springer 2006 Edition
3. Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling" D.T. Pham, S.S. Dimov Springer 2001Edition
4. Rapid Prototyping: Principles and Applications in Manufacturing Rafiq Nooran John Wiley & Sons 2006 Edition
5. Additive Manufacturing Technology Hari Prasad, A.V.Suresh Cengage 2019 Edition
6. Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing Andreas Gebhardt Hanser Publishers 2011 Edition.

Web links and Video Lectures (e-Resources):

- https://archive.nptel.ac.in/courses/112/103/112103306/
- https://www.digimat.in/nptel/courses/video/112103306/L20.html
- https://onlinecourses.nptel.ac.in/noc22_me130/preview

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

- Experimentation – gathering knowledge through experience through lab.
- Exploration – gathering knowledge and attaining skills through active investigation.
- Expression – encouraging students to express their views through visual presentations.

TURBOMACHINES		Semester	3
Course Code	**BAE405B**	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: This course will enable students to

- Understand the basics of Turbomachines, the energy transfer and energy transformation in them.
- Acquire the knowledge on design of centrifugal and axial Turbomachines.
- Study hydraulic pumps and turbines

Teaching-Learning Process (General Instructions)

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

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

Module-1

Introduction to turbomachines: Classification and parts of a turbo machines; comparison with positive displacement machines; dimensionless parameters and their physical significance; specific speed; illustrative examples on dimensional analysis and model studies.

Energy transfer in turbomachines: Basic Euler turbine equation and its alternate form; components of energy transfer; general expression for degree of reaction; construction of velocity triangles for different values of degree of reaction.

Module-2

Compression process: Overall isentropic efficiency of compression; stage efficiency; comparison and relation between overall efficiency and stage efficiency; polytropic efficiency; pre heat factor.

Expansion process: Overall isentropic efficiency for a turbine; stage efficiency for a turbine; comparison and relation between stage efficiency and overall efficiency, polytropic efficiency; reheat factor for expansion process.

Module-3

Design and performance analysis of Centrifugal compressors: Types, design parameters, flow analysis in impeller blades, volutes and diffusers, losses, slip factor, characteristic curves, surging, choking. Construction details.

Design and performance analysis of axial fans and compressors: Stage velocity diagrams, enthalpy-entropy diagrams, stage losses and efficiency, work done, simple stage design problems, performance characteristics, instability in axial compressors. Construction details.

Module-4

Design and performance analysis of axial flow turbines: Turbine stage, work done, degree of reaction, losses and efficiency, flow passage; subsonic, transonic and supersonic turbines, multi-staging of turbine; exit flow conditions; turbine cooling

Design and performance analysis of radial turbines: Thermodynamics and aerodynamics of radial turbines; radial turbine characteristics; losses and efficiency; design of radial turbine.

Module-5

Hydraulic pumps: Centrifugal and axial pumps. Manometric head, suction head, delivery head; manometric efficiency, hydraulic efficiency, volumetric efficiency, overall efficiency; multi stage pumps. Characteristics of pumps.

Hydraulic turbines: Classification; Module quantities; Pelton wheel, Francis turbine, Kaplan turbine and their velocity triangles. Draft tubes and their function. Characteristics of hydraulic turbines.

Course outcome (Course Skill Set)

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

1. Compute the energy transfer and energy transformation in turbomachines.
2. Analyze the design of turbomachine blades.
3. Apply hydraulic pumps and turbines for specific requirements

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

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

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

Semester-End Examination:

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

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

Suggested Learning Resources:

Books

1. S.M. Yahya, "Turbines, Compressors & Fans", Tata-McGraw Hill Co., 2nd Edition (2002), ISBN 13: 9780070707023.
2. D.G. Shephered, "Principles of Turbo Machinery", The Macmillan Company (1964), ISBN-13: 978-0024096609.

Reference Books:

1. V. Kadambi and Manohar Prasad, "An introduction to Energy conversion, Volume III, Turbo machine Wiley Eastern Ltd, 1977, ISBN: 9780852264539
2. Govinde Gowda and Nagaraj, "Turbomachines", 9th Edition, MM Publishers, 2016.
3. B.K.Venkanna, " Fundamentals of Turbomachinery, Prentice Hall India, 2009.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/112106303
- https://archive.nptel.ac.in/courses/112/106/112106200/

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

- Experimentation – gathering knowledge through experience through lab.
- Exploration – gathering knowledge and attaining skills through active investigation.
- Expression – encouraging students to express their views through visual presentations.

