KARNATAK LAW SOCIETY'S

GOGTE INSTITUTE OF TECHNOLOGY

UDYAMBAG, BELAGAVI-590008

(An Autonomous Institution under Visvesvaraya Technological University, Belagavi)

(APPROVED BY AICTE, NEW DELHI)

Department of Aeronautical Engineering

B.E. (Aeronautical)

Scheme (2021 Scheme)

1st to 8th Semester

INSTITUTION VISION

Gogte Institute of Technology shall stand out as an institution of excellence in technical education and in training individuals for outstanding caliber, character coupled with creativity and entrepreneurial skills.

MISSION

To train the students to become Quality Engineers with High Standards of Professionalism and Ethics who have Positive Attitude, a Perfect blend of Techno-Managerial Skills and Problem solving ability with an analytical and innovative mindset.

QUALITY POLICY

- Imparting value added technical education with state-of-the-art technology in a congenial, disciplined and a research oriented environment.
- Fostering cultural, ethical, moral and social values in the human resources of the institution.
- Reinforcing our bonds with the Parents, Industry, Alumni, and to seek their suggestions for innovating and excelling in every sphere of quality education.

DEPARTMENT VISION
The vision of the department of aeronautical engineering is to be recognized globally as a centre of excellence for education leading to well qualified professional engineers who are innovative, industry ready and also cater to the needs of the society.

MISSION
The mission of the department of aeronautical Engineering is to educate, inspire and mentor students to excel as professional with strong leadership skills and commitment to the society.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)	
1.	The graduates will acquire core competence in basic science and aeronautical engineering fundamentals necessary to formulate, analyze, and solve engineering problems and to pursue advanced study or research.
2.	The graduates will engage in the activities that demonstrate desire for ongoing personal and professional growth and self-confidence to adapt to rapid and major changes.
3.	The graduates will maintain high professionalism and ethical standards, effective oral and written communication skills, work as part of teams on multidisciplinary projects under diverse professional environments, and relate engineering issues to the society, global economy and to emerging technologies.

PROGRAM OUTCOMES (POs)	
1.	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.
2.	**Problem Analysis:** Identify, formulate, review research literature, and analyze 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 the specified needs with appropriate consideration for the public health and safety, and the 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 modeling 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 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 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:** Recognize the need for and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

PROGRAM SPECIFIC OUTCOMES (PSOs)	
1.	An ability to identify, formulate and apply knowledge of mathematics, science to solve Aeronautical engineering problems keeping in mind economical, environmental and social context.
2.	A Knowledge of contemporary issues and an ability to use the techniques, skills and modern engineering tools necessary to engage in lifelong learning in the field of Aerodynamics, propulsion, Avionics and structures streams.
3.	An ability to work in multidisciplinary projects professionally and ethically.

KLS Gogte Institute of Technology
B.E. in (name of the Program)
Draft Scheme of Teaching and Examination 2021-22 as per NEP 2020
Outcome-Based Education (OBE) and Choice Based Credit System (CBCS)
(Effective from the academic year 2021-22)

Total credits for B.E. Program: 160

As per the guidelines of UGC CBCS the courses can be classified into:

Abbreviations used:

BSC - Basic Science Course, **PCC-** Professional Core Course, **HSMC -** Humanity and Social Science & Management Courses, PEC- Professional Elective Course, **OEC –** Open Elective Course, **AEC –** Ability Enhancement Courses. **INT –** Internships, **UHV –**Universal Human Values, **MP -** Mini Project.
L –Lecture, **T –** Tutorial, **P-** Practical/Drawing, **S –** Self Study Component, **CIE –**Continuous Internal Evaluation, **SEE –**Semester End Examination

Foundation Courses: The Foundation Courses are of two kinds:
These courses are the courses based upon the content that leads to Knowledge enhancement. These courses provide opportunities to improve technological knowledge before entering industry as well as preparing students for higher degrees in technological subjects. They are mandatory for all disciplines. These courses will have 4 credits per course.
The courses are: **Basic Science Courses (BSC), Engineering Science Courses (ESC)**.

