R.V.COLLEGE OF ENGINEERING

(Autonomous Institution Affiliated to VTU, Belagavi)
R.V. Vidyaniketan Post, Mysore Road
Bengaluru – 560 059

Bachelor of Engineering (B.E)
Scheme and Syllabus for VII & VIII Semesters

2016 SCHEME

AEROSPACE ENGINEERING

VISION

Leadership in Quality Technical Education, Interdisciplinary Research & Innovation, with a Focus on Sustainable and Inclusive Technology

MISSION

1. To deliver outcome based Quality education, emphasizing on experiential learning with the state of the art infrastructure.
2. To create a conducive environment for interdisciplinary research and innovation.
3. To develop professionals through holistic education focusing on individual growth, discipline, integrity, ethics and social sensitivity.
4. To nurture industry-institution collaboration leading to competency enhancement and entrepreneurship.
5. To focus on technologies that are sustainable and inclusive, benefiting all sections of the society.

QUALITY POLICY

Achieving Excellence in Technical Education, Research and Consulting through an Outcome Based Curriculum focusing on Continuous Improvement and Innovation by Benchmarking against the global Best Practices.

CORE VALUES

Professionalism, Commitment, Integrity, Team Work, Innovation

R.V.COLLEGE OF ENGINEERING

(Autonomous Institution Affiliated to VTU, Belagavi)

R.V. Vidyaniketan Post, Mysore Road

Bengaluru – 560 059

Bachelor of Engineering (B.E)

Scheme and Syllabus for VII & VIII Semesters

2016 SCHEME

DEPARTMENT OF

AEROSPACE ENGINEERING

Department Vision

Emerge as a centre of excellence in Aerospace Engineering, Imparting Quality Technical Education, Interdisciplinary Research & Innovation with a focus on Societal empowerment through Sustainable & Inclusive Technologies.

Department Mission

- Imparting Quality Technical Knowledge in Basic & Applied areas of Aerospace Engineering incorporating the principles of Outcome Based Education.
- Provide state-of-the art laboratories and infrastructure facilities, conducive to motivate Interdisciplinary Research and Innovation in Aerospace Engineering.
- Develop self motivated engineers with a blend of Discipline, Integrity, Engineering Ethics and Social Responsibility.
- Strengthening collaboration with industries, research organizations and institutes for Internships, Joint Research And Consultancy.
- Focus towards Integrating Sustainable and Inclusive Technologies for Societal Symbiosis.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

PEO1: To provide opportunities for successful professional career with a sound fundamental knowledge in Mathematics, Physical Science & Aerospace Engineering.

PEO2: Motivate innovative research in specialized areas of Aerospace Engineering viz Aerospace structural design, Aerodynamics, Aerospace Propulsion and Guidance & Control systems.

PEO3: Promoting development of problem solving abilities by adopting analytical, numerical and experimental skills with awareness on societal impact.

PEO4: Imbibing sound communication skills, team working ability, professional ethics and zeal for lifelong learning.

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO	Description
PSO1	Utilization of the fundamental knowledge and skills of Aerospace Engineering to develop pragmatic solutions for complex Aerospace Engineering problems.
PSO2	Apply Professional Engineering practices and strategies in the development of systems and subsystems for Aerospace Applications.
PSO3	Exhibit Effective Communication skills and a Zeal to function with multi-disciplinary teams
PSO4	Demonstrate Professional Ethics and Responsibilities in Engineering practices towards the achievement of societal symbiosis.

ABBREVIATIONS

Sl. No.	Abbreviation	Meaning
1.	VTU	Visvesvaraya Technological University
2.	BS	Basic Sciences
3.	CIE	Continuous Internal Evaluation
4.	SEE	Semester End Examination
5.	PE	Professional Core Elective
6.	GE	Global Elective
7.	HSS	Humanities and Social Sciences
8.	CV	Civil Engineering
9.	ME	Mechanical Engineering
10.	EE	Electrical & Electronics Engineering
11.	EC	Electronics & Communication Engineering
12.	IM	Industrial Engineering & Management
13.	EI	Electronics & Instrumentation Engineering
14.	CH	Chemical Engineering
15.	CS	Computer Science & Engineering
16.	TE	Telecommunication Engineering
17.	IS	Information Science & Engineering
18.	BT	Biotechnology
19.	AS	Aerospace Engineering
20.	PY	Physics
21.	CY	Chemistry
22.	MA	Mathematics

INDEX

RV COLLEGE OF ENGINEERING®

(Autonomous Institution Affiliated to VTU, Belagavi)

AEROSPACE ENGINEERING

SEVENTH SEMESTER CREDIT SCHEME								
Sl. No.	**Course Code**	**Course Title**	**BOS**	**Credit Allocation**				
				Lecture	**Tutorial**	**Practical**	**SS**	**Total Credits**
1	16AS71	Control Engineering	AS	3	0	0	0	3
2	16AS72	Aircraft Stability & control	AS	3	0	0	0	3
3	16AS73P	Minor Project**	AS	3	0	0	0	3
4	16AS74	Avionics	AS	3	0	1	0	4
5	16AS7FX	Elective F (PE)	AS	4	0	0	0	4
6	16AS7GX	Elective G(PE)	AS	4	0	0	0	4
7	16G7HXX	Elective H (GE)*	Respective BoS	3	0	0	0	3
Total No. of Credits				**23**	**0**	**1**	**0**	**24**
No. of Hrs.				**23**	**0**	**2**	**0**	**25**

*Students should take other department Global Elective courses;

** Minor Project-6 hours per week;

EIGHTH SEMESTER CREDIT SCHEME								
Sl. No.	**Course Code**	**Course Title**	**BOS**	**Credit Allocation**				
				Lecture	**Tutorial**	**Practical**	**SS**	**Total Credits**
1	16AS81	Major Project	AS	0	0	16	0	16
2	16AS82	Technical Seminar	AS	0	0	2	0	2
3	16HS83	Innovation and Social Skills	HSS	0	0	2	0	2
Total No. of Credits				**0**	**0**	**20**	**0**	**20**
No. of Hrs.				**0**	**0**	**40**	**0**	**40**

VII Semester		
GROUP F: PROFESSIONAL ELECTIVES		
Sl. No.	**Course Code**	**Course Title**
18.	16AS7F1	Missile Aerodynamics
19.	16AS7F2	Operations Research
20.	16AS7F3	Space Dynamics
21.	16AS7F4	Smart Materials

VII Semester		
GROUP G: PROFESSIONAL ELECTIVES		
Sl. No.	**Course Code**	**Course Title**
1.	16AS7G1	Hypersonic Aerodynamics
2.	16AS7G2	Theory of Aeroelasticity
3.	16AS7G3	Helicopter Dynamics
4.	16AS7G4	Flight Testing

GLOBAL ELECTIVES			
Sl. No.	**Host Dept**	**Course Code**	**Course Title**
1.	BT	16G7H01	Nanotechnology
2.	CH	16G7H02	Industrial Safety and Risk Management
3.	CV	16G7H03	Intelligent Transport System
4.	CS	16G7H04	Intelligent Systems
5.	EC	16G7H05	Image Processing and Machine Learning
6.	EE	16G7H06	Design of Renewable Energy Systems
7.	IM	16G7H07	Systems Engineering
8.	EI	16G7H08	MEMS and Applications
9.	IS	16G7H09	Introduction to Internet of Things
10.	ME	16G7H10	Industry 4.0 – Smart Manufacturing for The Future
11.	TE	16G7H11	Space Technology and Applications
12.	MA	16G7H12	Advanced linear Algebra
13.	PY	16G7H13	Thin Film Nanotechnology
14.	CY	16G7H14	Engineering Material for Advanced Technology
15.	HSS	16G7H15	Applied Psychology for Engineers
16.	HSS	16G7H16	Foundational Course on Entrepreneurship
17.	AS	16G7H17	Unmanned Aerial Vehicles

Semester: VII						
CONTROL ENGINEERING (Theory)						
Course Code	**:**	16AS71		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	3:0:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	36L		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: To enable the students to:	
1	Understand the fundamental concepts of control systems, its elements and their representation through block diagrams
2	Describe and define the characteristics of a control system through stability, accuracy, resolution, time response etc
3	Explain the importance of State space methods
4	Analyse different types of control systems and its significant features

Unit-I	**08 Hrs**
Introduction and Applications: Types of Control Systems, Typical Block Diagrams, Performance Analysis, Applications: Aerospace Control, Representation of Processes and Control Elements, Mathematical Modelling. **Block Diagram Representation:** Representation of Systems or Processes, Comparison Elements, Representation of Feedback Control Systems, Block Diagram and Transfer Function Representation, Representation of Temperature Control System, Signal Flow Graphs.	
Unit -II	**06 Hrs**
Transient and Steady State Response: Time Domain Representation, Response of First order and Second Order Systems for Step Unit, Time Domain Specifications, Steady State Errors and Error Constants, Dynamic Error Coefficients.	
Unit -III	**07 Hrs**
Frequency Response Analysis: Bode Plots, Stability of Control Systems, Characteristics Equation, Routh's Criterion, Gain and Phase Margins.	
Unit -IV	**07 Hrs**
Root Locus Method: Introduction, Rules for Sketching root Loci, Relation between Root Locus Locations and Transient Response, Parametric Variation, Effect of addition of Poles and Zeros.	
Unit -V	**08 Hrs**
State Space Analysis of Control Systems: Introduction, Generalised State Equation, Techniques for Deriving Systems State-Space Equations, Transfer Functions from State Equations, Solution of State Vector, State Transition Matrix, Controllability and Observability. **Types of Controllers:** Introduction, Types of Control Action, Proportional, Integral and Derivative Controllers, PD, PI, PDI Controllers.	

Course Outcomes: At the end of this course the student will be able to :	
CO1:	Explain the working of a control system with appropriate block diagrams and signal flow graphs
CO2:	Apply time and frequency domain technique for the design of a control system
CO3:	Evaluate the performance of a control system for optimal design
CO4:	Choose and develop an optimal control system for a given aerospace application

Reference Books	
1	Modern Control Engineering, Katsuhiko Ogata, 5th Edition, 2009, Prentice Hall, ISBN 9780136156734
2	Automatic control system, Kuoi, 3rd Edition, 2010, Prentice Hall of India, New Delhi, ISBN-0130549738
3	Control System Engineering,, I.J Nagrath and M Gopal, 3rd Edition, 2010, New Age International Publishers, New Delhi, ISBN-8122411924
4	Control Systems, A Anand Kumar, 2nd Edition, 2014, PHI learning Pvt Ltd, PHI Learning; ISBN-978-81-203-3197-6
5	Control Engineering, V.U.Bakshi, 6th Edition, 2007, Technical Publications, ISBN 9788184312935

Scheme of Evaluation

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for Assignment/Presentation/Project 10.

Total CIE is 30(Q) +50(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**1**	**1**	**3**	**2**	**2**				**1**
CO2	**2**	**3**	**3**	**3**	**1**	**1**	**1**	**1**				**2**
CO3	**1**		**3**	**3**								**2**
CO4	**3**	**3**	**3**	**3**		**2**	**1**	**2**				**2**

High-3 : Medium-2: Low-1

Semester: VII						
AIRCRAFT STABILITY & CONTROL (Theory)						
Course Code	**:**	16AS72		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	3:0:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	36L		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: To enable the students to:	
1	State different parameters associated with airplane and their performance
2	Understand and Explain the terminologies related to steady performance of airplanes
3	Describe the effect of static longitudinal stability on the performance of propeller and jet planes
4	Derive conclusions on performance of airplanes subjected to dynamic longitudinal instability
5	Understand and explain the concept of Dynamic Lateral and Directional Stability

Unit-I	**08 Hrs**
Static Longitudinal Stability: Equilibrium conditions, Definition of static stability, Definition of longitudinal static stability, stability criteria, Contribution of airframe components: Wing contribution, Tail contribution, Fuselage contribution, Power effects- Propeller airplane and Jet airplane.	
Unit -II	**07 Hrs**
Static Longitudinal Stability and control Stick-Fixed: Trim Condition, Static Margin, Stick Fixed Neutral Point, Longitudinal control, Elevator Power, Elevated Angle vs. Equilibrium Lift Coefficient, Elevator required for Landing and Restrictions on Forward CG range. **Static Longitudinal Stability and control Stick-Free:** Hinge Moment Parameters, Control Surface Floating Characteristics, Balancing Methods, Trim Tabs, Stick Force Gradient, Stick Free Neutral Point, Restrictions on Aft CG.	
Unit -III	**07 Hrs**
Static Directional Stability and Control: Definitions, Static Directional Rudder Fixed, Rudder Power, Stick Free Directional Stability, Rudder Directional Control, Rudder Lock and Dorsal Fin **Static Lateral Stability and Control:** Definition of Roll Stability, Estimation of Dihedral Effect, Effect of Wing Sweep Flap and Power, Coupling between Rolling and Yawing Moment, Adverse Yaw Effects, Aileron Reversal, Lateral Control and Aileron Balancing.	
Unit -IV	**07 Hrs**
Dynamic Stability : Definitions of Longitudinal, Lateral and Dynamic Lateral Stability, Basics of Phugoid Motion & Short Period Motion (Without Derivation), Airplane Equations of Motion, Aerodynamic Forces and Moments Representation, Orientation and Positions of Airplane.	
Unit -V	**07 Hrs**
Dynamic Derivatives and Stability Criteria : Due to Forward Speed, Pitching Velocity, Change of Angle of Attack, Roll and Yaw Rate, Routh's criteria (Without Derivation & Numericals), Flying qualities in pitch, Cooper-Harper Scale, Response to Aileron Step-Function, Side-Slip Excursion, Dutch roll and Spiral instability, Auto-rotation and Spin, Roll-Pitch-Yaw Inertial Coupling.	

Course Outcomes: At the end of this course the student will be able to :	
CO1:	Derive and Develop static stability conditions for the longitudinal, lateral and directional stability of aircrafts
CO2:	Analyze the stick fixed and stick free longitudinal stability criteria and suggest stability margin
CO3:	Understand and Analyze Dynamic stability conditions for the longitudinal, lateral and directional stability of aircrafts
CO4:	Design the aircraft components based on stability requirements and suggest modification in design

Reference Books	
1	Flight Stability and Automatic Control, Nelson, R.C., 2nd Edition, 1997, McGraw-Hill Book Co., ISBN-978-0070462731
2	Airplane Performance stability and Control, Perkins, C.D and Hage, R.E., 2nd Edition, 1988,John Wiley Son Inc, New York, ISBN- 978-0471680468
3	Dynamics of Flight Stability and Control, Bernard Etkin, 2nd Edition, 1982, John Wiley & Sons ISBN- 978-047103418
4	Performance, Stability, Dynamics and Control of Airplanes, Bandu N. Pamadi, 2nd Edition Series, 2004, AIAA ISBN- 978-1563475832
5	Aerodynamics, Aeronautics, and Flight Mechanics, Barnes W. McCormick, 2nd Edition, 1995, John Wiley & Sons, Inc. ISBN- 978-0471575061

Scheme of Evaluation

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50. The marks component for Assignment/Presentation/Project 10.

Total CIE is 30(Q) +50(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**3**	**3**	**3**	**1**	**1**	**1**	**1**	**1**	**2**
CO2	**3**	**3**	**3**	**3**	**3**	**3**	**1**	**1**	**1**	**1**	**1**	**2**
CO3	**3**	**3**	**3**	**3**	**3**	**3**	**1**	**1**	**1**	**1**	**1**	**2**
CO4	**3**	**3**	**3**	**3**	**3**	**1**	**2**	**1**	**3**	**2**	**1**	**3**

High-3 : Medium-2: Low-1

Semester: VII						
MINOR PROJECT						
Course Code	**:**	16AS73P		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	0:0:3:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	06		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: To enable the students to:	
1	Create interest in innovative developments and preferably interdisciplinary field.
2	Work independently, analyze, evaluate and solve the given problem.
3	Inculcate the skills for good presentation and improve the technical report writing skills.
4	Recognize the need for planning, preparation, management and financial budgeting.
5	Acquire collaborative skills through working in a team to achieve common goals.