INTRODUCTION TO SPACE TECHNOLOGY		Semester	4
Course Code	**BAE405C/BAS405C**	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: This course will enable students to

- Understand the fundamentals of aerospace propulsion.
- Understand the orbit mechanics and orbit maneuvers.
- Acquire the knowledge of satellite attitude dynamics and space mission operations.

Teaching-Learning Process (General Instructions)

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

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

Module-1

Fundamentals of Aerospace Propulsion, Space Environment, fundamentals of solid propellant rockets, Fundamentals of liquid propellant rockets, Rocket equation, Tsiolkovsky rocket equation, Concepts of Specific Impulse.

Module-2

Atmospheric Re-entry: Introduction-Steep Ballistic Re-entry, Ballistic Orbital Re-entry, Skip Re-entry, "Double-Dip" Re-entry, Skip reentry, glide reentry

Module-3

Fundamentals of Orbit Mechanics, Orbit Manoeuvre,: Two-body motion, Basic Orbital Elements, Hohmann Transfer, Bielliptical Transfer

Module-4

Satellite Attitude Dynamics: Attitude Control for Spinning Spacecraft, Attitude Control for Non-spinning Spacecraft, The Yo-Yo Mechanism, Gravity – Gradient Satellite,

Module-5

Space Mission Operations: Supporting Ground Systems Architecture and Team interfaces, Mission phases and Core operations, Command, Planning, Tracking, Telemetry.

Course outcome (Course Skill Set)

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

1. Distinguish the types of aerospace propulsion.
2. Determine the attitude of the satellites.
3. Support the space mission operations.

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

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

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

Semester-End Examination:

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

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

Suggested Learning Resources:

Books

1. W.E. Wiesel,"Spaceflight Dynamics",McGraw Hill,2nd edition,2014,ISBN-13: 978-9332901650
2. J.W. Cornelisse, "Rocket Propulsion and Space Dynamics", J.W. Freeman & Co., Ltd., London, 1982.

Reference Books

1. Vincet L. Pisacane, "Fundamentals of Space Systems", Oxford University Press, 2005.
2. J.Sellers ,"Understanding Space: An Introduction to Astronautics" , McGraw Hill, 2nd edition,2000,ISBN-13: 978-0072424683
3. Francis J Hale,"Introduction to Space Flight", Pearson, 1993, ISBN-13: 978-0134819129.
4. CharlesD.Brown ,"Spacecraft Mission Design", AIAA education Series, 1998.
5. Meyer Rudolph X,"Elements of Space Technology for aerospace Engineers", Meyer Rudolph X, Academic Press, 1999.

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/101101079

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

- Experimentation – gathering knowledge through experience through lab.
- Exploration – gathering knowledge and attaining skills through active investigation.
- Expression – encouraging students to express their views through visual presentations.

Introduction to Combustion		Semester	4
Course Code	**BAE405D**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0	SEE Marks	50
Total Hours of Pedagogy	40hrs	Total Marks	100
Credits	03	Exam Hours	3
Examination type (SEE)	Theory		

Course objectives: This course will enable students to

- To understand the burning of any substances in air.
- To know about the essentials or requirements to produce fire.
- To understand different types of combustion.
- To observe the materials forming flames or not.

Teaching-Learning Process (General Instructions)

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

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

Module-1

Review of Basic Concepts:

Laws of thermodynamics, simple thermo chemical equations, and heat of combustion, properties of real gases, Rankine-Hugoniot curves, ideas of deflagration and detonation.

Chemical Equilibrium And Kinetics:

Concept of chemical equilibrium, Elements of adiabatic flame temperature calculation, Chemical kinetics – rates and order of reactions, Reaction mechanism and chain reactions

Module-2

Combustion thermodynamics: Theoretical (Stoichiometric) air and excess air for combustion of fuels. Mass balance, actual combustion. Exhaust gas analysis. A./ F ratio, Energy balance for a chemical reaction, enthalpy of formation, enthalpy and internal energy of combustion, Combustion efficiency, adiabatic flow temperature.

Module-3

Premixed Flames:

Mechanistic description of premixed flames, Burning velocity and parametric dependences, Experimental methods of measuring burning velocity, One dimensional Conservation Equations, Simple one-dimensional thermal theory of flame, concepts of minimum ignition energy, quenching distance, stability limits and flame stabilization.

Diffusion Flames:

Differences between premixed and diffusion flames, gas diffusion flames in parallel flow – jet flames and Burke Schumann flames, Liquid droplet combustion.