Professional Core Courses (PCC): This is the course which is to be compulsorily studied by a student as a core requirement to complete the requirements of a program in a said discipline of study. These courses will have 4 credits per course.

Universal Human Value Courses (UHV): These are value based courses aimed at man making education.
Humanities and Social Science including Management Studies Courses(HSMS). Humanity and Social Science Courses: The Humanities and Social Sciences are the studies of human behavior and interaction in social, cultural, environmental, economic, and political contexts. The Humanities and Social Sciences have a historical and contemporary focus, from personal to global contexts, and consider challenges for the future. Students will develop the ability to question, think critically, solve problems, communicate effectively, make decisions, and adapt to change. Thinking about and responding to issues requires an understanding of the key historical, geographical, political, economic, and societal factors involved, and how these different factors interrelate. Humanities and Social Science Courses includes-Technical-English, Courses on Regional/State languages (Kannada), etc.

Elective Courses: This is course, which can be chosen from the pool of papers. It may be supportive to the discipline/ providing extended scope/enabling an exposure to some other discipline / domain / nurturing student proficiency skills. These courses will have 3 credits per course.
An elective may be **Discipline Centric Course (PEC)** or may be chosen from other discipline (**Open Elective Course- OEC**).

Ability Enhancement Courses (AEC): The Ability Enhancement (AE) Courses may be of two kinds: Ability Enhancement Compulsory Courses (AECC) and Skill Enhancement Courses (SEC).
"AECC" courses are the courses based upon the content that leads to Knowledge enhancement; Environmental Science, English. Biology for Engineers, Bioinformatics, Music and Vibration, Art and Architecture etc
"SEC" courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc.

Mandatory Non-Credit Courses (MNC): These courses are mandatory but do not have any credits and students must successfully complete these courses before the completion of degree.

Credit definition:

Offline Courses	**Online Courses**
• 1-hour Lecture **(L)** per week = 1 Credit • 2 hours Tutorial **(T)** per week = 1 Credit, • 2 hours Practical /Drawing **(P)** per week = 1 Credit	04 weeks =1 Credit 08 weeks = 2 Credit 12 weeks = 3 Credit
• Four-credit courses are to be designed for 50 hours of Teaching-Learning process. • Three credit courses are to be designed for 40 hours of Teaching-Learning process. • Two credit courses are to be designed for 25 hours of Teaching-Learning process. • One credit courses are to be designed for 15 hours of Teaching-Learning process.	

Semester wise distribution of credits for B.E program

Year	**Semester**	**Credits**	**Total/Year**	**Cumulative Credits**
1st	**AE, CV, ME (I-P & II-C)**	19+21	**40**	**40**
	CSE, EC, EE, ISE (I-C & II-P)	18+22		
2nd	**III**	20	**40**	**80**
	IV	20		
3rd	**V**	23	**45**	**125**
	VI	22		
4th	**VII**	17	**35**	**160**
	VIII	18		
Total			**160**	

Curriculum frame work:

Structure of Undergraduate Engineering program

S.No.	Category of courses	VTU Breakup of credits	KLSGIT Breakup of credits
1	Humanities and Social Sciences including Management courses (English, Kannada, Indian Constitution, Environmental Sciences and Management)	10	8
2	Basic Science courses	23	22
3	Engineering Science courses including workshop, drawing	20	20
4	Professional Core Courses	46	49
5	Professional Elective courses relevant to chosen specialization/branch	9	9
6	Open subjects – Electives from other technical, emerging, arts commerce and	6	9
7	Mini, Project, Major Project work and Seminar	13	9
8	Summer Internship and Research /Industrial Internship	20	20
9	Ability Enhancement Courses, including Research Methodology, NCC/NSS/ Sports/Ex- Curricular, Online Certification Course	11	12
10	Universal Human Values	2	2
	TOTAL	**160**	**160**

L-T-P Model for Courses

	Contact Hours				Credits	
S.No.	**L-T-P**	**Lecture**	**Tutorial**	**Practical**	**L-T-P**	**Total**
1	3 - 0 - 0	3	0	0	3 - 0 - 0	3
2	3 - 2 - 0	3	2	0	3 - 1 - 0	4
3	3 - 0 - 2	3	0	2	3 - 0 - 1	4
4	2 - 0 - 2	2	0	2	2 - 0 - 1	3
	1 - 0 - 4	1	0	4	1 - 0 - 2	3

Theory courses having the corresponding lab are converted to integrated type course. Also, the electives (if possible) can also be made integrated type.