Mini Project Guidelines:

1. Each project group will have two to four students, they can form their groups amongst their class.
2. Each group has to select a current topic that will use the technical knowledge of their program of study after intensive literature survey.
3. Guides will be allotted by the department based on the topic chosen.
4. The project should result in system/module which can be demonstrated, using the available resources in the college.
5. The CIE evaluation will be done by the committee constituted by the department. The committee shall consist of respective guide & two senior faculty members as examiners. The evaluation will be done for each student separately.
6. The final copy of the report should be submitted after incorporation of any modifications suggested by the evaluation committee

Guidelines for Evaluation:

CIE Assessment:

Evaluation will be carried out in three phases:

Phase	Activity	Weightage
I	Synopsis submission, approval of the selected topic, formulation of objectives	20%
II	Mid-term evaluation to review the progress of work and documentation	30%
III	Submission of report, Final presentation and demonstration	50%

The following are the weightages given for the various stages of the project:

1. Selection of the topic and formulation of objectives: 10%
2. Design and Development of Project methodology: 30%
3. Execution of Project: 30%
4. Presentation, Demonstration and Discussion: 20%
5. Report Writing:10%

SEE Assessment:

The following are the weightages given during SEE Examination:

1. Written presentation of synopsis:10%
2. Presentation/Demonstration of the project: 30%
3. Methodology and Discussion: 30%
4. Technical Report: 10%
5. Viva Voce: 20%

Course Outcomes of Mini Project:	
CO1:	Define Specifications, Conceptualize, Design and implement a project
CO2:	Communicate the work carried out as a technical report and orally
CO3:	Work in a team and contribute to team work
CO4:	Indulge in self-learning and be motivated for life-long learning

Semester: VII						
AVIONICS (Theory & Practice)						
Course Code	**:**	16AS74		**CIE**	**:**	**100+100 Marks**
Credits: L:T:P:S	**:**	3:0:1:0		**SEE**	**:**	**100+100 Marks**
Total Hours	**:**	36L+30P		**SEE Duration**	**:**	**3.00 Hours+3.00Hours**

Course Learning Objectives: To enable the students to:	
1	Understand the importance of Avionics in civil and military aircrafts.
2	Acquire knowledge of Navigation, Guidance and Radar systems critical for the survivability of aircraft.
3	Know the importance of Integrated Avionics for monitoring and controlling of aircraft.
4	Appreciate the principles of basic communication systems used in aircrafts.

Unit-I	**08 Hrs**
Principle of Avionics: Need for Avionics in civil and military aircraft and space systems, Basic principle of avionics. Devices, circuits and systems of avionics. Avionics sub systems and functions: Air data computer (ADC); navigation, guidance and control system; Flight control systems, Utility management systems, Display and Control systems: HUD, MFD, EFI. MIL and ARINC Data buses. Concept of Integrated Avionics, advanced weapon systems and electronic warfare.	
Unit -II	**08 Hrs**
Navigation Systems: Principle and operation of: Radio Direction finders: ADF system, VOR and DVOR, LORAN, OMEGA, DME & TACAN. Instrument Landing System (ILS) and Microwave Landing system (MLS), Doppler Radio Altimeter, Inertial Navigation System (INS): types of INS, Components of INS, strap down INS, Satellite Navigational System: GPS, NAVSAT, DGPS and INGPS.	
Unit -III	**07 Hrs**
Radar and Tracking: Principle of working of Radar - continuous wave (CW) radar, Doppler radar and Pulse Doppler radar. Moving Target Indicator (MTI), Limitation of MTI. MTI from a moving platform, Mono pulse indicator. Scanning and lobbing. Surveillance Radar and Auto tracking with surveillance Radar.	
Unit -IV	**07 Hrs**
Guidance Systems: Basic Guidance system, Types of Guidance systems, Gyroscopes, Rate gyros , Accelerometers: Principle of operation, Inertial guidance and Laser based guidance, Infrared guidance.	
Unit -V	**06 Hrs**
Basic Principles of communication: HF, V/UHF, Satellite communication, Air traffic control (ATC), Traffic Collision and Avoidance System (TCAS), Identification of Friend or Foe (IFF), Flight Data Recorder (FDR), Cockpit Voice Recorder (CVR), ELT (Emergency Locator Transmitter (ELT)	

LABORATORY EXPERIMENTS

Experiments of Aircraft Systems

1. Radar
2. Navigation system
3. Display
4. HF Communications system
5. CVR (cockpit voice recorder)
6. Black box or Flight Data Recorder (FDR)

Study on Aircraft Devices

1. Accelerometer
2. Gyroscope Sensors

Study on Different Avionic Data Buses

1. MIL STD-1553B
2. ARINC-429
3. ARINC 629

Course Outcomes: At the end of this course the student will be able to :	
CO1:	Understand the basic principles of avionics, guidance and control systems
CO2:	Explain and characterize the systems used for navigation
CO3:	Describe the basic principles related to detection systems
CO4:	Identify and discuss the usage of different systems used for guidance

Reference Books	
1	Introduction to Avionics, Collinson RPG, 2nd Edition, 2003, Kluwer Academic Publishers, Chapman & Hall, ISBN 978-1-4419-7466-2
2	Principals of Avionics, Albert Helfrick, 2nd Edition, 2010, Avionics Communication Inc, ISBN 978-1885544278
3	Introduction to Radar Systems, M .I. Skolnik, 2nd Edition, 2007, Tata McGraw-Hill, ISBN 9780070634411
4	Avionics Navigation System, M. Kayton and W. Fried, 2nd Edition, 1997, Wiley Interscience, ISBN 9780471547952

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project is 10.
Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Scheme of Continuous Internal Evaluation (CIE); Practical Test for 50 Marks
The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average marks (AM) over number of weeks is considered for 30 marks. At the end of the semester a test (T) is conducted for 10 marks. The students are encouraged to implement additional innovative experiments (IE) in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.
Total CIE is 30(AM) +10 (T) +10 (IE) =50 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Scheme of Semester End Examination (SEE); Practical Exam for 50 Marks
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester End Evaluation (SEE): Theory (100 Marks) + Practical (50 Marks) = Total 150 Marks

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**1**	**1**	**3**	**2**	**2**				**1**
CO2	**2**	**3**	**3**	**3**	**1**	**1**	**1**	**1**				**2**
CO3	**1**		**3**	**3**								**2**
CO4	**3**	**3**	**3**	**3**		**2**	**1**	**2**				**2**

High-3 : Medium-2: Low-1

Semester: VII						
MISSILE AERODYNAMICS (Group F: Professional Elective)						
Course Code	**:**	16AS7F1		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	4:0:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	48L		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: To enable the students to:	
1	Classify the various types of missiles and their control mechanisms
2	Distinguish and Differentiate the aerodynamic characteristics of missiles from Airplane characteristics
3	Interpret the capability of missiles based on various performance parameters
4	Examine numerous problems encountered during launching and dispersing a missile

Unit-I	**10 Hrs**
Basic Concepts in Missile Aerodynamics : Missile Aerodynamics versus Airplane Aerodynamics, Classification of Missiles, Axes; Angle of Bank and Included Angle, Angles of Attack and Sideslip, Types of design and control: Wing, Canard, Tail, Tailless control, Dorsal, Jet control, Monowing, Triform, and Cruciform.	
Unit -II	**10 Hrs**
Aerodynamic Characteristics: Bodies of Revolution, Conical Forebody, Ogival Forebody, Hemispherical Forebody, Mid-Section & Aft-Section of the Missile, Aspect Ratio, Wing Planform, Airfoil Sections**.**	
Unit -III	**10 Hrs**
Missile Performance: Aerodynamic Controls of Missiles, Types of Drag acting on Missiles, Boost Glide Trajectory, Boost Sustain Trajectory, Long Range Cruise Trajectory, Long Range Ballistic Trajectory.	
Unit -IV	**09 Hrs**
Aerodynamic Launching Problems of Missiles: Safety of Parent Aircraft, Launch Boundaries, Parent-Aircraft Performance, Ground Launch, Range Safety, Shipboard & Underwater Launches.	
Unit -V	**09 Hrs**
Dispersion Characteristics of Missiles: Introduction, Boost Phase, Power-off Flight, Dispersion Sensitivity Factors in Vacuum.	

Course Outcomes: At the end of this course the student will be able to :	
CO1:	Identify the various techniques used in designing and controlling a missile
CO2:	Distinguish the various aerodynamic characteristics of a missile
CO3:	Familiarize with numerous performance parameters and Judge the capability of the missile
CO4:	Estimate different problems faced by a missile while launching and dispersing

Reference Books	
1	Missile Aerodynamics, Jack N Neilson, 1st Edition, 1988, McGraw hill Book Company, Inc, ISBN-13: 978-0962062902
2	Missile Configuration Design, S S Chin, 1st Edition, 1961, McGraw Hill, ASIN B003WL5YVY
3	Tactical Missile Aerodynamics, M.J. Hemsch, and J.N. Nielsen, 2nd Edition, 2006, AIAA
4	Automatic Control of Aircraft and Missiles, J.H. Blacklock, 2nd Edition, 1991John Wiley & Sons ISBN: 978-0-471-50651-5
5	Rocket Propulsion Element, George P Sutton and Oscar Biblarz, 8th Edition, 2010, John Wiley and Sons Inc 2001, ISBN-13: 978-0470080245

Scheme of Evaluation

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project is 10.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**1**	**1**	**3**	**2**	**2**				**1**
CO2	**2**	**3**	**3**	**3**	**1**	**1**	**1**	**1**				**2**
CO3	**1**		**3**	**3**								**2**
CO4	**3**	**3**	**3**	**3**		**2**	**1**	**2**				**2**

High-3 : Medium-2: Low-1

Semester: VII						
OPERATIONS RESEARCH (Group F: Professional Elective)						
Course Code	**:**	16AS7F2		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	4:0:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	48L		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: To enable the students to:	
1	Define and explain the applications of Operations Research
2	Demonstrate the time of completion of project using PERT and CPM techniques
3	Formulate and solve Linear Programming Problems (LPP)
4	Organise and solve transportation problems to provide optimal solution
5	Demonstrate the methodology of scheduling of machines by using sequencing methods

Unit-I	**10 Hrs**
Introduction: Evolution of OR, definition of OR, scope of OR, application areas of OR, steps (phases) in OR study, characteristics and limitations of OR, models used in OR, linear programming (LP) problem-formulation and solution by graphical method.	
Unit -II	**09 Hrs**
Solution of Linear Programming Problems : The simple method canonical and standard form of an LP problem, slack, surplus and artificial variables, big M method and concept of duality, dual simplex method.	
Unit -III	**10 Hrs**
Transportation Problem : Formulation of transportation problem, types, initial basic feasible solution using different methods, optimal solution by MODI method, degeneracy in transportation problems, application of transportation problem concept for maximization cases. Assignment Problem-formulation, types, application to maximization cases and travelling salesman problem.	
Unit -IV	**10 Hrs**
Pert-CPM Techniques : Introduction, network construction - rules, Fulkerson's rule for numbering the events, AON and AOA diagrams; Critical path method to find the expected completion time of a project, floats; PERT for finding expected duration of an activity and project, determining the probability of completing a project, predicting the completion time of project; crashing of simple projects.	
Unit -V	**09 Hrs**
Sequencing: Basic assumptions, sequencing 'n' jobs on single machine using priority rules, sequencing using Johnson's rule-'n' jobs on 2 machines, 'n' jobs on 3 machines, 'n' jobs on 'm' machines. Sequencing 2 jobs on 'm' machines using graphical method.	

Course Outcomes: At the end of this course the student will be able to :	
CO1:	Define and explain the applications of Operations Research
CO2:	Demonstrate the time of completion of project using PERT and CPM techniques
CO3:	Formulate and solve Linear Programming Problems (LPP)
CO4:	Organise and solve transportation problems to provide optimal solution
CO5:	Demonstrate the methodology of scheduling of machines by using sequencing methods

Reference Books	
1	Operations Research: Theory and Applications, S D Sharma, 4th Edition 2009, Laxmi Publications ISBN-13: 978-0230638853
2	Operations Research: Theory and Applications, J K Sharma, 5th Edition (2012), MACIN; ISBN: 978-9350593363
3	Operations Research: An Introduction, Hamdy A Taha, 9th Edition (2014), Pearson Education India; ISBN: 978-9332518223

4	Introduction to Operations Research, Frederick K. Hiller, Bodhibrata Nag, Preetam Basu, Geralld J. Lieberman, 9th edition (29 September 2011), McGraw Hill Education; ISBN-13: 978-0071333467

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project is 10.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**2**	**3**	**3**	**2**	**2**	**2**	**2**	**1**	**1**	**1**	**1**	**1**
CO2	**3**	**2**	**2**	**2**	**3**	**1**	**1**	**1**	**1**	**1**	**1**	**1**
CO3	**3**	**3**	**3**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**2**	**1**
CO4	**3**	**3**	**1**	**2**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

High-3 : Medium-2: Low-1

Semester: VII						
SPACE DYNAMICS **(Group F: Professional Elective)**						
Course Code	**:**	16AS7F3		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	4:0:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	48L		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: To enable the students to:	
1	Develop an understanding of celestial mechanics required to predict the behaviour of various celestial bodies
2	Obtain a detailed knowledge of orbital mechanics and its solutions with applications to geocentric orbits and interplanetary transfers
3	Examine the effect of perturbations on the performance of a satellite in its orbit
4	Familiarize with various types of Interplanetary Trajectories in space domain

Unit-I	**10 Hrs**
Understanding Astronomy: The Universe, Solar System: Planets, Asteroids, Comets, & Meteoroids, Reference Frame & Coordinate System: Position of the Earth's Surface, The Celestial Sphere, The Ecliptic, Geocentric Reference Frames, Heliocentric Reference Frames, Vernal Equinox Motion, Velocity Vector, Time & Calendar: Sidereal Time, Solar Time, Mean Solar Time, Standard Time, Ephemeris Time & Atomic Time, The Year, The Julian Date, The Earth and its Shape, The Earth's Atmosphere.	
Unit -II	**10 Hrs**
Fundamentals of Orbital Mechanics : Two Body Motion, Circular & Escape Velocity, Orbit Equation, Kepler's Equation, Motion in Various Orbits, Position & Velocity, Orbit Determination & Satellite Tracking.	
Unit -III	**09 Hrs**
Rigid Body Dynamics : Choice of Origin, Angular Momentum & Energy, Principal Body Axis Frame, Parallel Axis Theorem, Euler's Equation, Orientation Angles.	
Unit -IV	**10 Hrs**
Satellite Attitude Dynamics : Torque Free Axisymmetric Rigid Body, General Torque Free Rigid Body, Attitude Control: Spinning & Non-Spinning Spacecraft, Yo-Yo Mechanism, Gravity Gradient Satellite, Dual Spin Spacecraft, Attitude Determination.	
Unit -V	**09 Hrs**
Satellite Launching & Injection : Launch Vehicle Ascent Trajectories, Injection of a Satellite: General Aspects of Injection, Dependence of Orbital Parameters, Launch Vehicle Performances, Orbital Deviations due to Injection Errors.	

Course Outcomes: At the end of this course the student will be able to :	
CO1:	Comprehend the fundamental behaviour of various planets through celestial mechanics
CO2:	Extend the knowledge of orbital mechanics to achieve space flight
CO3:	Study the attitude characteristics of satellites in space under various celestial environments
CO4:	Estimate and reduce the perturbations encountered by a satellite during injection operations

Reference Books	
1	Rocket Propulsion and Spaceflight Dynamics, J.W.Cornelisse, H.F.R. Schoyer, and K.F. Wakker, , 1st Edition, 2000, Pitman Publishing, ISBN-13: 978-0273011415
2	Spaceflight Dynamics, William E.Wiesel, 2nd Edition, 1997, McGraw-Hill, 2001, I SBN-13: 978-0070701106
3	Orbital Mechanics, Vladimir A. Chobotov, 3rd Edition, 2002, AIAA Education Series, Published by AIAA, ISBN 978-1-56347-537-5

4	Spacecraft Mission Design, Charles D.Brown, 2nd Edition, 2001, AIAA Education Series, ISBN-13: 978-1563472626

Scheme of Evaluation

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project is 10.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**1**	**1**	**3**	**2**	**2**				**1**
CO2	**2**	**3**	**3**	**3**	**1**	**1**	**1**	**1**				**2**
CO3	**1**		**3**	**3**								**2**
CO4	**3**	**3**	**3**	**3**		**2**	**1**	**2**				**2**

High-3 : Medium-2: Low-1

Semester: VII						
SMART MATERIALS **(Group F: Professional Elective)**						
Course Code	**:**	16AS7F4		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	4:0:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	48L		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: To enable the students to:	
1	Differentiate composites and ceramics based on their characteristics
2	Explain the usage of smart materials in manufacturing of sensors and actuators
3	Identify and appreciate the usage of MR Fluids for valves and dampers
4	Justify the usage of smart material based on their characteristics to control drag and turbulence
5	Describe the applications of smart materials for MEMS, PZT actuators based on their characteristics

Unit-I	**10 Hrs**
Introduction: Characteristics of composites and ceramics materials, Dynamics and controls, concepts, Electro-magnetic materials and shape memory alloys-processing and characteristics.	
Unit -II	**10 Hrs**
Sensing And Actuation : Principles of electromagnetic, acoustics, chemical and mechanical sensing and actuation, Types of sensors and their applications, their compatibility writer conventional and advanced materials, signal processing, principles and characterization.	
Unit -III	**10 Hrs**
Control Design : Design of shape memory alloys, Types of MR fluids, Characteristics and application, principles of MR fluid value designs, Magnetic circuit design, MR Dampers, Design issues.	
Unit -IV	**09 Hrs**
Structures : Principles of drag and turbulence control through smart skins, applications in environment such as aerospace and transportation vehicles, manufacturing, repair and maintainability aspects.	
Unit -V	**09 Hrs**
Principles of Vibration And Modal Analysis : PZT Actuators, MEMS, Magnetic shape Memory Alloys, Characteristics and Applications.	