Module-4

Combustion in Piston Engines:

Review of operation of reciprocating engines, Description of the combustion process in piston engines, Combustion efficiency and factors affecting it, detonation in reciprocating engines and preventive methods.

Combustion in Gas-Turbine Engines:

Description of different types of combustion chambers in gas-turbine engines, primary requirements of the combustor, Flow structure, recirculation and flame stabilization in main combustion chamber, afterburners.

Module-5

Combustion in Rocket Engines:

Combustion of carbon particle, boundary layer combustion, basic principles of combustion solid propellants, extension of droplet combustion to liquid propellant rockets.

Emissions:

Flame radiation, pollutants - unburnt hydrocarbons, oxides of nitrogen and carbon monoxide, methods of reducing pollutants, Principle of exhaust gas analysis.

Course outcome (Course Skill Set)

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

1. The students will be able to define combustion and explosion
2. The Students will be understood with chemical process in which a substance reacts rapidly with oxygen and gives off heat.
3. The Students would have understood with the combustion techniques & flames

Assessment Details (both CIE and SEE)

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

Continuous Internal Evaluation:

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

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

Semester-End Examination:

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

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

Suggested Learning Resources:

Books

1. Introduction to Combustion by Stephen Turns.
2. Combustion fundamentals by Roger Strehlow

Reference Books:

1. Industrial Combustion by Charles E. Baukal.
2. Heat Transfer in Industrial Combustion by CE BaukalJr
3. Combustion, Fossil Power Systems by G. Singer. 4th Ed. 1966 Ed Pub.
4. Fuels and Combustion, Sharma, S.P., and Chandra Mohan , Tata Mc.Graw Hill Publishing Co.,Ltd., New Delhi, 1987.
5. Gas Turbine, Jet and Rocket Propulsion, Mathur, M.L., and Sharma,R.P., ,' Standard Publishers and Distributors, Delhi, 1988

Web links and Video Lectures (e-Resources):

- https://nptel.ac.in/courses/101104014/
- https://nptel.ac.in/courses/101106037/2.

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

- Experimentation – gathering knowledge through experience through lab.
- Exploration – gathering knowledge and attaining skills through active investigation.
- Expression – encouraging students to express their views through visual presentations.

FUNDAMENTALS ON SPREADSHEET		Semester	4
Course Code	**BAE456A**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2	SEE Marks	50
Credits	01	Exam Hours	100
Examination type (SEE)	Practical		

Course objectives:

- 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	**Aerospace equations:** Many of the aerospace equations, such as lift and drag coefficients, can be calculated using custom formulas in Excel
10	**Wind tunnel correction functions:** To correct wind tunnel data based on atmospheric conditions.("ISBLANK" and "IF" functions can be used)
11	**Flight trajectory functions:** To look up flight path parameters based on any given conditions.("Vlookup" and "Match" functions can be used)
12	**Launch vehicle functions:** To look up rocket performance parameters based on any given conditions.("INDEX" and "MATCH" functions can be used)

Course outcomes (Course Skill Set):
At the end of the course the student will be able to:

- 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

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:

- McFedries PaulMicrosoft Excel 2019 Formulas And Functions Microsoft Press, U.S, 2019 Edition

DRONE Pilot Training		Semester	4
Course Code	**BAE456B/BAS456B**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	1:0:0:1	SEE Marks	50
Total Hours of Pedagogy	15	Total Marks	100
Credits	01	Exam Hours	1
Examination type (SEE)	Theory		

Course objectives: The course will enable the students to

- Remember the basics principles and rules of flying a drone
- Understand the functioning of all components of drone
- Make and Fly the drone

Teaching-Learning Process (General Instructions)

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

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

Module-1
Regulations of DGCA , Basic Principles of Flight, ATC Procedures & Radio Telephony
Module-2
Fixed wing Operations/Aerodynamics, Multi rotor Operations/Aerodynamics
Module-3
Weather &Meteorology , Drone equipment and maintenance , Emergency Identification & handling
Module-4
Payload installation & utilization, Image/video interpretation, Final Test Theory
Module-5
Flight Simulator training, Practical lessons in Lab, Practical flying lessons

Course outcome (Course Skill Set)

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

1. Apply the principles of Drone flying
2. Repair and Install the components of drone
3. Judge flying conditions for Drone

Assessment Details (both CIE and SEE)

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

Continuous internal Examination (CIE)

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

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

Semester End Examinations (SEE)