Integrated courses (Professional Core/Electives): Integrated courses will have **Theory Syllabus with Practical Syllabus of the same course**. In such a course there is **no Semester End Examination (SEE) for the practical syllabus** of the course, however, Continuous Internal Evaluation (CIE) will be conducted for the practical topics.

New Scheme of Teaching 2021 (Including branch specific additional course)

B.E. (Common to all branches)

Scheme of Teaching and Examination 2021-22

		1st Semester	For AE,CV,ME – Physics Cycle		Total contact hours/week				Credits	Examination		
S.No.	Course Type	Course Code	Course Title	Teaching Dept.	L	T	P			CIE	SEE	Total
1	BSC	21MAT11	Calculus and Linear Algebra	Mathematics	3	2	0	5	4	100	100	200
2	BSC	21PHY12	Applied Physics	Physics	3	0	0	3	3	100	100	200
3	ESC	21CIV13	Engineering Mechanics	CV	3	0	0	3	3	100	100	200
4	ESC	21EME14	Basics of Mechanical Engg.	ME	3	0	0	3	3	100	100	200
5	ESC	21EGR15	Engineering Graphics	ME	1	0	4	5	3	100	100	200
6	BSC	21PHL16	Applied Physics Lab	Physics	0	0	2	2	1	50	50	100
7	AEC	21IIL17	Idea to Innovation Lab	Engg. Depts	1	0	2	3	1	100	-	100
8	HSMS	21ENG18	Communicative English	English	1	0	0	1	1	50	50	100
			Total						**19**	**700**	**600**	**1300**

		2nd Semester	For AE, CV, ME – Chemistry Cycle		Hours/week			Total contact hours/week	Credits	Examination		
S.No.	Course Type	Course Code	Course Title	Teaching Dept.	L	T	P			CIE	SEE	Total
1	BSC	21MAT21	Differential Equations and Laplace Transforms	Mathematics	3	2	0	5	4	100	100	200
2	BSC	21CHE22	Applied Chemistry	Chemistry	3	0	0	3	3	100	100	200
3	ESC	21ELE23	Basics of Electrical and Electronics Engg.	E & E	3	0	0	3	3	100	100	200
4	ESC	21CCP24	Problem Solving using C	CSE & ISE	3	0	0	3	3	100	100	200
5	BSC	21CHL25	Chemistry Lab	Chemistry	0	0	2	2	1	50	50	100
6	ESC	21CPL26	C Programming Lab	CSE & ISE	0	0	2	2	1	50	50	100
7	ESC	21EEL27	Electrical and Electronics Engg. Lab	E & E	0	0	2	2	1	50	50	100
8	HSMS	21ENG28	Professional Writing Skills in English	English	1	0	0	1	1	50	50	100
9	AEC	21AEC29A1	Introduction to Innovation and Startup	Any Dept.	1	0	0	1	1	50	--	50
		21AEC29A2	Leadership and Public Speaking									
		21AEC29A3	Interpersonal Skills									

10	ESC	21AAE29B	Elements Of Aeronautics	AE	3	0	0	3	3	100	100	200
		21ACV29B	Basics of Civil Engineering	CV								
		21AME29B	Material Science and Engineering	ME								
			Total						**21**	**750**	**700**	**1450**