Course Outcomes: At the end of this course the student will be able to :	
CO1:	Differentiate composites and ceramics based on their characteristics
CO2:	Explain the usage of smart materials in manufacturing of sensors and actuators
CO3:	Identify and appreciate the usage of MR Fluids for valves and dampers
CO4:	Justify the usage of smart material based on their characteristics to control drag and turbulence

Reference Books	
1	Smart Materials and Structures, M V Gandhi and B S Thompson, 2nd Edition, 1992, Chapmen & Hall, London, ISBN-13: 978-0412370106
2	Smart Materials and Structures, Banks HT, RC Smith, Y Wang, Massow S A, 1st Edition, 1996, Wiley-Masson, ISBN-13: 978-0471970248
3	Smart Structures: Analysis and Design, A. V. Srinivasan, 1st Edition, 2000, Cambridge Universities Press, New York, ISBN-13: 978-0521659772

Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project is 10.
Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)
SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**1**	**1**	**3**	**2**	**2**				**1**
CO2	**2**	**3**	**3**	**3**	**1**	**1**	**1**	**1**				**2**
CO3	**1**		**3**	**3**								**2**
CO4	**3**	**3**	**3**	**3**		**2**	**1**	**2**				**2**

High-3 : Medium-2: Low-1

Semester: VII						
HYPERSONIC AERODYNAMICS (Group G: Professional Elective)						
Course Code	**:**	16AS7G1		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	4:0:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	48L		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: To enable the students to:	
1	Outline all the important aspects required to understand the hypersonic flight regime
2	Understand various theories and establish equations specific to hypersonic flow conditions
3	Formulate the governing equations instrumental in determining the flow properties involving viscous behaviour of fluid
4	Thoroughly comprehend the concepts of rarefied gas dynamics and their effect on crafts in outer atmosphere

Unit-I	**10 Hrs**
Fundamentals of Hypersonic Flows : Qualitative aspects of hypersonic flow, Physical phenomena in hypersonic flows: Thin shock layers, Entropy layer, Viscous interaction, High temperature flows, Low-density flows, Recapitulation, Hypersonic flight path-velocity altitude map, Stagnation region flow field properties.	
Unit -II	**10 Hrs**
Inviscid Hypersonic Flows : Basic Hypersonic Relations, Hypersonic Similarity Parameter, Hypersonic Expansion-Wave Relations, Newtonian Flow, Modified Newtonian Law, Centrifugal Force Corrections to Newtonian Theory, Tangent-Wedge Tangent-Cone Methods, Shock-Expansion Method.	
Unit -III	**09 Hrs**
Solutions for Hypersonic Inviscid Flowfields : Basic Governing Equations, Mach Number Independence, Hypersonic Small-Disturbance Equations, Hypersonic Similarity, Hypersonic Equivalence Principle and Blast-Wave Theory, Thin Shock-Layer Theory, Method of Characteristics.	
Unit -IV	**09 Hrs**
Viscous Hypersonic Flow : Governing Equations for Viscous Flow: Navier–Stokes Equations, Similarity Parameters and Boundary Conditions, Boundary-Layer Equations for Hypersonic Flow, Hypersonic Transition, Hypersonic Aerodynamic Heating, Entropy-Layer Effects on Aerodynamic Heating.	
Unit -V	**10 Hrs**
Rarefied Gas Dynamics : The Conception of Rarefied Gas Dynamics, Molecular Model of Gases, Mean Free Path of Molecules, Division of Flow Regimes, Non-equilibrium Phenomena and Rarefied Gas Dynamics, Similarity Criteria, Collision Frequency and Mean Free Path, Velocity and Speed Distribution Functions: Mean Velocities.	

Course Outcomes: At the end of this course the student will be able to :	
CO1:	Comprehend the important aerodynamic features distinguishing hypersonic flight regime
CO2:	Utilize different theories to build basic equations specific to high speed flow regimes
CO3:	Establish fundamental governing equations to determine the significant hypersonic flow properties
CO4:	Analyze the effect of free molecular flow on the construction of an hypersonic vehicle operating in exosphere

Reference Books	
1	Hypersonic and High Temperature Gas Dynamics, John David Anderson , 2nd Edition, 2006, AIAA Education Series, USA, ISBN 978-1-56347-780-5
2	Hypersonic Aerothermodynamics, John J. Bertin, 1994 AIAA Education Series, USA., ASIN B01A68GUDG

3	Introduction to Hypersonic flow, Cherni C. G, 1st Edition, 1961Academic Press, New York, ISBN 9781483271682
4	Hypersonic Flow Theory, Hayes W. D and Probstein R F, 2nd Edition, 1966, Academic Press, New York
5	Elements of Hypersonic Aerodynamics, Cox R. N, Crabtree L. P, 1st Edition, 1965, Academic press,New York, ASIN B003RNTS9G

Scheme of Evaluation

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project is 10.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**1**	**1**	**3**	**2**	**2**				**1**
CO2	**2**	**3**	**3**	**3**	**1**	**1**	**1**	**1**				**2**
CO3	**1**		**3**	**3**								**2**
CO4	**3**	**3**	**3**	**3**		**2**	**1**	**2**				**2**

High-3 : Medium-2: Low-1

Semester: VII						
THEORY OF AEROELASTICITY (Group G: Professional Elective)						
Course Code	**:**	16AS7G2		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	4:0:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	48L		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: To enable the students to:	
1	Understand classical Aeroelastic problems arising due to fluid structure interaction.
2	Understand the underlying principles of static aeroelasticity.
3	Understand the significance of unsteady aerodynamics on the aircraft structures.
4	Comprehend solution of dynamic instability and aeroelastic response problems.

Unit-I	**10 Hrs**
Introduction to Aeroelasticity: Vibration and its forces, Flexibility effect on aerodynamics, structure and aerodynamic interaction, Aeroelasticity, Classificatin of Aeroelasticity, Collar's triangle, Simple definition on Static aeroelasticity: Divergence, load distribution, control effectiveness, control system reversal, Simple definition on Dynamic aeroelasticity: Flutter, buffeting, dynamic response.	
Unit -II	**10 Hrs**
Static Aeroelasticity: Divergence: Torsional Wing Box, Divergence of A Two Dimensional Rigid Aerofoil With Spring Attachment, Static Aeroelastic Behaviour Of Fixed Root Flexible Wing, Divergence Prediction Using Dynamic Method, Numericals On Divergence. **Control effectiveness and Reversal**: Effect of wing Flexibility on Control Effectiveness, Rolling Effectiveness of a Flexible Wing- Steady Roll Case, and Determination of Reversal Speed for Steady Roll Case, Problems On Control Reversal.	
Unit -III	**09 Hrs**
Unsteady Aerodynamics: Quasi Steady Aerodynamics, Unsteady Aerodynamics, Aerodynamic lift and moment for a harmonically oscillating Aerofoil, Oscillatory aerodynamic derivatives, Aerodynamic damping and stiffness, Unsteady Aerodynamics Related to Gusts**.**	
Unit -IV	**09 Hrs**
Dynamic aeroelasticity: Fluter*:* Simplified Unsteady Aerodynamic Model, Binary Aeroelastic Model, General Form of the aeroelastic Equations, Eigenvalue Solution of Flutter Equations, Aeroelastic behaviour of the Binary Model, Aeroelastic behaviour of a Flexible Wing, Flutter speed prediction for binary systems.	
Unit -V	**10 Hrs**
Dynamic Aeroelasticity: Gusts and Turbulence: Types of Gust, Assumption in modelling Gust, Gust response in time domain – Flexible Aircraft, equations of motions, Definition of Continuous turbulence and harmonic gust velocity component, FRF for flexible aircraft response in Heave/Pitch per Harmonic gust velocity.	

Course Outcomes: At the end of this course the student will be able to :	
CO1:	Identify the type and parameters influencing different classical Aeroelastic problems.
CO2:	Formulate mathematical model for solution of common static Aeroelastic problems
CO3:	Realize the effect of unsteady aerodynamics on the behavior of Aeroelastic systems
CO4:	Understand the dynamic behavior of aircraft structures to identify dynamic instabilities

Reference Books	
1	A Modern Course in Aeroelasticity, Dowell, E. H., Crawley, E. F., Curtiss Jr., H. C., Peters, D. A., Scanlan, R. H., and Sisto, F., 3rd Edition, 1995, Kluwer Academic Publishers,. (TL574.A37.M62)
2	Aeroelasticity, Bisplinghoff, R., Ashley, H., and Halfman, R. L., 1st Edition, 1996, Dover Publications, ISBN-13: 978-0486691893
3	An Introduction to the Theory of Aeroelasticity, Fung, Y. C., 1st Edition, 1955, Dover

	Publications, ISBN 9780486495057
4	Aircraft structures for Engineering students, Megson THG, 3rd Edition, 1999, Edward Arnold, ISBN-13: 978-0470349373
5	Jan R. Wright, Jonathan E. Cooper, Introduction to Aircraft Aeroelasticity and Loads, 1st Edition, 2007, AIAA, ISBN-13: 978-1563479359

Scheme of Evaluation

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project is 10.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**1**	**1**	**3**	**2**	**2**				**1**
CO2	**2**	**3**	**3**	**3**	**1**	**1**	**1**	**1**				**2**
CO3	**1**	**2**	**3**	**3**	**1**							**2**
CO4	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**2**				**2**

High-3 : Medium-2: Low-1

Semester: VII						
HELICOPTER DYNAMICS (Group G: Professional Elective)						
Course Code	**:**	16AS7G3		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	4:0:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	48L		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: To enable the students to	
1	Understand the basic concepts associated with rotor aerodynamics
2	Classify the types of rotor and determine their behaviour in various configurations
3	Interpret the performance of the helicopter along various axes
4	Apply the basic concepts of trim in achieving the stability of an helicopter

Unit-I	**10 Hrs**
Fundamentals of Rotor Aerodynamics: Momentum Analysis in Axial: Flow near a Hovering Rotor, Conservation Laws applied to the Hovering Rotor, Disc Loading and Power Loading, Forward Flight: Induced Velocity, Axial Climb and Decent, Working States of Rotor in Axial Flight, Autorotation, Induced Inflow Ratio, Application of Momentum Theory to Coaxial, Tandem and Ducted Fan Rotor Design.	
Unit -II	**10 Hrs**
Blade Element Analysis: Blade Element Analysis in Hover and Axial Flight: Integrated Rotor Thrust and Power, Untwisted Blades and Uniform Flow, Linearly Twisted Blades and Uniform Flow, Torque Power Approximation, Tip Loss Factor, Blade Element Momentum Theory: Analytical Approach, Circulation Theory of Lift, Weighted Solidity: Thrust, Power and Torque, Tip Losses.	
Unit -III	**10 Hrs**
Rotating Blade Motion: Types of Rotors, Equilibrium about Flapping and Lead/Lag Hinge, Equations of Motion for Flapping Blades, Blade Flapping: Longitudinal and Lateral, Rotor Control using Swash plates, Concepts of Blade Feathering.	
Unit -IV	**09 Hrs**
Helicopter Performance: Hovering and Axial Climb Performance, Forward Flight Performance: Induced and Blade Profile Power, Climb Power, Tail Rotor Power, Total Power, Optimum Speed, Maximum Level Speeds, Rotor Limits Envelop.	
Unit -V	**09 Hrs**
Helicopter Trim, Stability and Control: Trim, Treatment of Stability and Control, Static Stability, Dynamic Stability, Hingeless Rotor and Control, Autostabilization.	

Course Outcomes: At the end of this course the student will be able to :	
CO1:	Apply the knowledge of blade element momentum theory to determine the aerodynamic characteristics of the rotor blade
CO2:	Study the behavior of the helicopter under various blade configurations
CO3:	Estimate the performance parameters of a helicopter
CO4:	Evaluate the stability and control characteristics of a helicopter under various conditions

Reference Books	
1	Principles of Helicopter Aerodynamics, Gordon Leisshman J, 2002, Cambridge University Press, ISBN 9780521523967
2	Basic Helicopter Aerodynamics, John M. Seddon , Simon Newman, 3rd Revised Edition, 2011, Wiley-Blackwell; ISBN-13: 978-0470665015
3	Helicopter Dynamics, Bramwell, 2nd Edition, 2001, Butterworth-Heinemann, ISBN-13: 978-0750650755
4	The Helicopter, History, Piloting & How it Flies, John Fay, 4th Revised edition, 1990, Sterling Book House 2007, ISBN 978-0715389409

Scheme of Evaluation

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project is 10.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**1**	**2**	**3**	**2**		**1**						**2**
CO2	**2**	**2**	**2**	**3**								**1**
CO3	**3**	**3**	**3**	**1**								**2**
CO4	**3**	**2**	**3**	**3**		**1**	**1**	**1**				**1**

High-3 : Medium-2: Low-1

Semester: VII						
FLIGHT TESTING **(Group G: Professional Elective)**						
Course Code	**:**	16AS7G4		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	4:0:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	48L		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: To enable the students to:	
1	Familiarize with the mandatory flight testing procedures employed for assessing the handling qualities of a given airplane
2	Identify all possible sources of errors and their magnitude during the assessment of an airplane
3	Assess the handling qualities of any given airplane subjected to various flight parameters
4	Evaluate the complete stability and control characteristics of an aircraft along various axes

Unit-I	**10 Hrs**
Introduction to Flight Testing : Types of Flight Tests, Sequence of Flight Testing, Planning of Test Program, Aircraft Weight and Centre of Gravity. **Data Reduction in Flight Testing :** Sources and Magnitudes of Error, Avoiding and Minimizing Errors, Error Analysis.	
Unit -II	**10 Hrs**
Performance flight testing - range, endurance and climb : Airspeed–in flight calibration. Level flight performance for propeller driven aircraft and for Jet aircraft-Techniques and data reduction. Estimation of range, endurance and climb performance.	
Unit -III	**09 Hrs**
Performance flight testing-take-off, landing, turning flight : Manoeuvring performance estimation, Take-off and landing -methods, procedures and data reduction.	
Unit -IV	**09 Hrs**
Stability and control - longitudinal and manoeuvring : Static & dynamic longitudinal stability: - methods of flight testing and data reduction techniques. Stick free stability methods. Manoeuvring stability methods & data reduction.	
Unit -V	**10 Hrs**
Stability and control - lateral and directional : Lateral and directional static & dynamic stability:- Coupling between rolling and yawing moments. Steady heading slide slip. Definition of Roll stability. Adverse yaw effects. Aileron reversal. Regulations, test techniques and method of data reduction.	

Course Outcomes: At the end of this course the student will be able to :	
CO1:	List the various flight testing procedures incorporated to evaluate the flying characteristics of an airplane
CO2:	Classify various types of errors based on their origin and criticality to the safety of the airplane
CO3:	Evaluate the performance of an aircraft under various flying conditions
CO4:	Estimate the complete stability characteristics of the given airplane along various principle axes

Reference Books	
1	Flight Testing of Fixed Wing Aircraft, Ralph D Kimberlin, 2003, AIAA educational Series, ISBN-13: 978-1563475641
2	Flight Testing- Conventional and Jet propelled Airplanes, Benson Hamlin, 1st Edition, 1946, Mac Millan, ASIN: B000UDZ1B0
3	Introduction to Flight Test Engineering, Donald T Ward, Thomas W Strganac,; 3rd Edition 2006, Kendall Hunt Publishing, ISBN-10: 0757529348
4	AGARD, Flight Test Manual Vol. I to IV

Scheme of Evaluation

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project is 10.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**1**	**1**	**3**	**2**	**2**				**1**
CO2	**2**	**3**	**3**	**3**	**1**	**1**	**1**	**1**				**2**
CO3	**1**		**3**	**3**								**2**
CO4	**3**	**3**	**3**	**3**		**2**	**1**	**2**				**2**

High-3 : Medium-2: Low-1

Semester: IV						
NANOTECHNOLOGY (Group H: Open Elective)						
Course Code	**:**	16G7H01		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	36L		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	To have the basic knowledge of nanomaterials and the process.
2	Describe methods of nanoscale manufacturing and characterization can be enabled.
3	To learn about Nano sensors and their applications in mechanical, electrical, electronic, Magnetic, Chemical field.
4	To understand the concept for a nanoscale product based on sensing, transducing, and actuating mechanism.
5	To have awareness about the nanoscale products used in multidisciplinary fields.