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

OR

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

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

Suggested Learning Resources:

Books

1. https://dgt.gov.in/sites/default/files/CTSRPA-DronePilot_CTS_NSQF-4.pdf
2. https://www.faa.gov/training_testing/testing/acs/media/uas_acs.pdf
3. https://irp.fas.org/doddir/army/34-212.pdf

Web links and Video Lectures (e-Resources):

- https://www.udemy.com/course/uasuav-drone-remote-pilot-certification-test-part-107/?utm_source=adwords&utm_medium=udemyads&utm_campaign=LongTail_la.EN_cc.INDIA&utm_content=deal4584&utm_term=_.ag_118445032537_.ad_533094112755_.kw__.de_c_.dm__.pl__.ti_dsa-1212271230479_.li_9061992_.pd__&matchtype=&gclid=Cj0KCQjwpv2TBhDoARIsALBnVnlSE-vcBq9_eqdjjxQwqhUpnkk5V3mLMhYOcjdiEsfCc1Kd-VtLdpUaAjFTEALw_wcB
- https://www.youtube.com/watch?v=ixYnzcZZu9g

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

- Experimentation – gathering knowledge through experience through lab.
- Exploration – gathering knowledge and attaining skills through active investigation.
- Expression – encouraging students to express their views through visual presentations.

CONCEPT OF AUGMENTED REALITY		Semester	4
Course Code	**BAE456C**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:2:0	SEE Marks	50
Total Hours of Pedagogy	30	Total Marks	100
Credits	01	Exam Hours	1
Examination type (SEE)	Theory		

Course objectives:

- Describe how AR systems work and list the applications of AR.
- Understand and analyze the hardware requirement of AR.
- Use computer vision concepts for AR and describe AR techniques
- Analyze and understand the working of various state of the art AR devices
- Acquire knowledge of mixed reality

Teaching-Learning Process (General Instructions)

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

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

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 & Markerless 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, Gamescene

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:

1. Describe how AR systems work and list the applications of AR.
2. Understand and analyse the hardware requirement of AR.
3. Use computer vision concepts for AR and describe AR techniques
4. Analyse and understand the working of various state of the art AR devices
5. Acquire knowledge of 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 Examination (CIE)

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

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

Semester End Examinations (SEE)

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

OR

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

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

Suggested Learning Resources:

Books

1. 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/hololens-introduction-to-the-hololens

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

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Introduction to programming with MATLAB and Python		Semester	4
Course Code	BAE456D	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	0:0:2	SEE Marks	50
Credits	01	Exam Hours	100
Examination type (SEE)	Practical		

Course objectives: The course will enable the students to

- Learn how to programme with MATLAB and Python
- Be familiar with programming environments of MATLAB and Python
- Carry out lab sessions using MATLAB and Python

Sl.NO	Experiments
1	Write a MATLAB program to obtain linear convolution of the given sequences.
2	Write a MATLAB program to perform amplitude-scaling, time-scaling and time-shifting on a given signal.
3	Write a MATLAB program to obtain Cross correlation of sequence x(n) and y(n) & autocorrelation of a sequence x (n) of the given sequences & verify the property.
4	Write a MATLAB program to generate Fourier series of a Square Wave.
5	Write a Python Program to find the square root of a number by Newton's Method.
6	Write a python program to search an element in an array using Linear search technique & Binary search technique.
7	Write a Python program to sort the elements using selection sort & insertion sort.
8	Write a python program to check whether the given string is palindrome or not.
	Demonstration Experiments (For CIE)
9	Write a MATLAB program to Calculate and plot using MATLAB Fourier Transform and Z-Transform of a given signal.
10	Checking linearity/non-linearity of a system using SIMULINK Build a system that amplifies a sine wave by a factor of two.
11	Demonstrate a Python program to sort all the elements in proper order using the logic of Merge sort.
12	Demonstration of working with PDF and word files

Course outcomes (Course Skill Set):

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

- Program with MATLAB and Python
- Develop basic to complex code in the programming environments of MATLAB and Python
- Modify and Maintain codes written using MATLAB and Python
- Examine working of PDF and word file formats

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:

- Programming in MATLAB ®: A problem-solving approach, 1e Paperback by Patel / Mittal (Author)
- Python Programming: Using Problem Solving Approach by Reema Thareja (Author)
- https://cfm.ehu.es/ricardo/docs/python/Learning_Python.pdf
- https://www.mccormick.northwestern.edu/documents/students/undergraduate/introduction-to-matlab.pdf