		1st Semester	**For CSE, EC, EE and ISE – Chemistry Cycle**		**Hours/week**			**Total contact hours/week**	**Credits**	**Examination**		
S.No.	**Course Type**	**Course Code**	**Course Title**	**Teaching Dept.**	**L**	**T**	**P**			**CIE**	**SEE**	**Total**
1	BSC	21MAT11	Calculus and Linear Algebra	Mathematics	3	2	0	5	4	100	100	200
2	BSC	21CHE12	Applied Chemistry	Chemistry	3	0	0	3	3	100	100	200
3	ESC	21ELE13	Basics of Electrical and Electronics Engg.	E & E	3	0	0	3	3	100	100	200
4	ESC	21CCP14	Problem Solving using C	CSE & ISE	3	0	0	3	3	100	100	200
5	BSC	21CHL15	Chemistry Lab	Chemistry	0	0	2	2	1	50	50	100
6	ESC	21CPL16	C Programming Lab	CSE & ISE	0	0	2	2	1	50	50	100
7	ESC	21EEL17	Electrical and Electronics Engg. Lab	E & E	0	0	2	2	1	50	50	100
8	HSMS	21ENG18	Communicative English	English	1	0	0	1	1	50	50	100
9	AEC	21AEC191	Introduction to Innovation and Startup	Any Dept.	1	0	0	1	1	50	--	50
		21AEC192	Leadership and Public Speaking									
		21AEC193	Interpersonal Skills									
			Total						**18**	**650**	**600**	**1250**

		2nd Semester	**For CSE, EC, EE and ISE – Physics Cycle**		**Hours/week**			**Total contact hours/week**	**Credits**	**Examination**		
S.No.	**Course Type**	**Course Code**	**Course Title**	**Teaching Dept.**	**L**	**T**	**P**			**CIE**	**SEE**	**Total**
1	BSC	21MAT21	Differential Equations and Laplace Transforms	Mathematics	3	2	0	5	4	100	100	200
2	BSC	21PHY22	Applied Physics	Physics	3	0	0	3	3	100	100	200
3	ESC	21CIV23	Engineering Mechanics	CV	3	0	0	3	3	100	100	200
4	ESC	21EME24	Basics of Mechanical Engg.	ME	3	0	0	3	3	100	100	200

5	ESC	21EGR25	Engineering Graphics	ME	1	0	4	5	3	100	100	200
6	BSC	21PHL26	Applied Physics Lab	Physics	0	0	2	2	1	50	50	100
7	AEC	21IIL27	Idea to Innovation Lab	All Engg. depts	0	0	2	2	1	100	--	100
8	HSMS	21ENG28	Professional Writing Skills in English	English	1	0	0	1	1	50	50	100
9	ESC	21ACS29	Object Oriented Programming Using C++	CSE	3	0	0	3	3	100	100	200
		21AEC29	Fundamentals of Electronics and Communication Engineering	E & C								
		21AEE29	Fundamentals of DC and AC Systems	E & E								
		21AIS29	Object Oriented Programming Using C++	ISE								
			Total						**22**	**800**	**700**	**1500**

NOTE:

Summer Internship - I:

All the 1st year students admitted to B.E. program shall have to undergo a **mandatory summer internship of 03 weeks** during the vacation of II semesters. Summer Internship shall include Inter / Intra Institutional activities. A Viva-voce examination shall be conducted during III semester and the prescribed credit shall be included in III semesters. The internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take up / complete the internship shall be declared fail and shall have to complete during subsequent University examination after satisfying the internship requirements. **SEE component will be the only seminar/Presentation and question answer session.** (The faculty coordinator or mentor has to monitor the students' internship progress and interact to guide them for the successful completion of the internship.

The course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs:

1. The **mandatory non – credit courses Additional Mathematics I and II (MATDIP) prescribed for III and IV semesters respectively**, to the lateral entry Diploma holders admitted to III semester of BE/B.Tech., programs, shall attend the classes during the respective semesters to complete all the formalities of the course and appear for the **Continuous Internal Evaluation (CIE).** In case, any student fails to register for the said course/fails to secure the minimum 40 % of the prescribed CIE marks, he/she shall be deemed to have secured an F grade. In such a case, the student has to fulfill the requirements during subsequent semester/s to appear for CIE. These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.
2. All the students admitted under the lateral entry category shall have to undergo a mandatory **SUMMER INTERNSHIP-I of 03 weeks during the intervening vacation of III and IV semesters**. Summer Internship shall include Inter / Intra Institutional activities. A Vivavoce examination shall be conducted during the IV semester and the prescribed credit shall be included in the III semester after students clear this head. The internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take up / complete the internship shall be declared fail and shall have to complete during subsequent University examination after satisfying the internship requirements. (The faculty coordinator or mentor has to monitor the students' internship progress and interact to guide them for the successful completion of the internship.)