Unit-I	**06 Hrs**
Introduction to Nanomaterials: History of Nanotechnology, structures and properties of carbon based: Fullerenes (Bucky Ball, Nanotubes), metal based: Nano Shells, Quantum Dots, Dendrimers, Diamond like carbon(DLC) Nanocarriers, bionanomaterails: protein & DNA based nanostructures, Hybrids: hybrid biological/inorganic, Nanosafety Issues: Toxicology health effects caused by nanoparticles.	
Unit – II	**08 Hrs**
Characterization of Nanostructures: Spectroscopy: UV-Visible spectroscopy, Fourier Transform infrared spectroscopy (FTIR), Raman Spectroscopy, X-ray spectroscopy. **Electron microscopy**: Scanning electron microscopy (SEM), Transmission electron microscopy (TEM).**Scanning probe microscopy**: Atomic Force microscopy (AFM), Scanning tunnel microscopy (STM). **Nano Synthesis and Fabrication**: Introduction & overview of Nanofabrication: Bottom up and Top down approaches using processes like Ball milling, Sol-gel Process, Chemical Vapour deposition (CVD), plsma arching and various lithography techniques (Hard & Soft lithography).	
Unit –III	**09 Hrs**
Nanosensors: Overview of nanosensors, prospects and market. Types of Nanosensors and their applications. Electromagnetic nanosensors: Electronic nose and electronic tongue, Magnetic nanosensors. Mechanical nanosensors: Cantilever Nanosensors, Mechanics of CNTs, Biosensors: Biosensors in modern medicine.	
Unit –IV	**06 Hrs**
Micro & Nano-Electromechanical systems and Microfluidics: MEMS/NEMS: Magnetic, Chemical and Mechanical Transducers –Sensing and Actuators. Microfludics: Laminar flow, Hagen-Peouiselle equation, basic fluid ideas, Special considerations of flow in small channels, mixing, microvalves & micropumps.	
Unit –V	**07 Hrs**
Applications of Nanotechnology: Molecular electronics, molecular switches, mechanical cutting tools, machine components, DLC coated grinding wheels. solar cells, Batteries, fuel cells, Nanofilters. Medical nanotechnology: in Diagnostics, Therapeutics, Drug delivery and Nanosurgery.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Remember, understand, and apply knowledge about of nanomaterials and their uses.
CO2:	Interpret and apply the techniques of manufacturing and characterization processes
CO3:	Apply the knowledge of Nanosensors, related to nanosensors in electronics, mechanical, chemical, and biological systems.
CO4:	Create and evaluate nano Design, Devices and Systems in various disciplines

Reference Books	
1	B.S. Murty., P. Shankar., B.Raj, B..B. Rath, and J. Murday, Textbook of Nanosciences and Nanotechnology, Springer, Co-publication with University Press (India) Pvt. Ltd. VCH, XII.1st Edition, 2013, ISBN- 978-3-642-28030-6.
2	V. K. Khanna, Nanosensors:, Physical, Chemical and Biological, CRC press, 1st edition, 2013, ISBN 9781439827123 (Unit III).
3	C. C. Kock., Nanostructured materials, Nanostructured materials, William Andrew Publishing, 2nd edition, 2007, ISBN 0-8155-1534-0.
4	M .Wilson., K. Kannangara., G.Smith., M.Simmons., B. Raguse., Nanotechnology, , overseas Press (India) Private Ltd.,1st edition, 2005,ISBN 81-88689-20-3.

Scheme of Evaluation

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project 10.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Semester: VII						
INDUSTRIAL SAFETY AND RISK MANAGEMENT (Group H: Open Elective)						
Course Code	**:**	16G7H02		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	36L		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Understand the basics of risk assessment methodologies
2	Select appropriate risk assessment techniques
3	Analyze public and individual perception of risk
4	Relate safety, ergonomics and human factors
5	Carry out risk assessment in process industries

Unit-I	**08 Hrs**
General Risk Identification Methods – I: Hazard identification methodologies, risk assessment methods-PHA, HAZOP, MCA, consequence analysis, hazards in workplaces-nature and type of work places, types of hazards, hazards due to improper housekeeping, hazards due to fire in multi floor industries and buildings.	
Unit – II	**07 Hrs**
Risk Assessment Methods – II: Risk adjusted discounted rate method, certainty equivalent coefficient method, quantitative analysis, probability distribution, coefficient of variation method, Simulation method, Shackle approach, Hiller‟s model, Hertz Model.	
Unit –III	**07 Hrs**
Risk Management – III: Emergency relief Systems, Diers program, bench scale experiments, design of emergency relief systems, risk management plan, mandatory technology option analysis, risk management alternatives, risk management tools, risk management plans, risk index method, Dowfire and explosion method, Mond index Method.	
Unit –IV	**07 Hrs**
Risk Assurance and Assessment – IV: Property insurance, transport insurance, liability insurance, risk Assessment, low Probability high consequence events. Fault tree analysis, Event tree analysis.	
Unit –V	**07Hrs**
Risk Analysis in Chemical Industries– V: Handling and storage of chemicals, process plants, personnel protection equipment's. International environmental management system.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Recall risk assessment techniques used in process industry
CO2:	Interpret the various risk assessment tools
CO3:	Use hazard identification tools for safety management
CO4:	Analyze tools and safety procedures for protection in process industries

Reference Books	
1	Kirkcaldy K.J.D Chauhan, Functional Safety in the Process Industry : A Handbook of practical Guidance in the application of IEC61511 and ANSI/ISA-84,North corolina, Lulu publication,2012,ISBN:1291187235
2	Goble and William M. Safety Instrumented Systems Verification Practical probabilistic calculations, Pensulvania ISA publication,2005,ISBN:155617909X
3	Laird Wilson and Doug Mc Cutcheon. Industrial safety and risk Management,The University of Alberta press,Canada, 1st Edition,2003,ISBN: 0888643942.

4	Sincero A P and Sincero G A Environmental Engineering – A Design Approach,Prentice Hall of India, New Delhi,1996, ISBN: 0024105643
5	Pandya C G, Risks in Chemical units, Oxford and IBH publications, New Delhi,1992,ISBN: 8120406907

Scheme of Evaluation

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project 10.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Semester: VII						
INTELLIGENT TRANSPORT SYSTEM (Group H: Open Elective)						
Course Code	**:**	16G7H03		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	36L		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand basic traffic flow and control for ITS
2	Understand user services for application in transportation system
3	Understand ITS architecture and its planning at various levels
4	Evaluate user services at various levels

Unit – I	**08 Hrs**
Introduction: –Historical Background, Definition, Future prospectus, ITS training and educational needs. **Fundamentals of Traffic Flow and Control**- Traffic flow elements, Traffic flow models, Shock waves in Traffic streams, Traffic signalization and control principles, Ramp metering, Traffic simulation.	
Unit – II	**06 Hrs**
ITS User services-User services bundles, Travel and Traffic management, Public Transportation Operations, Electronic Payment, Commercial Vehicles Operations, Emergency Management, Advanced Vehicle Control and safety systems, Information Management, Maintenance and construction Management	
Unit –III	**07 Hrs**
ITS Applications and their benefits-Freeway and incident management systems-objectives, functions, traffic Surveillance and incident detection, Ramp control, incident management, Advanced arterial traffic control systems- historical development, Adaptive traffic control algorithms, Advanced Public Transportation Systems-Automatic vehicle location systems, Transit Operations software and information systems, Electronic fare payment systems, Multimodal Traveler Information systems	
Unit –IV	**07 Hrs**
ITS Architecture-Regional and Project ITS Architecture, Need of ITS architecture, concept of Operations, National ITS Architecture, Architecture development tool. **ITS Planning**-Transportation planning and ITS, Planning and the National ITS Architecture, Planning for ITS, Integrating ITS into Transportation Planning, relevant case studies.	
Unit –V	**08 Hrs**
ITS Standards-Standard development process, National ITS architecture and standards, ITS standards application areas, National Transportation Communications for ITS Protocol, Standards testing. **ITS Evaluation** – Project selection at the planning level, Deployment Tracking, Impact Assessment, Benefits by ITS components, Evaluation Guidelines, Challenges and Opportunities.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Identify various applications of ITS
CO2:	Apply ITS applications at different levels.
CO3:	Examine ITS architecture for planning process.
CO4:	Define the significance of ITS for various levels

Reference Books	
1	Choudury M A and Sadek A, "Fundamentals of Intelligent Transportation Systems Planning" Artech House publishers (31 March 2003); ISBN-10: 1580531601
2	Bob Williams, "Intelligent transportation systems standards" ,Artech House, London, 2008. ISBN-13: 978-1-59693-291-3.
3	Asier Perallos, Unai Hernandez-Jayo, Enrique Onieva, Ignacio Julio García Zuazola "Intelligent Transport Systems: Technologies and Applications" Wiley Publishing ©2015, ISBN:1118894782 9781118894781
4	ITS Hand Book 2000 Recommendations for World Road Association (PIARC) by Kan Paul Chen, John Miles.
5	Dominique Luzeaux ,Jean-René Ruault, Michel Chavret "Intelligent Transport Systems" 7 MAR 2013 Copyright © 2010 by John Wiley & Sons, Inc DOI: 10.1002/9781118557495.ch6

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment. A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for assignment is 10. The total marks of CIE are 100.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks are executed by means of an examination. The Question paper for each course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Semester: VII						
INTELLIGENT SYSTEMS (Group H: Open Elective)						
Course Code	**:**	16G7H04		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	36L		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand fundamental AI concepts and current issues.
2	Understand and apply a range of AI techniques including search, logic-based reasoning, neural networks and reasoning with uncertain information.
3	Recognize computational problems suited to an intelligent system solution.
4	Identify and list the basic issues of knowledge representation, blind and heuristic search.

Unit-I	**07 Hrs**
Introduction: The Foundations of Artificial Intelligence, History of Artificial Intelligence, The State of the Art, **Intelligent Agent:** Introduction, How Agents Should Act, Structure of Intelligent Agents, **Problem-solving**: Solving Problems by Searching Search Strategies, Avoiding Repeated States ,Avoiding Repeated States	
Unit – II	**07 Hrs**
Informed Search Methods: Best-First Search, Heuristic Functions, Memory Bounded Search, Iterative Improvement Algorithms **Game Playing:** Introduction: Games as Search Problems, Perfect Decisions in Two-Person, Games Imperfect Decisions, Alpha-Beta Pruning, Games That Include an Element of Chance	
Unit –III	**07 Hrs**
Knowledge Inference Knowledge representation -Production based system, Frame based system. Inference - Backward chaining, Forward chaining, Rule value approach, Fuzzy reasoning - Certainty factors, Bayes Rule, Uncertainty Principles, Bayesian Theory-Bayesian Network-Dempster - Shafer theory.	
Unit –IV	**07 Hrs**
Learning from Observations: A General Model of Learning Agents, Inductive Learning, Learning Decision Trees, Using Information Theory, Learning General Logical Descriptions, Why Learning Works: Computational Learning Theory **Reinforcement Learning:** Passive Learning in a Known Environment, Passive Learning in an Unknown Environment, Active Learning in an Unknown Environment	
Unit –V	**07 Hrs**
Expert Systems, Components, Production rules, Statistical reasoning, certainty factors,measure of belief and disbelief, Meta level knowledge, Introspection. Expert systems - Architecture of expert systems, Roles of expert systems - Knowledge Acquisition –Meta knowledge, Heuristics. Typical expert systems - MYCIN, DART, XOON, Expert systems shells.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand and explore the basic concepts and challenges of Artificial Intelligence.
CO2:	Analyze and explain basic intelligent system algorithms to solve problems.
CO3:	Apply Artificial Intelligence and various logic-based techniques in real world problems.
CO4:	Assess their applicability by comparing different Intelligent System techniques

Reference Books	
1	AI – A Modern Approach ,Stuart Russel, Peter Norvig , 2nd Edition, Pearson Education, 2010, ISBN-13: 978-0137903955.
2	Artificial Intelligence (SIE) ,Kevin Night, Elaine Rich, Nair B., ,McGraw Hill, 1st Edition, 2008, ISBN: 9780070087705

3	Introduction to AI and ES ,Dan W. Patterson, Pearson Education, 1st Edition ,2007. ISBN: 0132097680
4	Introduction to Expert Systems ,Peter Jackson, 3rd Edition, Pearson Education, 2007, ISBN-978-0201876864

Scheme of Evaluation

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project 10.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**2**	**-**	**2**	**2**
CO2	**3**	**3**	**3**	**3**	**3**	**2**	**2**	**1**	**2**	**-**	**2**	**2**
CO3	**3**	**3**	**3**	**3**	**3**	**2**	**1**	**1**	**2**	**-**	**2**	**2**
CO4	**3**	**3**	**3**	**3**	**3**	**1**	**2**	**1**	**1**	**1**	**2**	**2**

High-3: Medium-2 : Low-1

Semester: VII						
IMAGE PROCESSING AND MACHINE LEARNING (Group H: Open Elective)						
Course Code	**:**	16G7H05		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	3:0:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	40L		**SEE Duration**	**:**	**03 Hours**

Course Learning Objectives: The students will be able to	
1	Understand the major concepts and techniques in image processing and Machine Learning
2	To explore, manipulate and analyze image processing techniques
3	To become familiar with regression methods, classification methods, clustering methods.
4	Demonstrate image processing and Machine Learning knowledge by designing and implementing algorithms to solve practical problems

Unit-I	**08 Hrs**
Introduction to image processing: Images, Pixels, Image resolution, PPI and DPI, Bitmap images, Lossless and lossy compression, Image file formats, Color spaces, Bezier curve, Ellipsoid, Gamma correction, Advanced image concepts	
Unit – II	**08 Hrs**
Basics of Python & Scikit image: Basics of python, variables & data types, data structures, control flow & conditional statements, uploading & viewing an image, Image resolution, gamma correction, determining structural similarities.	
Unit –III	**08 Hrs**
Advanced Image processing using Open CV Blending Two Images, Changing Contrast and Brightness Adding Text to Images Smoothing Images , Median Filter ,Gaussian Filter ,Bilateral Filter ,Changing the Shape of Images ,Effecting Image Thresholding ,Calculating Gradients , Performing Histogram Equalization	
Unit –IV	**08 Hrs**
Machine Learning Techniques in Image Processing Bayesian Classification, Maximum Likelihood Methods, Neural Networks; Non-parametric models; Manifold estimation, Support Vector Machines, Logistic Regression	
Unit –V	**08 Hrs**
Introduction to object Tracking , Modeling & Recognition Exhaustive vs. Stochastic Search, Shapes, Contours, and Appearance Models. Mean-shift tracking; Contour-based models, Adaboost approaches: Face Detection / Recognition, Tracking.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Gain knowledge about basic concepts of Image Processing
CO2:	Identify machine learning techniques suitable for a given problem
CO3:	Write programs for specific applications in image processing
CO4:	Apply different techniques for various applications using machine learning techniques.

Reference Books	
1	Practical Machine Learning and Image Processing: For Facial Recognition, Object Detection, and Pattern Recognition Using Python", by Himanshu Singh, Apress publisher.
2	Pattern Recognition and Machine Learning, by Christopher Bishop, Springer, 2008
3	Computer Vision: A modern Approach" by David Forsyth and Jean Ponce, Prentice Hall India 2004.
4	Machine Vision : Theory Algorithms Practicalities ,by E.R. Davies Elsevier 2005.
5	Digital Image Processing, Rafael C. Gonzalez and Richard E. Woods Pearson Education, Ed, 2001.

Scheme of Evaluation

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project 10.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

SEMESTER: VII						
DESIGN OF RENEWABLE ENERGY SYSTEMS (Group H: Open Elective)						
Course Code	**:**	16G7H06		**CIE Marks**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	3:0:0		**SEE Marks**	**:**	**100 Marks**
Total Hours	**:**	40L		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	To provide opportunity for students to work on multidisciplinary projects.
2	To familiarize the students with the basic concepts of nonconventional energy sources and allied technological systems for energy conversion
3	To impart skill to formulate, solve and analyze basic Non – conventional energy problems and prepare them for graduate studies.
4	To enable the student to design primarily solar and wind power systems.
5	To expose the students to various applications of solar, wind and tidal systems.

UNIT – I	**07 Hrs**

An introduction to energy sources:
Industry overview, incentives for renewable, utility perspective, Relevant problems discussion, current positions of renewable energy conditions

UNIT – II	**09 Hrs**

PV Technology:
photovoltaic power, PV projects, Building-integrated PV system, PV cell technologies, solar energy maps, Technology trends, **Photovoltaic Power Systems**: PV cell, Module and Array, Equivalent electrical circuit, open-circuit voltage and short-circuit current, I-V and P-V curves, Array design (different methodologies), peak-power operation, system components.

UNIT – III	**09 Hrs**

Wind Speed and Energy:
Speed and power relations, power extracted from the wind, Air density, Global wind patterns, wind speed distribution (parameters calculations) , wind speed prediction, **Wind Power Systems :** system components , turbine rating , power vs. speed and TSR, maximum energy capture, maximum power operation, system-design trade-offs , system control requirements, environmental aspects.

UNIT – IV	**07 Hrs**

Geothermal and ocean energy:
Geothermal power, geo pressured sources, Geothermal well drilling, advantages and disadvantages, Comparison of flashed steam and total flow concept
Energy from ocean: OTEC power generation, OPEN and CLOSED cycle OTEC. Estimate of Energy and power in simple single basin tidal and double basin tidal system

UNIT – V	**08 Hrs**

Stand alone system:
PV stand-alone, Electric vehicle, wind standalone, hybrid systems (case study), system sizing, wind farm sizing.
Grid-Connected Systems: introduction**,** interface requirements, synchronizing with the grid, operating limit, Energy storage and load scheduling**,** Grid stability issues**,** distributed power generation.

Course outcomes:

CO1: Demonstrate an understanding of the scientific principles of methodology of Non-conventional energy.
CO2: Acquire working knowledge of different Renewable energy science-related topics.
CO3: Ability to analyze the system related concepts effectively in the wind energy designing.
CO4: Students will be able to decide the appropriate procedures to ensure that the working model has developed properly.

Reference Books	
1.	Wind and Solar Power Systems Design, Analysis and operation, Mukund R Patel, 2nd Edition, 2006, Taylor and Francis publishers, ISBN 978-0-8493-1570-1.
2.	Non-Conventional sources of energy, G.D.Rai, 4th Edition, 2009, Khanna Publishers, ISBN 8174090738, 9788174090737,
3.	Solar Energy, Sukhatme, 4th Edition, 2017, McGraw Hill Education, **ISBN-13:** 978-9352607112
4.	Renewable energy sources, John Twidell, Tony Weir, 3rd Edition, 2015, Routledge Publisher, ISBN-13: 978-0415584388.

Scheme of Evaluation

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project 10.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

VII Semester						
SYSTEMS ENGINEERING (Group H: Open Elective)						
Course Code	**:**	16G7H07		**CIE Marks**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	3:0:0:0		**SEE Marks**	**:**	**100 Marks**
Total Hours	**:**	33L		**SEE Duration**	**:**	**03 Hours**

Course Learning Objectives: The students will be able to

1	Develop an appreciation and understanding of the role of systems engineering processes and systems management in producing products and services.
2	Document systematic measurement approaches for generally cross disciplinary development effort.
3	Discuss capability assessment models to evaluate and improve orgnizational systems engineering capabilities.

Unit-I	**07 Hrs**
System Engineering and the World of Modem System: What is System Engineering?, Origins of System Engineering, Examples of Systems Requiring Systems Engineering, System Engineering viewpoint, Systems Engineering as a Profession, The power of Systems Engineering, problems. **Structure of Complex Systems:** System building blocks and interfaces, Hierarchy of Complex systems, System building blocks, The system environment, Interfaces and Interactions. **The System Development Process:** Systems Engineering through the system Life Cycle, Evolutionary Characteristics of the development process, The system engineering method, Testing throughout system development, problems.	
Unit – II	**07 Hrs**
Systems Engineering Management: Managing systems development and risks, Work breakdown structure (WBS), System Engineering Management Plan (SEMP), Risk Management, Organization of Systems Engineering, Systems Engineering Capability Maturity Assessment, Systems Engineering standards, Problem. **Needs Analysis:** Originating a new system, Operations analysis, Functional analysis, Feasibility analysis, Feasibility definition, Needs validation, System operational requirements, problems. **Concept Exploration:** Developing the system requirements, Operational requirements analysis, Performance requirements formulation, Implementation concept exploration, Performance requirements validation, problems.	
Unit – III	**07 Hrs**
Concept Definition: Selecting the system concept, Performance requirements analysis, Functional analysis and formulation, Concept selection, Concept validation, System Development planning, System Functional Specifications, problems **Advanced Development:** Reducing program risks, Requirements analysis, Functional Analysis and Design, Prototype development, Development testing, Risk reduction, problems.	
Unit – IV	**06 Hrs**
Engineering Design: Implementing the System Building blocks, requirements analysis, Functional analysis and design, Component design, Design validation, Configuration Management, problems. **Integration and Evaluation:** Integrating, Testing and evaluating the total system, Test planning and preparation, System integration, Developmental system testing, Operational test and evaluation, problems.	
Unit – V	**06 Hrs**
Production: Systems Engineering in the factory, Engineering for production, Transition from development to production, Production operations, Acquiring a production knowledge base, problems. **Operations and support**: Installing, maintenance and upgrading the system, Installation and test, In-service support, Major system upgrades: Modernization, Operational factors in system development, problems.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the Life Cycle of Systems.
CO2:	Explain the role of Stake holders and their needs in organizational systems.
CO3:	Develop and Document the knowledge base for effective systems engineering processes.
CO4:	Apply available tools, methods and technologies to support complex high technology systems.
CO5:	Create the frameworks for quality processes to ensure high reliability of systems.
Reference Books	
1	Systems Engineering – Principles and Practice, Alexander Kossoakoff, William N Sweet, 2012, John Wiley & Sons, Inc, ISBN: 978-81-265-2453-2
2	Systems Engineering and Analysis, Blanchard, B., and Fabrycky W, 5th Edition, 2010, Saddle River, NJ, USA: Prentice Hall.
3	Handbook of Human Systems Integration, Booher, H. (ed.) 2003. Hoboken, NJ, USA: Wiley.
4	Systems Engineering: A 21st Century Methodology, Hitchins, D., 2007. Chichester, England: Wiley.

Scheme of Evaluation

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project 10.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Semester: VII						
MEMS AND APPLICATIONS (Group H: Open Elective)						
Course Code	**:**	16G7H08		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	3:0:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	35L		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the rudiments of Micro fabrication techniques.
2	Identify and associate the various sensors and actuators to applications.
3	Analyse different materials used for MEMS.
4	Design applications of MEMS to disciplines.

Unit - I	**06 Hrs**
Overview of MEMS & Microsystems: MEMS and Microsystems, Typical MEMS and micro system products, Evolution of micro fabrication, Microsystems and microelectronics, Multidisciplinary nature of Microsystems, Design and manufacture, Applications of Microsystems in automotive, healthcare, aerospace and other industries. **Working Principle of Microsystems**: Biomedical and biosensors. Micro sensors: Acoustic, Chemical, Optical, Pressure, Thermal.	
Unit – II	**08 Hrs**
Micro actuation: Using thermal forces, shape memory alloys, Piezoelectric crystals and electrostatic forces. MEMS with micro actuators: Microgrippers, micromotors, microvalves and micropumps, microaccelerometers, microfluidics**.** **Introduction to Scaling:** Scaling in Geometry, Scaling in Rigid body dynamics, Scaling in Electrostatic forces, scaling in electromagnetic forces and scaling in fluid mechanics.	
Unit – III	**08 Hrs**
Materials for MEMS and Microsystems: Substrates and wafers, Active substrate materials, Silicon as substrate material, Silicon Compounds, Si-Piezoresistors, GaAs, Quartz, Piezoelectric Crystals, Polymers and packaging materials. Three level of Microsystem packaging, Die level packaging, Device level packaging, System level packaging. Interfaces in microsystem packaging. Essential packaging technologies: die preparation, Surface bonding, Wire bonding, Sealing, 3D packaging.	
Unit – IV	**06 Hrs**
Microsystem Fabrication Process: Introduction to microsystems, Photolithography, Ion Implantation, Diffusion, Oxidation, CVD,PVD-Sputtering, Deposition of Epiaxy, Etching, LIGA process: General description, Materials for substrates and photoresists, Electroplating and SLIGA process.	
Unit – V	**07 Hrs**
Tactile and Flow sensors – Piezoelectric sensors and actuators – piezoelectric effects – piezoelectric materials – Applications to Inertia, Acoustic, Tactile and Flow sensors. **Overview, Application, Fabrication Process in Applications:** Silicon Capacitive Accelerometer, Piezo resistive Pressure sensor, Electrostatic Comb drive, Portable blood analyzer, Piezo electric Inkjet Print head, Micromirror array for Video projection.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the operation of micro devices, micro systems and their applications.
CO2:	Apply the principle of material science to sensor design.
CO3:	Analyze the materials used for sensor designs.
CO4:	Conceptualize and design micro devices, micro systems.

Reference Books	
1	MEMS & Microsystems Design and Manufacture, Tai-Ran Hsu, 2nd Edition, 2002, Tata McGraw Hill Education, New Delhi, ISBN-13:978-0-07-048709-3.
2	Foundations of MEMS, Chang Liu, 2012, Pearson Education Inc., ISBN-13:978-0-13-249736-7.

3	Smart Material Systems and MEMS, Vijay K Varadan, K. J. Vinoy, S. Gopalakrishnan, 2006, Wiley-INDIA, ISBN-978-81-265-3170-7.
4	Micro and Smart Systems, G.K. Ananthasuresh, K.J .Vinoy, K.N. Bhat, V.K. Aatre, 2015, Wiley Publications, ISBN-:978-81-265-2715-1.

Scheme of Evaluation

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project 10.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Semester: VII						
INTRODUCTION TO INTERNET OF THINGS (Group H: Open Elective)						
Course Code	**:**	16G7H09		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	39L		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Learn the fundamentals of IoT
2	Understands the hardware, networks & protocols used in IoT development
3	Illustrate smart applications using IoT devices and building applications
4	Know more advanced concepts like cloud connectivity in IoT
5	Learn the fundamentals of IoT

Unit-I	**06 Hrs**
Fundamentals Of IOT: Introduction, Physical design of IoT, Logical design of IoT, IoT Enabling technologies, IoT Levels and Deployment Templates, IoTvs M2M	
Unit – II	**06 Hrs**
IOT Design Methodology: Need for IoT systems management, IoT Design Methodology **Internet of Things Strategic Research and Innovation Agenda:** Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Smart-X Applications, Internet of Things and Related Future Internet Technologies.	
Unit –III	**11 Hrs**
IOT Systems - Logical Design using Python: Provides an introduction to Python, installing Python, Python data types & data structures, control flow, functions, modules, packages, file input/output, data/time operations and classes.	
Unit –IV	**09 Hrs**
IOT Physical Devices & Endpoints: What is an IoT device, Raspberry Pi device, About the board, Linux on Raspberry Pi, Raspberry Pi interfaces, Programming Raspberry Pi with Python.	
Unit –V	**07 Hrs**
IOT Physical Servers & Cloud Offerings: Provides an introduction to the use of cloud platforms and frameworks such as Xively and AWS for developing IoT applications.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the fundamentals of IoT.
CO2:	Analyse the IoT devices, programming, networking requirements and protocols for building IoT products.
CO3:	Apply the concepts to design and develop IoT applications
CO4:	Creating applications of IoT using physical devices and interfacing with cloud.

Reference Books	
1	Internet of Things (A Hands-on-Approach), Vijay Madisetti and ArshdeepBahga, 1st Edition, VPT, 2014, ISBN-13: 978-0996025515.
2	Internet of Things – From Research and Innovation to Market Deployment, OvidiuVermesan, Peter Friess, River Publishers Series in Communication, River Publishers, 2014, ISBN: ISBN: 978-87-93102-94-1 (Hard copy), 978-87-93102-95-8 (Ebook) (UnitsII 2nd part)
3	Rethinking the Internet of Things: A Scalable Approach to Connecting Everything, Francis daCosta, , 1st Edition, A press Publications, 2013, ISBN-13: 978-1430257400.
4	Meta products - Building the Internet of Things, WimerHazenberg, Menno Huisman, BIS Publishers, 2012, ISBN: 9789863692515.

Scheme of Evaluation

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project 10.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Semester: VII						
INDUSTRY 4.0– SMART MANUFACTURING FOR THE FUTURE (Group H: Open Elective)						
Course Code	**:**	16G7H10		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	39L		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the importance and role of Smart Manufacturing Systems, IoT and IIoT
2	Explain importance of automation technologies, sensors, Robotics and Machine vision.
3	Understand application of artificial intelligence and the need for data transformation, handling, storing and security.
4	Understand simulation, predictive and knowledge modeling along with analysis
5	Learn networking, sustainable technology and factory networks.

Unit-I	**06 Hrs**
Smart Manufacturing and Industry 4.0 Need for Smart Manufacturing, Advantages, Emerging technologies in Smart manufacturing, CAD Architecture surrounding 3D Models (B-rep and CSG), MEMS, Industry 4.0–Interoperability, Information transparency, Technical assistance, Decentralized decision-making, Internet of Things(IoT), Industry Internet of Things (IIoT), Future of Manufacturing industries	
Unit – II	**09 Hrs**
Manufacturing Automation Technology intensive manufacturing and cyber-physical systems, Automation using Robotics, Data storage, retrieval, manipulation and presentation; Mechanisms for sensing state and modifying processes, Material handling systems, controlling material movement and machine flow, Mechatronics, Transducers and sensors, Proximity sensors, Biosensors, Acceleration Machine Vision–Flaw detection, Positioning, Identification, Verification and Measurement–Application of Machine Vision in industries	
Unit –III	**09 Hrs**
Data handling using Embedded Systems Data transformation–Mathematical functions, Regression, Need for different functions, Data merging–Discrete and Random variables, Transformation languages, Interfacing systems-Microprocessors, Direct memory access, Data transfer schemes and systems, Communication systems–Modulation, Time domain and frequency domain, Industrial Network Data Communications, Data Security Artificial Intelligence – Intelligent systems, Fuzzy logics, Neural networks –Supervised, Unsupervised and Reinforced learning	
Unit –IV	**06 Hrs**
Simulation, Modeling and Analysis Simulation - system entities, input variables, performance measures, and Functional relationships, types of simulation. Predictive modeling and simulation tools, Knowledge Modeling –types and technology options, Functional analysis of control systems – Linear and Non-linear, Functional decomposition, Functional sequencing, Information / dataflow, Interface	
Unit –V	**09 Hrs**
Performance Measures of Smart Manufacturing Systems- Smart manufacturing- Sensing and Perception, Manipulation, Mobility and Autonomy, Factory Networks, Information Modeling and Testing, Performance Measurement and Optimization, Engineering System integration, Production Network integration, Production network data quality, Sustainable Processes and Resources, Integration Infrastructure for Sustainable Manufacturing	

Course Outcomes: After completing the course, the students will be able to

CO1:	Explain role and importance of Smart Manufacturing Systems, IoT and IIoT
CO2:	Explain importance of automation technologies, sensors, robotics and machine vision
CO3:	Illustrate the application of artificial intelligence and need for data transformation, handling
CO4:	Explain analytical and simulation for performance study of smart technologies and networks

Reference Books	
1	Zongwei Luo, Smart Manufacturing Innovation and Transformation: Interconnection And Intelligence, 1st Edition, IGI Global Publications, 2014,ISBN-13: 978-1466658363 ISBN-10: 1466658363
2	Yan Lu. KC Morris, Simon Frechette, Smart Manufacturing Standards, NIST, 1st Edition, 2016, Project report.

Scheme of Evaluation

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project 10.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Semester: VII						
SPACE TECHNOLOGY AND APPLICATIONS (Group H: Open Elective)						
Course Code	**:**	**16G7H11**		**CIE**	**:**	**100 Marks**
Credits: L:T:P :S	**:**	**3 : 0 : 0 : 0**		**SEE**	**:**	**100 Marks**
Total Hours	**:**	**35L**		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to	
1	Define the earth environment and its behavior, launching vehicles for satellites and its associated concepts.
2	Analyze satellites in terms of technology, structure and communications.
3	Use satellites for space applications, remote sensing and metrology.
4	Apply the space technology, technology mission and advanced space systems to nation's growth.

UNIT-I	**07 Hrs**
Earth's environment: Atmosphere, Ionosphere, Magnetosphere, Van Allen Radiation belts, Interplanetary medium, Solar wind, Solar- Earth Weather Relations. **Launch Vehicles:** Rocketry, Propellants, Propulsion, Combustion, Solid, Liquid and Cryogenic engines, Control and Guidance system, Ion propulsion and Nuclear Propulsion.	
UNIT-II	**07 Hrs**
Satellite Technology: Structural, Mechanical, Thermal, Power control, Telemetry, Telecomm and Quality and Reliability, Payloads, Space simulation. **Satellite structure:** Satellite Communications, Transponders, Satellite antennas.	
UNIT-III	**07 Hrs**
Satellite Communications: LEO, MEO and GEO orbits, Altitude and orbit controls, Multiple Access Techniques. **Space applications:** Telephony, V-SAT, DBS system, Satellite Radio and TV, Tele-Education, Tele-medicine, Satellite navigation, GPS.	
UNIT-IV	**07 Hrs**
Remote Sensing: Visual bands, Agricultural, Crop vegetation, Forestry, water Resources, Land use, Land mapping, geology, Urban development resource Management, and image processing techniques. **Metrology:** Weather forecast (Long term and Short term), weather modelling, Cyclone predictions, Disaster and flood warning, rainfall predictions using satellites.	
UNIT-V	**07Hrs**
Satellite payloads: Technology missions, deep space planetary missions, Lunar missions, zero gravity experiments, space biology and International space Missions. **Advanced space systems:** Remote sensing cameras, planetary payloads, space shuttle, space station, Inter-space communication systems.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Explain different types of satellites, orbit and associated subsystems.
CO2:	Apply the basics of launching vehicles, satellites and sub systems for space applications.
CO3:	Analyze the applications of satellite in the area of communication, remote sensing, metrology
CO4:	Study technology trends, satellite missions and advanced space systems.