3rd Semester B.E				Teaching Dept.	Hours/week			Total contact hours/week	Credits	Examination		
S.No.	Course Type	Course Code	Course Title		L	T	P			CIE	SEE	Total
1	BSC	21AE31	Fourier Techniques, Partial differential Equations and Numerical Methods	Mathematics	3	0	0	3	3	100	100	200
2	PCC	21AE32	Mechanics of Materials	AE	3	0	2	5	4	100	100	200
3	PCC	21AE33	Fluid mechanics	AE	3	0	2	5	4	100	100	200
4	PCC	21AE34	Computer aided Aircraft Component's drawing	AE	3	0	2	5	4	100	100	200
5	INT	21INT1	Summer Internship -I	AE					2	50	50	100
6	HSMS	21AE35	Kannada	Kannada	1	1	0	1	1	50	50	100
			Constitution of India and Professional Ethics		1	0	0	1				
7	UHV	21AE36	Universal Human Values	AE	1	0	0	1	1	50	50	100
			Social Connect and Responsibility									
8	AEC	21AECAE37	Introduction to the MATLAB & SIMULINK	AE	0	0	2	2	1	50	50	100
9	BSC*	21MDIPAE-31	MATDIP	Mathematics	3	0	0	3	MNC	100	--	100
			TOTAL						20	700	600	1300

*Only for Diploma Lateral Entry Students

4th Semester B.E				Teaching Dept.	Hours/week			Total contact hours/week	Credits	Examination		
S.No.	Course Type	Course Code	Course Title		L	T	P			CIE	SEE	Total
1	BSC	21AE41	Statistics And Probability	Mathematics	3	0	0	3	3	100	100	200
2	PCC	21AE42	Aerodynamics	AE	3	0	2	5	4	100	100	200
3	PCC	21AE43	Aircraft structures	AE	3	0	2	5	4	100	100	200
4	PCC	21AE44	Engineering Thermodynamics	AE	3	0	2	5	4	100	100	200
5	AEC	21AE45	Health & Wellness	Medical Sciences	2	0	0	2	2	50	50	100
6	HSMS	21AE46	Constitution of India and Professional Ethics	AE	1	0	0	1	1	50	50	100
			Kannada		1	1	0	1				
7	UHV	212AE47	Social Connect and Responsibility	AE					1	50	50	100

			Universal Human Values		1	0	0	1				
8	AEC	21AECAE48	Introduction to PYTHON	AE	0	0	2	2	1	50	50	100
9	BSC*	21MDIPAE-41	MATDIP	Mathematics	3	0	0	3	MNC	100	--	100
			TOTAL						20	700	600	1300

*Only for Diploma Lateral Entry Students

Summer Internship-II: At the End Of **fourth Semester four - weeks Summer Internship** Shall Be Carried Out – Based on Industrial/Govt./NGO/MSME/Rural Internship/Innovation/Entrepreneurship. It will be credited in fifth Semester. All the students admitted shall have to undergo mandatory internship of 04 weeks during the vacation of IV semesters. A Viva-Voce examination shall be conducted during V semester and the prescribed credit shall be included in V semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take up/complete the internship shall be declared fail and shall have to complete during subsequent University examination after satisfying the internship requirements. SEE component will be the only seminar/Presentation and question answer session. (The faculty coordinator or mentor has to monitor the students' internship progress and interact to guide them for the successful completion of the internship).

Kannada: Balake Kannada (Kannada for communication) is for non-Kannada speaking, reading, and writing students, and Samskrutika Kannada (Kannada for Administration) is for students who speak, read and write Kannada.

Professional Elective Courses [5th-7th sem]: Elective will be offered by the respective department.

Open Elective Courses [5th-7th sem]: All Open Electives are offered to students of all branches in general. However, a student shall choose an open Elective from the list in such a manner that he/she has not studied the same course in any form during the Programme. Students can select any one of the open electives offered by other Departments except those that are offered by the parent Department.

Selection of an open elective shall not be allowed if,

- The candidate has studied the same course during the previous semesters of the programme.
- The syllabus content of open electives is similar to that of the Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters of the programme.
- Registration to electives shall be documented under the guidance of Programme Coordinator/ Advisor/Mentor.

Mini-project work(Single discipline/Interdisciplinary)[6th sem]: Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini-project can be assigned to an individual student or a group having not more than 4 students. (or Mini Project is a laboratory-oriented course which will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications)

Research/Industrial Internship - At the End of the sixth / Seventh semester (in two cycles to accommodate all the students of the University) Research/Industrial Internship shall be carried out – Based on industrial/Govt./NGO/MSME/Rural Internship/Innovation/Entrepreneurship. All the students admitted shall have to undergo a mandatory internship of 24 weeks during the vacation of VI/VII semesters. A Viva-Voce examination shall be conducted during VII/VIII semester and the prescribed credit shall be

included in VII/VIII semester. The internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take up/complete the internship shall be declared fail and shall have to complete during subsequent University examination after satisfying the internship requirements.

Research internship: Students have to take up research internships at Centers of Excellence (CoE) / Study Centers established in the same institute and /or out of the institute at reputed research organizations / Institutes. A research internship is intended to give you the flavour of current research going on a particular topic/s. The internships serve this purpose. They help students get familiarized with the field, the skill needed the effort amount and kind of effort required for carrying out research in that field.

Certification (6- 8 weeks duration; Shall have proctored examination): **It can be done any time between 5th – 8th sem and credited during the 8th semester.**
NPTEL/SWAYAM/NASSCOM /Industry-Institute partnered certification. (List of the courses will be notified by the departments).

		5th Semester			**Hours/week**			**Total contact hours/week**	**Credits**	**Examination**		
S.No.	**Course Type**	**Course Code**	**Course Title**	**Teaching Dept.**	**L**	**T**	**P**			**CIE**	**SEE**	**Total**
1	PCC	21AE51	Aircraft Performance	AE	3	0	0	3	3	100	100	200
2	PCC	21AE52	Computational Fluid Dynamics	AE	3	0	2	5	4	100	100	200
3	PCC	21AE53	Aircraft Propulsion	AE	3	0	2	5	4	100	100	200
4	PEC	21AE541X	Professional Elective-1	AE	3	0	0	3	3	100	100	200
5	OEC	21AE551X	Open Elective -1	AE	3	0	0	3	3	100	100	200
6	INT	21AE56	**Summer Internship - II**						3	100	-	100
7	AEC	21AE57	Research Methodology & Intellectual property rights	--	1	0	0	1	1	50	50	100
8	AEC	21AECAE58	Employability Skills -1	Bizotic	1	0	0	1	1	100	-	100
9	HSMS	21AE59	Environmental Studies	Chem/CV	1	0	0	1	1	50	50	100
10	MNC	21EDIPAE51	**Communicative English (Lateral entry students)**	--	1	0	0	1	MNC	50	-	50
			TOTAL						**23**	800	600	1400

Environmental Studies: Paper setting: Civil Engineering Board

Professional Elective: The minimum students' strength for offering professional electives is **05**, if the strength is less than the 05 then the department has to take the permission to offer the course.

Open Elective Courses: All Open Electives are offered to students of all branches in general. However, a student shall choose an open Elective from the list in such a manner that he/she has not studied the same course in any form during the Programme. Students can select any one of the open electives offered by other Departments except those that are offered by the parent Department.

Selection of an open elective shall not be allowed if,

- The candidate has studied the same course during the previous semesters of the programme.
- The syllabus content of open electives is similar to that of the Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters of the programme.
- Registration to electives shall be documented under the guidance of Programme Coordinator/ Advisor/Mentor.

Courses from Law, Business (MBA), Medicine, Arts, Commerce, may be offered as Open Elective Courses (OEC).

The minimum students' strength for offering professional electives is **05,** if the strength is less than the 05 then departments have to take the permission to offer the course.