Reference Books	
1	Atmosphere, weather and climate, R G Barry, Routledge publications, 2009, ISBN- 10 :0415465702.
2	Fundamentals of Satellite Communication, K N Raja Rao, PHI, 2012, ISBN:9788120324015.
3	Satellite Communication, Timothy pratt, John Wiley, 1986 ISBN: 978-0- 471- 37007 -9, ISBN 10: 047137007X.

4	Remote sensing and applications, B C Panda, VIVA books Pvt. Ltd., 2009, ISBN: 108176496308.

Scheme of Evaluation

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project 10.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Semester: VII						
ADVANCED LINEAR ALGEBRA (Group H: Open Elective)						
Course Code	**:**	16G7H12		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	39L		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Adequate exposure to learn the fundamental concepts to model a system of linear equations and to obtain the solution of system of linear equations.
2	Analyze and extend the structure of vector spaces, linear transformations, Symmetric matrices, quadratic forms required in applications of Business, Science and Engineering.
3	Apply the concept of Eigenvalues to study differential equations and dynamical systems. Apply the concept of Orthogonality to examine some of the least-squares problems.
4	Apply Linear Programming to Network problems and Game theory.

Unit-I	**07 Hrs**
System of linear equations Matrices and system of linear equations, Geometry of linear equations, Linear models in Business, Science and Engineering-Input-Output model in Economics, Balancing chemical equations and Electrical networks.	
Unit – II	**09 Hrs**
Vector spaces and linear transformations Revision of Vector Spaces, Subspaces, Linear independence, Basis, Dimension and Change of basis. Applications to Difference equations, Markov chains. Intersection, Sum, Product of spaces and Tensor product of two vector spaces. Introduction to Linear transformations, Geometrical interpretations in 2-dimensions and 3-dimensions.	
Unit –III	**09 Hrs**
Orthogonality, Eigen values and Eigen vectors Orthogonality, Inner product spaces, Applications to Weighted least-squares and Fourier series, Fast Fourier transform. Eigen values and Eigen vectors, Applications to Differential equations, Discrete dynamical systems.	
Unit –IV	**07 Hrs**
Symmetric matrices and quadratic forms Introduction to symmetric matrices, Quadratic forms, Test for Positive definiteness, Constrained Optimization, Singular Value Decomposition. Applications to image processing.	
Unit –V	**07 Hrs**
Linear programming and game theory A Geometrical introduction to Linear programming, Simplex method and its geometrical meaning, Network models-Max flow-min cut theorem, Payoff matrix and Matrix games.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	Identify and interpret the fundamental concepts of linear equations, vector spaces, linear transformations, Orthogonality, Eigen values, symmetric matrices, quadratic forms, linear programming and game theory.
CO2:	Apply the knowledge and skills of Linear algebra to solve linear equations, difference and differential equations, constrained optimization problems, linear programming problems and related problems.
CO3:	Analyze the input-output models, Markov chains, discrete dynamical systems, singular value decomposition, network models and related problems.
CO4:	Using the overall mathematical knowledge of Linear Algebra to solve problems arising in practical situations.

Reference Books	
1	David C Lay; Linear Algebra and Its Applications; Pearson Education; III Edition; 2003; ISBN: 978-81-775-8333-5.
2	Gareth Williams; Linear Algebra with Applications; 6th edition; 2008; Narosa publications; ISBN: 978-81-7319-981-3.
3	Gilbert Strang; Linear Algebra and Its Applications; IV Edition; Cengage Learning India Edition; 2006; ISBN: 81-315-0172-8.
4	Howard Anton and Chris Rorres; Elementary Linear Algebra Applications Version; Wiley Global Education; 11th Edition; 2013; ISBN: 9781118879160.

Scheme of Evaluation

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project 10.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	1	-	-	-	-	-	-	-	2
CO2	3	2	1	-	-	-	-	-	-	-	-	2
CO3	2	3	2	2	-	-	-	-	-	-	-	1
CO4	3	3	1	2	1	-	-	-	-	-	-	3

High-3: Medium-2 : Low-1

Semester: VII						
THIN FILM NANOTECHNOLOGY (Group H: Open Elective)						
Course Code	**:**	16G7H13		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	39L		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Understand the importance of vacuum in thin film fabrication
2	Acquire the knowledge of thin film preparation by various techniques
3	Analyze the properties of thin films using different characterization methods
4	Optimize the process parameter and property dependence
5	Apply the knowledge for developing thin film devices.

Unit-I	**08 Hrs**
Vacuum Technology: Basics of Vacuum - Principles of different vacuum pumps: Rotary, Roots, Diffusion, Turbo molecular and Cryogenic pumps; Measurement of vacuum - Concept of Capacitance Manometer, Pirani and Penning gauges - Vacuum Systems & Applications.	
Unit – II	**08 Hrs**
Methods of thin film preparation Physical Vapor Deposition (PVD) Techniques**:** *Evaporation*: Thermal evaporation, Electron beam evaporation, Laser ablation, and Cathode arc deposition. *Sputtering*: DC sputtering, RF Sputtering, Magnetron sputtering, Reactive Sputtering, and Ion beam sputtering. Chemical Vapor Deposition (CVD) Techniques**:** Conventional CVD, Plasma Enhance CVD (PECVD) and Atomic layer deposition (ALD). Other Methods: Spin coating and Spray Pyrolysis.	
Unit –III	**07 Hrs**
Surface Modification and Growth of Thin Films: Surface preparation & Engineering for Thin film growth: Cleaning, Modification, Masking & Patterning, Base Coats and Top Coats. Thin Film growth: Sequence of thin film growth, Defects and impurities, Effect of Deposition Parameters on film growth.	
Unit –IV	**08 Hrs**
Properties and Characterization of Thin Films Film thickness (Quartz crystal thickness monitor and Stylus Profiler); Film Adhesion (Tape, Cross-hatch test, and Humidity methods); Surface morphology and topography (SEM and AFM); Film composition (X-ray Photoelectron Spectroscopy); Film structure (X-ray diffraction and Raman studies); Electrical characterization (Four Probe and Semiconductor Analyzer); and Optical characterization (Spectrophotometer).	
Unit –V	**08 Hrs**
Thin Film Applications: ▪ Electrodes: Deposition of a Metal film, Ex: Aluminum. ▪ Transparent conducting oxides (TCO) – Preparation and Optimization of a semiconducting film, Ex: ZnO. ▪ Optimization of a dielectric film, Ex: Al_2O_3 or Si_3N_4. **Thin Film Devices**: • Thin Film Transistors (TFT), • Thin Film Sensors • Thin Film Capacitors • Thin film Solar Cells,	

- Thin film Solar Absorbers
- Diamond-like carbon (DLC) coating
- EMI Shielding coatings
- Hard coatings
- Coatings on Plastics/Polymers.

Course Outcomes: After completing the course, the students will be able to	
CO1:	Understand the importance of vacuum technology for thin film growth
CO2:	Prepare various kinds of thin films using different deposition techniques
CO3:	Characterize the deposited films for various properties
CO4:	Fabricate thin film based devices.

Reference Books	
1.	Vacuum Technology by A. Roth, Elsevier, 3rd Edition, 1976, ISBN: 9780444880109, 9780444598745,
2.	Thin Film Phenomenon by K.L. Chopra, McGraw-Hill, 1st Edition, 1969, ISBN: 0070107998, 978-0070107991
3.	Materials Science of Thin Films by Milton Ohring, Elsevier, 2rdEdition, 2001, ISBN: 9780125249751
4.	Thin-Film Deposition: Principles and Practice by Donald Smith, McGraw-Hill, 1st Edition, 1995, ISBN: 0070585024, 9780070585027

Scheme of Evaluation

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project 10.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1			**1**									**2**
CO2				**2**								**2**
CO3					**2**							**2**
CO4			**2**	**2**	**2**		**2**		**2**	**2**		**2**

High-3; Medium-2; Low-1

Semester: VII						
ENGINEERING MATERIALS FOR ADVANCED TECHNOLOGY (Group H: Open Elective)						
Course Code	**:**	16G7H14		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	39L		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	Apply the basic concepts of Chemistry to develop futuristic materials for high-tech applications in the area of Engineering.
2	Impart sound knowledge in the different fields of material chemistry so as to apply it to the problems in engineering field.
3	Develop analytical capabilities of students so that they can characterize, transform and use materials in engineering and apply knowledge gained in solving related engineering problems.

Unit-I	**08 Hrs**

Coating and packaging materials

Surface Coating materials:

Synthesis and applications of Polymer coating materials: Teflon, Silicone films Polyvinyl chloride & its copolymers, Poly vinyl acetate, Poly ethylene-HDPE, LDPE, Polyurethane.

Properties required in a pigment and extenders.

Inorganic pigments-titanium dioxide, zinc oxide, carbon black, chromate pigments, chrome green, ultramarine blue, iron blue, cadmium red.

Corrosion inhibiting pigments- zinc phosphate, zinc and barium chromate pigments, ceramic pigments, metal flake pigments, extenders.

Developments in new polymers such as dendrimers, biopoplymers & biodegradable polymers.

Packaging materials:

Food products: Cellulosic and Polymeric packaging materials and their properties – including barrier properties, strength properties, optical properties. Glass, aluminium, tin, paper, plastics, composites.

Pharmaceutical products: Injectibles and tablet packaging materials.

Unit – II	**07 Hrs**

Adhesives

Introduction-Classification of Adhesives-Natural adhesives, synthetic adhesives-drying adhesives, pressure sensitive adhesives, contact adhesives, hot adhesives. One part adhesives, multi part adhesives. Adhesive Action. Development of Adhesive strength- Physical factors influencing Adhesive Action-surface tension, surface smoothness, thickness of adhesive film, elasticity and tensile strength. Chemical Factors Influencing Adhesive action - presence of polar groups, degree of polymerization, complexity of the adhesive molecules, effect of pH. Adhesive action- specific adhesive action, mechanical adhesive action, fusion adhesion. Development of adhesive strength- adsorption theory and diffusion theory. Preparation, curing and bonding Processes by adhesives-with reference to Epoxy, phenolics, Silicone, Polyurethane, Acrylic adhesives, Poly vinyl alcohol, Polyvinyl acetate.

Unit –III	**08 Hrs**

Optical fibre materials

Fiber Optics, Advantages of optical fiber communication over analog communication, Classification based on refractive index of the core- step index and graded index optical fibres, Classification based on core radius-single mode and multimode optical fibres, Fibre fabrication.-Methods to manufacture optical glass fibres. Double crucible method and preform methods. Manufacture of perform- Chemical Vapour Deposition (CVD), Modified vapour deposition (MCVD) Plasma activated vapour deposition (PCVD), Outside vapour deposition (OVD)-Vapour-phase axial deposition (VAD). Drawing the fibres from perform, coating and jacketing process.

Ion exchange resins and membranes

Ion exchange resins-Introduction, Types, physical properties, chemical properties-capacity, swelling, kinetics, stability, ion exchange equilibrium, regeneration. Applications of ion exchange resins-softening of water, demineralization of water, advantages and disadvantages of ion exchange resins-calcium sulphate fouling, iron fouling, adsorption of organic matter, bacterial contamination. Ion exchange

membranes, Types, Classification, Fabrication of ion exchange cottons- anion exchange cotton and cation exchange cotton. Application of ion exchange membranes in purification of water by electro dialysis method.
Unit –IV **08 Hrs**
Spectroscopic Characterization of materials: Electromagnetic radiation, interaction of materials with electromagnetic radiation. UV- visible spectrophotometry :Introduction-Electronic transitions- factors influencing position and intensity of absorption bands-absorption spectra of dienes, polyene and α,β-unsaturated carbonyl compounds, Working of UV-Vis spectrophotometer, Theoretical calculation of λ_{max} by using Woodward-Fieser rules- for cyclic and α,β-unsaturated carbonyl compounds. IR Spectroscopy: Introduction, principle, molecular vibrations, vibrational frequency, number of fundamental vibrations, factors influencing fundamental vibrations, instrumentation of IR spectrophotometer, sampling techniques and application of IR spectroscopy in characterization of functional groups.
Unit –V **08 Hrs**
NMR spectroscopy: H^1 NMR Spectroscopy: Basic concepts- relaxation process. NMR spectrometer-FT NMR-Solvents used in NMR, internal standards-Chemical equivalence -Integrals and Integrations- chemical shift-Factors affecting chemical shifts- shielding and deshielding effects – chemical and magnetic equivalent – magnetic anisotropy-spin-spin splitting rules- Application of NMR on various compounds such as alkanes, alkenes, alkynes, alkyl halides, alcohols, ethers, amines, aldehydes, ketones, carboxylic acids, esters, amides & mono substituted aromatic compounds. Problems on prediction of structure of compounds.

Course Outcomes: After completing the course, the students will be able to	
CO1:	Identify sustainable engineering materials and understand their properties.
CO2:	Apply the basic concepts of chemistry to develop futuristic materials for high-tech applications in different areas of engineering.
CO3:	Analyze and evaluate the specific application of materials.
CO4:	Design the route for synthesis of material and its characterization.

Reference Books	
1	Materials Science, G.K.Narula, K.S.Narula & V.K.Gupta. 38th Edtion, 2015, Tata McGraw-Hill Publishing Company Limited ISBN: 978-0-07-451796-3.
2	Solar Lighting, Ramachandra Pode and Boucar Diouf, Springer e-book, 2011, ISBN: 978-1-44-712133-6 (Print) 978-1-44-712134-3 (Online),
3	Spectroscopy of organic compounds, P.S.Kalsi, 6th Edition, 2013, New Age International(P) ltd,publisher, ISBN: 978-1-22-415438-6.
4	Food Packaging Materials, Mahadeviah M & Gowramma RV, 6th Edition, 1996, Tata McGraw Hill Publishing Company Ltd, ISBN :746-2-23-82 9780-0.

Scheme of Evaluation

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project 10.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	3	2	-	1	-	-	-	-	-	-	-	2
CO2	3	2	1	-	-	-	-	-	-	-	-	2
CO3	2	3	2	2	-	-	-	-	-	-	-	1
CO4	3	3	1	2	1	-	-	-	-	-	-	3

High-3: Medium-2 : Low-1

Semester: VII						
APPLIED PSYCHOLOGY FOR ENGINEERS (Group H: Open Elective)						
Course Code	**:**	16G7H15		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	3:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	35		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: The students will be able to

1	To appreciate human behavior and human mind in the context of learner's immediate society and environment.
2	To understand the importance of lifelong learning and personal flexibility to sustain personal and Professional development as the nature of work evolves.
3	To provide students with knowledge and skills for building firm foundation for the suitable engineering professions.
4	To prepare students to function as effective Engineering Psychologists in an Industrial, Governmental or consulting organization.
5	To enable students to use psychological knowledge, skills, and values in occupational pursuits in a variety of settings that meet personal goals and societal needs.

Unit – I	**07 Hrs**
Introduction to Psychology: Definition and goals of Psychology: Role of a Psychologist in the Society: Today's Perspectives (Branches of psychology). Psychodynamic, Behavioristic, Cognitive, Humanistic, Psychological Research and Methods to study Human Behavior: Experimental, Observation, Questionnaire and Clinical Method.	
Unit - II	**07 Hrs**
Intelligence and Aptitude: Concept and definition of Intelligence and Aptitude, Nature of Intelligence. Theories of Intelligence – Spearman, Thurston, Guilford Vernon. Characteristics of Intelligence tests, Types of tests. Measurement of Intelligence and Aptitude, Concept of IQ, Measurement of Multiple Intelligence – Fluid and Crystallized Intelligence.	
Unit – III	**07 Hrs**
Personality: Concept and definition of personality, Approaches of personality- psychoanalytical, Socio-Cultural, Interpersonal and developmental, Humanistic, Behaviorist, Trait and type approaches. Assessment of Personality: Self- report measures of Personality, Questionnaires, Rating Scales and Projective techniques, its Characteristics, advantages & limitations, examples. Behavioral Assessment. Psychological Stress: a. Stress- Definition, Symptoms of Stress, Extreme products of stress v s Burnout, Work Place Trauma. Causes of Stress – Job related causes of stress. Sources of Frustration, Stress and Job Performance, Stress Vulnerability-Stress threshold, perceived control.	
Unit – IV	**07 Hrs**
Application of Psychology in Working Environment: The present scenario of information technology, the role of psychologist in the organization, Selection and Training of Psychology Professionals to work in the field of Information Technology. Distance learning, Psychological consequences of recent developments in Information Technology. Type A and Type B Psychological Counseling - Need for Counseling, Types – Directed, Non- Directed, Participative Counseling.	
Unit – V	**07 Hrs**
Learning: Definition, Conditioning – Classical Conditioning, Basics of Classical Conditioning (Pavlov), the process of Extinction, Discrimination and Generalization. Operant Conditioning (Skinner expt). The basics of operant conditioning, Schedules of reinforcement. Cognitive – Social approaches to learning – Latent Learning, Observational Learning, Trial and Error Method, Insightful Learning.	
Experimental Psychology (Practicals)- Self Study 2 Hrs /Week	
1.Bhatia's Battery of Performance and intelligence test 2.Multidimensional Assessment of Personality 3.David's Battery of Differential Abilities (Aptitude test) 4.Bilateral Transfer of Training Mirror drawing apparatus with Electronic Digital Reset Error Counter	

(Performance) 5. Student Stress Scale.	
Course Outcomes: After completing the course, the students will be able to	
CO1:	Describe the basic theories, principles, and concepts of applied psychology as they relate to behaviors and mental processes.
CO2:	Define learning and compare and contrast the factors that cognitive, behavioral, and Humanistic theorists believe influence the learning process.
CO3:	Develop understanding of psychological attributes such as intelligence, aptitude, creativity, resulting in their enhancement and apply effective strategies for self-management and self-improvement.
CO4:	Apply the theories into their own and others' lives in order to better understand their personalities and experiences.
CO5:	Understand the application of psychology in engineering and technology and develop a route to accomplish goals in their work environment.
Reference Books:	
1. . Understanding Psychology Feldman R. S, IV edition, (1996) McGraw Hill India	
2. Psychology Robert A. Baron, III edition (1995) Prentice Hall India.	
3. Organizational Behaviour , Stephen P Robbins Pearson Education Publications, 13th Edition, ISBN – 81-317 – 1132 – 3	
4. Organisational Behaviour : Human Behaviour at Work ,John W.Newstrem and Keith Davis. Tata McGraw Hill India, 10th Edition, ISBN 0-07-046504-5	
5. Psychology-themes and variations , Wayne Weiten, IV edition, Brooks / Cole Publishing Co.	
Scheme of Continuous Internal Evaluation (CIE):	
Continuous Internal Evaluation (CIE); Theory (100 Marks) **CIE** is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project 10. **Total CIE is 30(Q) +60(T) +10(A) =100 Marks.**	
Scheme of Semester End Examination (SEE):	
Semester End Evaluation (SEE); Theory (100 Marks) **SEE** for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.	

VII Semester						
FOUNDATIONAL COURSE ON ENTREPRENEURSHIP (Group H: Open Elective)						
Course Code	**:**	16G7H16		**CIE Marks**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	3:0:0:0		**SEE Marks**	**:**	**100 Marks**
Total Hours	**:**	36L		**SEE Duration**	**:**	**03 Hours**

Course Learning Objectives:	
1	To make participants self-discover their innate flow, entrepreneurial style, and identify problems worth solving thereby becoming entrepreneurs
2	To handhold participants on lean methodology to craft value proposition and get ready with lean canvas
3	To create solution demo by conducting customer interviews and finding problem-solution fit for building Minimum Viable Product (MVP)
4	To make participants understand cost structure, pricing, revenue types and importance of adopting shared leadership to build good team
5	To help participants build a strong brand and identify various sales channels for their products and services
6	To take participants through basics of business regulations and other legal terms along-with understanding of Intellectual Property Rights

Unit-I	**07 Hrs**
Self Discovery and Opportunity Discovery Finding the Flow; Effectuation; Identifying the Effectuation principles used in activities; Identifying Problem Worth Solving; Design Thinking; Brainstorming; Presenting the Identified problems; Identifying the Entrepreneurial Style.	
Unit – II	**07 Hrs**
Customer, Solution and Lean Methodology Customers and Markets; Segmentation and Targeting; Identifying Jobs, Pains, and Gains and Early Adopters; Crafting Value Proposition Canvas (VPC); Presenting VPC; Basics of Business Model and Lean Approach; Sketching the Lean Canvas; Risks and Assumptions; Presenting Lean Canvas.	
Unit – III	**07 Hrs**
Problem-Solution Fit and Building MVP Blue Ocean Strategy - Plotting the Strategy Canvas; Four Action Framework: Eliminate-Reduce-Raise-Create Grid of Blue Ocean Strategy; Building Solution Demo and Conducting Solution Interviews; Problem-Solution Fit; Building MVP; Product-Market Fit; Presenting MVP.	
Unit – IV	**06 Hrs**
Financial Planning & Team Building Cost Structure - Estimating Costs; Revenues and Pricing: Revenue Streams, Revenue Types, Identifying Secondary Revenue Streams, Estimating Revenue and Price; Profitability Checks; Bootstrapping and Initial Financing; Practising Pitch; Shared Leadership; Hiring and Fitment, Team Role and Responsibilities.	
Unit – V	**09 Hrs**
Marketing, Sales, Regulations and Intellectual Property Positioning and Branding; Channels; Sales Planning; Project Management; Basics of Business Regulations; How to Get Help to Get Started; Patents, Trademark, Licensing, Contracts; Common Legal mistakes, Types of Permits, Tax Registration Documents, Compliance; Infringement and Remedies, Ownership and Transfer.	

Course Outcomes: After completing the course, the students will be able to	
CO1:	showcase the ability to discern distinct entrepreneurial traits
CO2:	Know the parameters to assess opportunities and constraints for new business ideas
CO3:	Understand the systematic process to select and screen a business idea
CO4:	design strategies for successful implementation of ideas
CO5:	Create Business Model and develop Minimum Viable Product

Reference Books	
1	Running Lean: Iterate from Plan A to a Plan That Works. O'Reilly Media, Maurya, A., 2012.
2	Entrepreneurship.Roy, R., 2012. Oxford University Press
3	Intellectual Property Law in India. Gupta, T. S., 2011. Kluwer Law International
4	Flow: The Psychology of Optimal Experience. Czikszentmihalyi, M., 2008. Harper Perennial Modern Classics
5	Effectuation: Elements of Entrepreneurial Expertise. Sarasvathy, S. D., 2009. Edward Elgar Publishing Ltd.

Scheme of Evaluation

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project 10.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

Semester: IIV						
UNMANNED AERIAL VEHICLES (Group H: Open Elective)						
Course Code	**:**	16G7H17		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	3:0:0:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	36L		**SEE Duration:**	**:**	**3.00Hrs**

Course Learning Objectives: The students will be able to	
1	Get an overview of the history of UAV systems
2	Understand the importance of aerodynamics, propulsion, structures and avionics in the design of UAV
3	Demonstrate ability to address the various mission payloads - on-board & off-board, propulsion systems, integration with manned systems
4	Assess the performance and airworthiness of the designed UAV

Unit-I	**06 Hrs**
Introduction to Flight Vehicles: History of Flight Vehicles and UAVs, Classifications, Woking principles of flight vehicle. **Introduction to Unmanned Aircraft Systems** Types of UAVs, configurations and their advantages disadvantages, System Composition, Applications of UAVs, Characteristics of Aircraft	
Unit – II	**07 Hrs**
Design of UAV Systems: Governing aspects: **a. Aerodynamics, b. Propulsion, C. structure, d. Controls** **Aerodynamics:** Introduction basic Aerodynamics, lift, drag, Aerofoils, wing area optimization. **Propulsion:** Introduction to propulsion system in UAV, Propulsion system for fixed wing UAV and VTOL (Vertical take-off and landing) UAV, Advanced propulsion systems, fuel cells, generators based systems.	
Unit -III	**07Hrs**
Structures of UAV: Mechanic loading, basics of types of load calculation and structural engineering, Material used for UAV (general introduction), FRP and methods of usage in UAV, Testing of FRP specimens for UAV, selection criteria for structure, Types of structural elements used in UAV their significance and characteristics, Methods of manufacturing UAV structure.	
Unit -IV	**07 Hrs**
Controls, Avionics, Hardware, Communication, Payloads: Basics of control system and Systems for control system in UAV, PID control, simulation introduction to Hardware in loop system (HILS), Avionics: Autopilot (AP) – architecture of AP, sensors, actuators, power supply, integration, installation, configuration, and testing. **Hardware, Communication** Electronics Hardware in UAV, Communication methods, communication antenna and their significance. **Payloads:** Payload types and their applications	
Unit -V	**09 Hrs**
Design of UAV Systems: Fixed wing UAV and Rotary wing UAV (VTOL) Task specific, activity based exercise	

Course Outcomes: At the end of this course the student will be able to :	
CO1:	Appraise the evolution of UAVs and understand the current potential benefits of UAVs
CO2:	Apply the principles of Aerospace Engineering in design and development of UAVs
CO3:	Determine and evaluate the performance of UAV designed for various Missions and applications
CO4:	Assess the performance and airworthiness of the designed UAV

Reference Books	
1	Unmanned Aircraft Systems UAV design, development and deployment, Reg Austin, 1st Edition, 2010, Wiley, ISBN 9780470058190.
2	Flight Stability and Automatic Control, Robert C. Nelson, 2nd Edition, October 1, 1997, McGraw-Hill, Inc, ISBN 978-0070462731.
3	Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy, Kimon P. Valavanis, 1st Edition,2007, Springer ISBN 9781402061141
4	Introduction to UAV Systems, Paul G Fahlstrom, Thomas J Gleason, 4th Edition, 2012, Wiley, ISBN: 978-1-119-97866-4
5	Design of Unmanned Air Vehicle Systems, Dr. Armand J. Chaput, 3rd Edition, 2001, Lockheed Martin Aeronautics Company, ISBN: 978-1-60086-843-6

Scheme of Evaluation

Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and Assignment/Presentation/Project (A). A minimum of three quizzes are conducted and each quiz is evaluated for 10 marks adding up to 30 marks. All quizzes are conducted online. Faculty may adopt innovative methods for conducting quizzes effectively. The number of quizzes may be more than three also. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 60. The marks component for Assignment/Presentation/Project 10.

Total CIE is 30(Q) +60(T) +10(A) =100 Marks.

Semester End Evaluation (SEE); Theory (100 Marks)

SEE for 100 marks is executed by means of an examination. The Question paper for the course contains two parts, Part – A and Part – B. Part – A consists of objective type questions for 20 marks covering the complete syllabus. Part – B consists of five main questions, one from each unit for 16 marks adding up to 80 marks. Each main question may have sub questions. The question from Units I, IV and V have no internal choice. Units II and III have internal choice in which both questions cover entire unit having same complexity in terms of COs and Bloom's taxonomy level.

CO-PO Mapping												
CO/PO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
CO1	**3**	**3**	**3**	**1**	**1**	**3**	**2**	**2**				**1**
CO2	**2**	**3**	**3**	**3**	**1**	**1**	**1**	**1**				**2**
CO3	**1**		**3**	**3**								**2**
CO4	**3**	**3**	**3**	**3**		**2**	**1**	**2**				**2**

High-3 : Medium-2 : Low-1

Semester: VII						
MAJOR PROJECT (Common to all Programs)						
Course Code	**:**	16AS81		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	0:0:16:0		**SEE**	**:**	**100 Marks**
Total Hours	**:**	32		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: To enable the students to:	
1	Acquire the ability to make links across different areas of knowledge and to generate, develop and evaluate ideas and information so as to apply these skills to the project task.
2	Acquire the skills to communicate effectively and to present ideas clearly and coherently to a specific audience in both written and oral forms.
3	Acquire collaborative skills through working in a team to achieve common goals.
4	Self-learn, reflect on their learning and take appropriate action to improve it.
5	Prepare schedules and budgets and keep track of the progress and expenditure.

Major Project Guidelines:

1. The project topic, title and synopsis have to be finalized and submitted to their respective internal guide(s) before the beginning of the 8th semester.
2. The detailed Synopsis ***(approved by the department Project Review Committee***) has to be submitted during the 1st week after the commencement of 8th semester.

Batch Formation:

- Students are free to choose their project partners from within the program or any other program;
- Each student in the team must contribute towards the successful completion of the project. The project may be carried out In-house / Industry / R & D Institution;
- ***The project work is to be carried out by a team of two to four students , in exceptional cases where a student is placed in a company and offered an internship through the competitive process or student is selected for internship at national or international level through competitive process*****,** the student can work independently.
- ***The students are allowed to do either a project for full 5 days in the industry or full 5 days in the college.***
- ***In case the project work is carried out outside Bengaluru, such students must be available during Project Evaluation process scheduled by the respective departments and they must also interact with their guide regularly through Email / Webinar / Skype etc.***

Project Topic Selection:

The topics of the project work must be in the *field of respective program areas or in line with CoE's (Centre of Excellence) identified by the college* or List of project areas as given by industry/Faculty. The projects as far as possible should have societal relevance with focus on sustainability.

Project Evaluation:

- Continuous monitoring of project work will be carried out and cumulative evaluation will be done.
- The students are required to meet their internal guides once in a week to report their progress in project work.
- **Weekly Activity Report** (WAR) has to be maintained in the form of a diary by the project batch and the same has to be discussed with the Internal Guide regularly.
- In case of ***Industry project***, during the course of project work, the internal guides will have continuous interaction with external guides and will visit the industry at least twice during the project period.
- For CIE assessment the project groups must give a final seminar with the draft copy of the project report.

- The presentation by each group will be for 20-30 minutes and every member of the team needs to justify the contributions to the project.
- The project team is required to submit Hard copies of the detailed Project Report in the prescribed format to the department.
- For CIE 50% weightage should be given to the project guide and 50% weightage to the project evaluation committee.
- Before the final evaluations the project group is required to produce a No dues certificate from Industry, Central Library and Department.

Course Outcomes of Major Project:	
1	Apply knowledge of mathematics, science and engineering to solve respective engineering domain problems.
2	Design, develop, present and document innovative/multidisciplinary modules for a complete engineering system.
3	Use modern engineering tools, software and equipment to solve problem and engage in life-long learning to follow technological developments.
4	Function effectively as an individual, or leader in diverse teams, with the understanding of professional ethics and responsibilities.

CIE Assessment:

The following are the weightings given for the various stages of the project.

1. Selection of the topic and formulation of objectives 10%
2. Design and Development of Project methodology 25%
3. Execution of Project 25%
4. Presentation, Demonstration and Results Discussion 30%
5. Report Writing & Publication 10%

SEE Assessment:

The following are the weightages given during Viva Examination.

1. Written presentation of synopsis 10%
2. Presentation/Demonstration of the project 30%
3. Methodology and Experimental Results & Discussion 30%
4. Report 10%
5. Viva Voce 20%

Calendar of Events for the Project Work:

Week	Event
Beginning of 7th Semester	Formation of group and approval by the department committee.
7th Semester	Problem selection and literature survey
Last two weeks of 7th Semester	Finalization of project and guide allotment
II Week of 8th Semester	Synopsis submission and preliminary seminar
III Week	First visit of the internal guides to industry (In case of project being carried out in industry)
III to VI Week	Design and development of project methodology
VII to IX Week	Implementation of the project
X Week	Submission of draft copy of the project report
XI and XII Week	Second visit by guide to industry for demonstration. Final seminar by Department project Committee and guide for internal assessment. Finalization of CIE.

Scheme of Evaluation for CIE		**Scheme of Evaluation for SEE**	
Particulars	**%Marks**	**Particulars**	**%Marks**
Project Evaluation I	10%	Project Synopsis (Initial Write up)	10%
Project Evaluation II	25%	Project Demo / Presentation	30%
Project Evaluation III	25%	Methodology and Results Discussion	30%
Project Evaluation Phase-IV (Submission of Draft Project Report for Verification**)**	30%	Project Work Report	10%
Project Evaluation Phase-V (Project Final Internal Evaluation**)**	10%	Viva-voce	20%
Total	100	Total	100

Semester: VII						
TECHNICAL SEMINAR (Common to all Programs)						
Course Code	**:**	16AS82		**CIE**	**:**	**100 Marks**
Credits: L:T:P:S	**:**	0:0:2:0		**SEE**	**:**	**100 Marks**
Hours / Week	**:**	4		**SEE Duration**	**:**	**3.00 Hours**

Course Learning Objectives: To enable the students to:	
1	Recognize recent developments in specific program and in multidisciplinary fields.
2	Summarize the recent technologies and inculcate the skills for literature survey.
3	Demonstrate good presentation skills.
4	Plan and improve the Technical Report writing skills.
5	Support Group discussion and Team work.

General Guidelines for the Seminar

General Guidelines for the Seminar

1. The seminar has to be presented by individual student.
2. The topic of the seminar should be from current thrust area along with consultation with the guide.
3. The topic can be based on standard papers (like IEEE/ACM/CSI etc.) in the thrust area for the selected topic.
4. Presenting/publishing this paper in conference/ Journal will be given weightage in CIE.
5. The student needs to submit both hard & soft copy of the seminar report.
6. **As Outcome of Technical Seminar, each student has to prepare a technical paper out of seminar topic.**

Course Outcomes of Technical Seminar:	
1	Communicate effectively on complex engineering problems and demonstrate contextual knowledge to assess societal and environmental contexts.
2	Identify, formulate, review research literature, analyze and Design solutions for complex engineering problems using appropriate techniques with effective documentation.
3	Analyze, interpret and synthesize the information to provide valid conclusions with innovative ideas and ethical principles.
4	Apply the knowledge of engineering specialization to suggest solutions to complex engineering problems and recognize the need for technological changes.

Evaluation of CIE Marks:

1. Relevance of the topic 10%
2. Literature Survey 10%
3. Presentation 40%
4. Report 20%
5. Paper Publication 20%

Semester: VII						
INNOVATION & SOCIAL SKILLS (Common to all Programs)						
Course Code	**:**	16HS83		**CIE**	**:**	**NA**
Credits: L:T:P:S	**:**	0:0:1:0		**SEE**	**:**	**NA**
Hours / Week	**:**	2		**SEE Duration**	**:**	**NA**

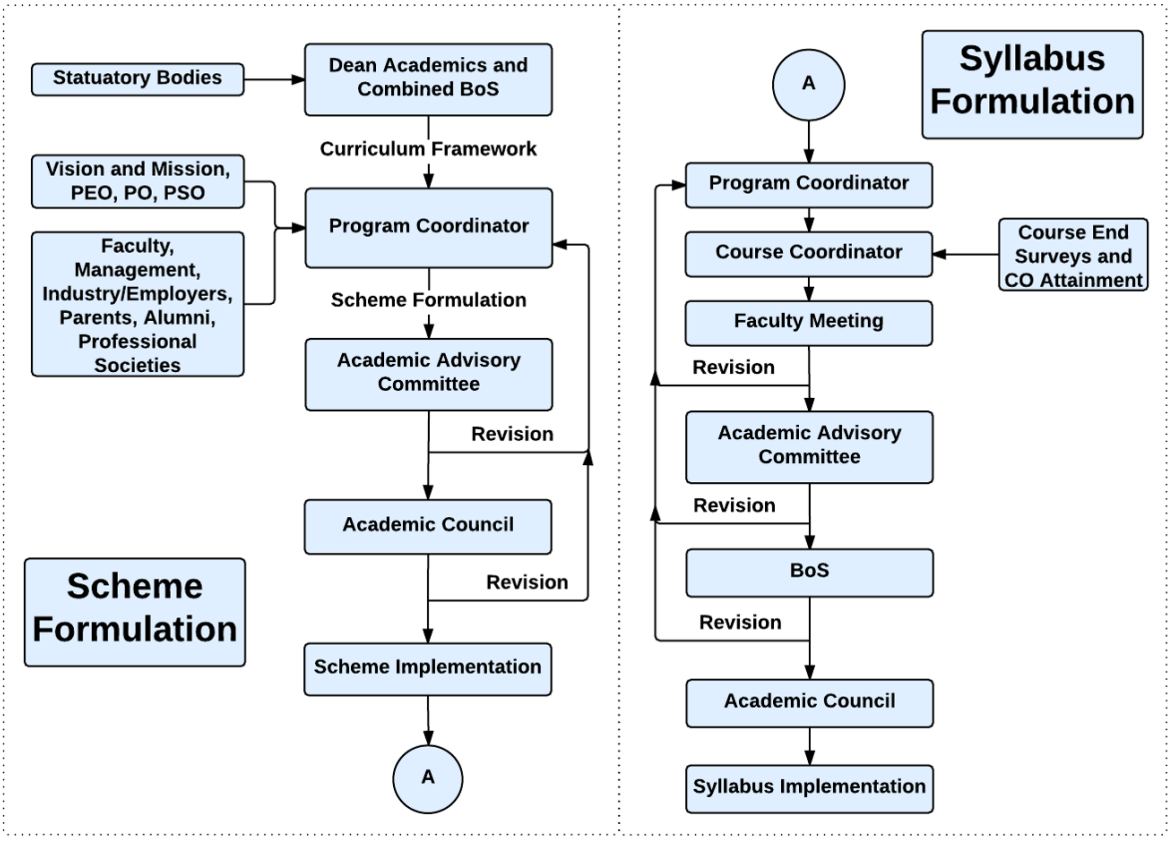
Course Learning Objectives: To enable the students to:	
1	To provide a platform for the students to exhibit their organizational capabilities, team building, ethical values and extra mural abilities.
2	To encourage to carryout innovative ideas and projects.
3	Take part in societal and community building activities.
4	Make self-learning, ethics and lifelong learning a motto.

Guidelines

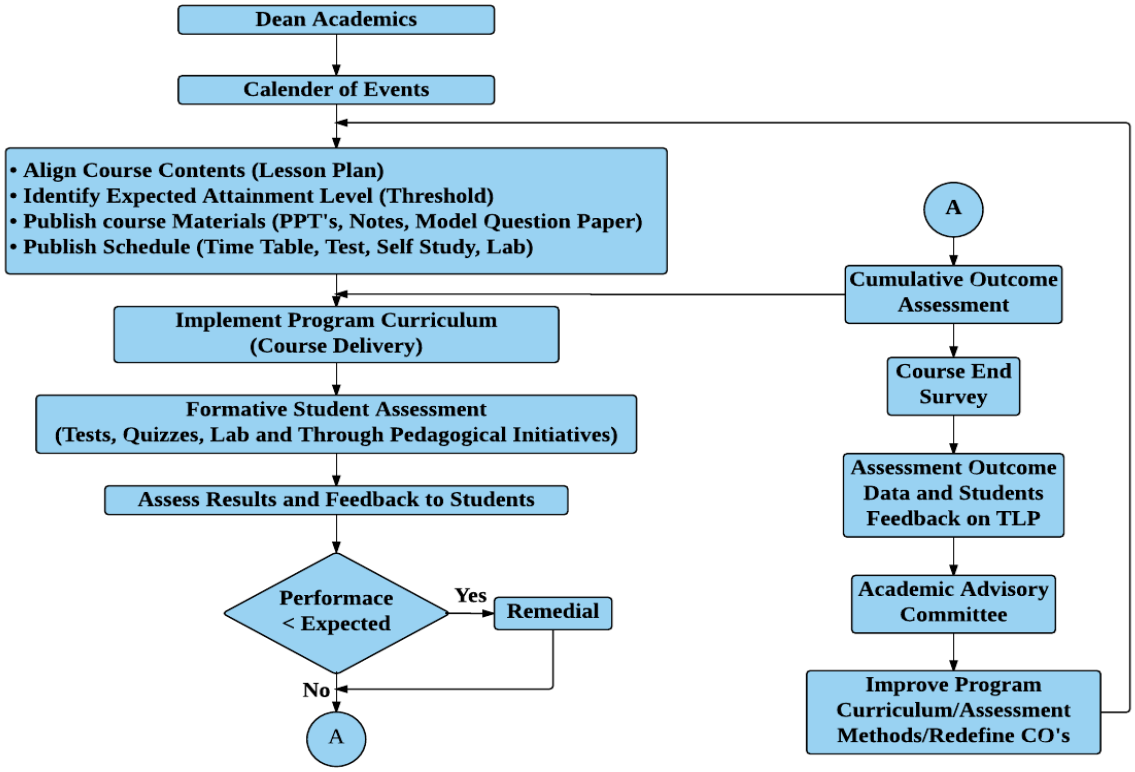
1. The HSS will be evaluated individually based on the broad parameters which include the progress made by student during 3rd& 4th year in innovative projects, Seminar, Paper Presentation, Field activity & other Co-curricular activities.
2. Students shall submit a report and documents as a proof his/her achievements.

Course Outcomes of Innovation & Social Skills:	
1	Apply the knowledge and skills for solving societal issues
2	Plan to work in team in various areas with inclusive effort and sustainability
3	Organize various events and use managerial and budgeting abilities
4	Demonstrate leadership qualities and ethics

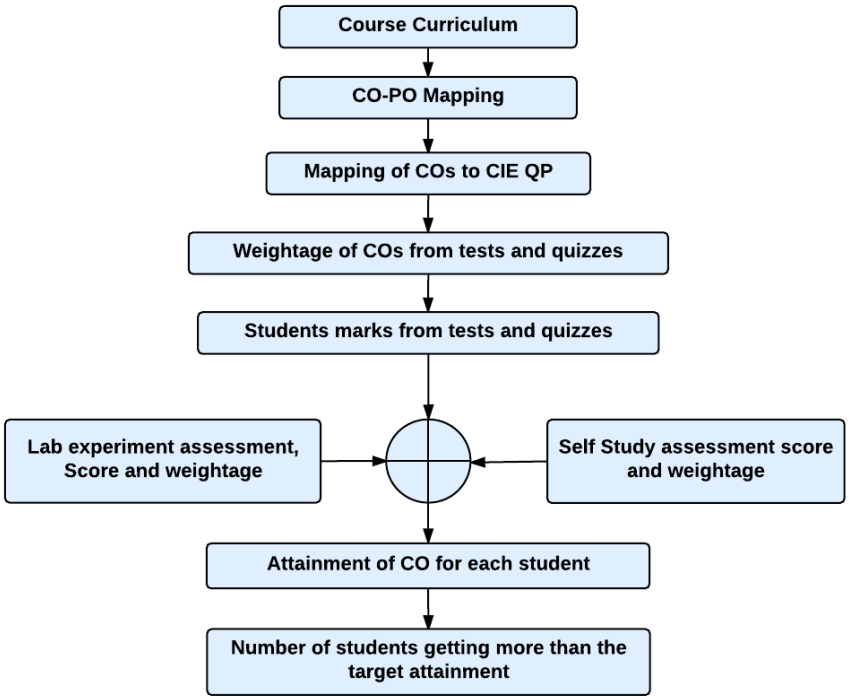
Curriculum Design Process



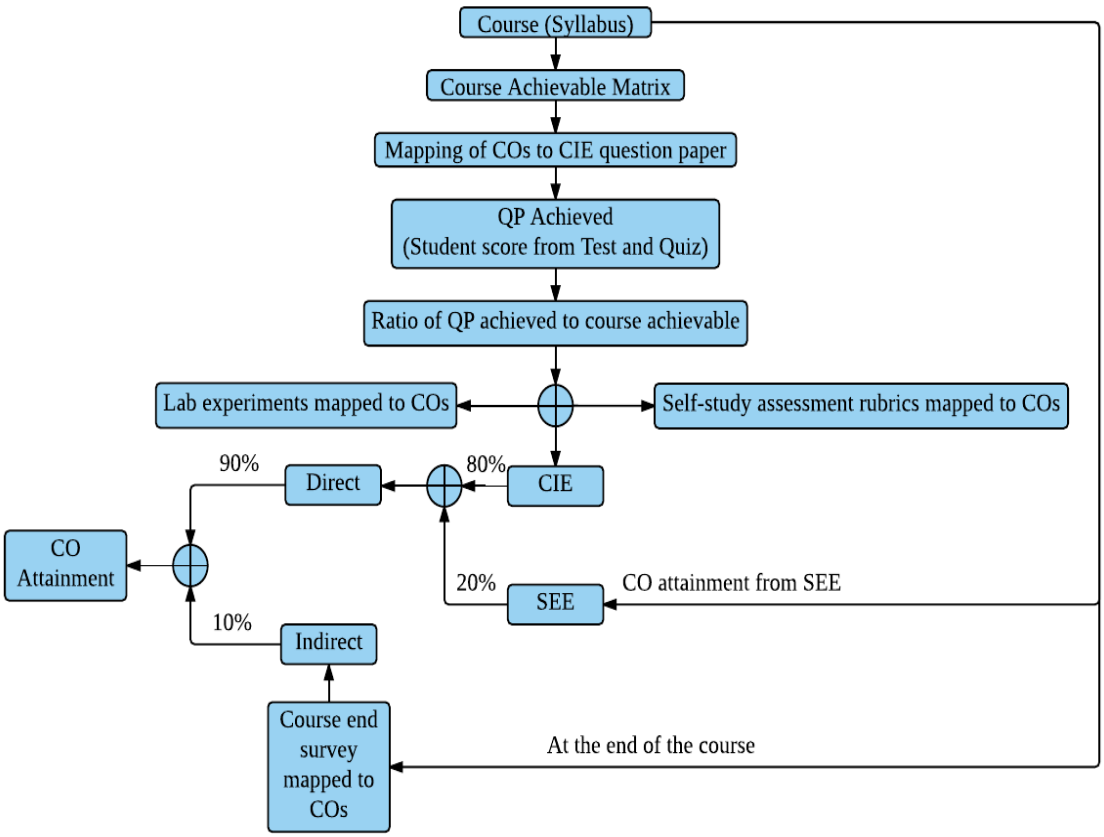
Academic Planning and Implementation



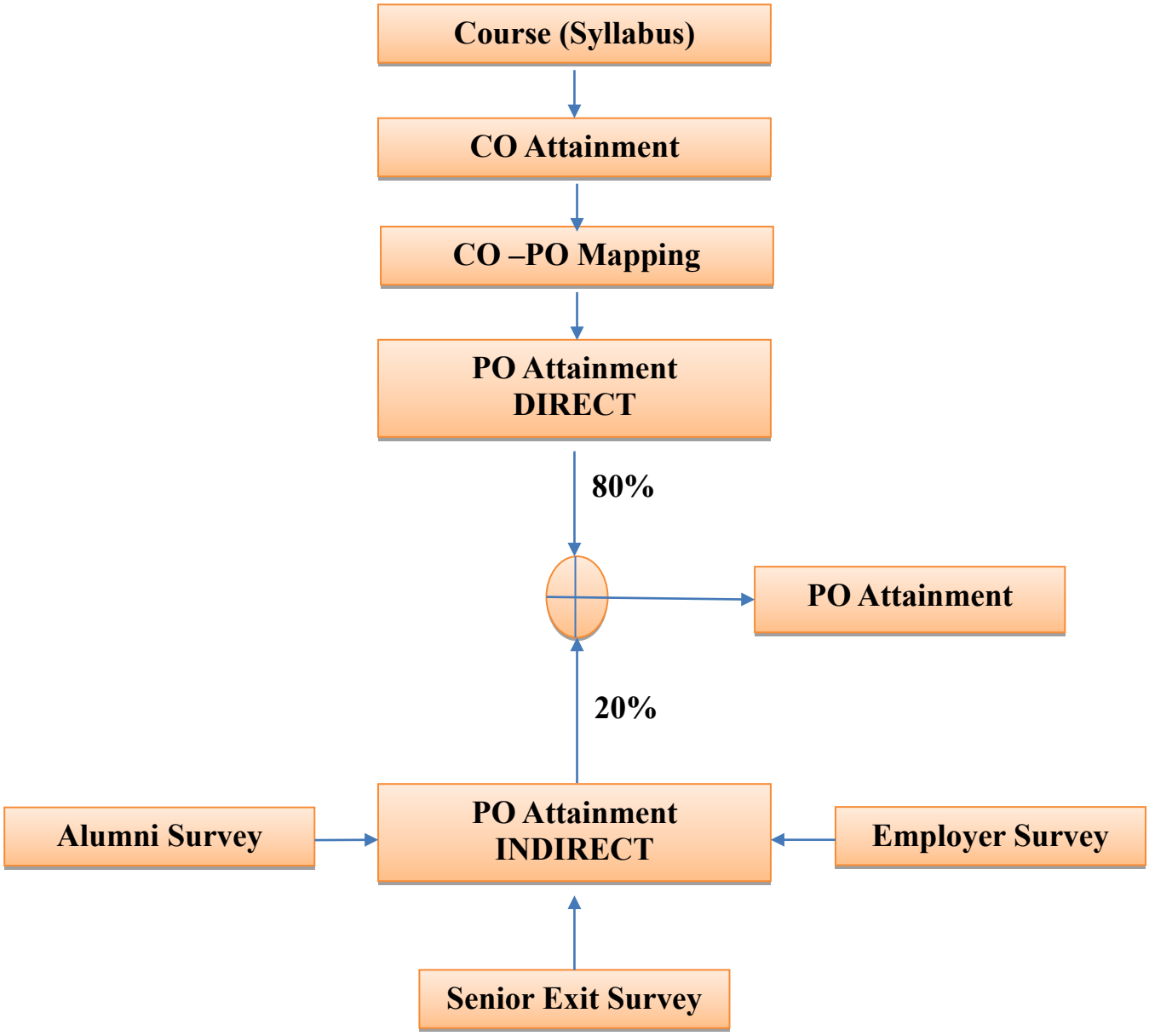
PROCESS FOR COURSE OUTCOME ATTAINMENT



Final CO Attainment Process



Program Outcome Attainment Process



Guidelines for Fixing Targets

- The target may be fixed based on last 3 years' average attainment

PROGRAM OUTCOMES (POs)

1. **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialisation for the solution of complex engineering problems.

2. **Problem analysis:** Identify, formulate, research literature, and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet t h e specified needs with appropriate consideration for public health and safety, and cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling to complex engineering activities, with an understanding of the limitations.

6. **The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal, and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Communication:** Communicate effectively on complex engineering activities with the engineering community and with t h e society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

11. **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

12. **Life-long learning:** Recognise the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.