		6th Semester			**Hours/week**			**Total contact hours/week**	**Credits**	**Examination**		
S.No.	**Course Type**	**Course Code**	**Course Title**	**Teaching Dept.**	**L**	**T**	**P**			**CIE**	**SEE**	**Total**
1	HSMS	21AE61	Airport planning and management	AE	3	0	0	3	3	100	100	200
2	PCC	21AE62	Avionics and Instrumentation	AE	3	0	0	3	3	100	100	200
3	PCC	21AE63	Aircraft stability and control	AE	3	0	2	5	4	100	100	200
4	PCC	21AE64	Vibrations & Aero-elasticity	AE	3	0	2	5	4	100	100	200
5	PEC	21AE651X	Professional Elective-2	AE	3	0	0	3	3	100	100	200
6	OEC	21AE661X	Open Elective -2	AE	3	0	0	3	3	100	100	200
7	MP	21AE67	Mini Project	AE	0	0	2	2	1	100	-	100
8	AEC	21AECAE68	Employability Skills -2	Bizotic	1	0	0	1	1	100	-	100
			TOTAL						**22**	800	600	1400

Mini-project work (Single discipline/Interdisciplinary): Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini-project can be assigned to an individual student or a group having not more than 4 students. (or Mini Project is a laboratory-oriented course which will provide a platform to students to enhance their practical knowledge and skills by the development of small systems/applications)

Research/Industrial Internship - At the End of the sixth / Seventh semester (in two cycles to accommodate all the students of the University) Research/Industrial Internship shall be carried out – Based on industrial/Govt./NGO/MSME/Rural Internship/Innovation/Entrepreneurship. All the students admitted shall have to undergo a mandatory

internship of 24 weeks during the vacation of VI/VII semesters. A Viva-Voce examination shall be conducted during VII/VIII semester and the prescribed credit shall be included in VII/VIII semester. The internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take up/complete the internship shall be declared fail and shall have to complete during subsequent University examination after satisfying the internship requirements.

Research internship: Students have to take up research internships at Centers of Excellence (CoE) / Study Centers established in the same institute and /or out of the institute at reputed research organizations / Institutes. A research internship is intended to give you the flavour of current research going on a particular topic/s. The internships serve this purpose. They help students get familiarized with the field, the skill needed the effort amount and kind of effort required for carrying out research in that field.

		7th Semester			**Hours/week**				**Total contact hours/week**	**Credits**	**Examination**		
S.No.	**Course Type**	**Course Code**	**Course Title**	**Teaching Dept.**	**L**	**T**	**P**				**CIE**	**SEE**	**Total**
1	PCC	21AE71	Flight vehicle design	AE	3	0	0	-	3	3	100	100	200
2	PEC	21AE721X	Professional Elective-3	AE	3	0	0	-	3	3	100	100	200
3	OEC	21AE731X	Open Elective - 3	AE	3	0	0	-	3	3	100	100	200
4	Project	21AE74	Project work	AE	0	0	14	-	14	7	100	100	200
5	AEC	21AECAE75	Sports/Cultural/NSS/NCC/Club activities	--	0	0	0	1	1	1	100	-	100
			TOTAL							**17**	500	400	900

		8th Semester			**Hours/week**			**Total contact hours/week**	**Credits**	**Examination**		
S.No.	**Course Type**	**Course Code**	**Course Title**	**Teaching Dept.**	**L**	**T**	**P**			**CIE**	**SEE**	**Total**
1	Seminar	21AE81	Technical Seminar	AE	0	0	1	1	1	100	-	100
2	AEC	21AECAE82	Certification (Minimum 6 - 8 weeks)	AE	0	0	4	4	2	100	-	100
3	Internship	21AE83	Research/Industry Internship (24 weeks)	AE	0	0	30	30	15	100	100	200
			TOTAL						**18**	300	100	400

Certification (Shall have proctored examination):

- NPTEL/SWAYAM/NASSCOM /Industry-Institute partnered certification.
- List of the courses will be notified by the departments

TECHNICAL SEMINAR: The objective of the seminar is to inculcate self-learning, present the seminar topic confidently, enhance communication skill, involve in group discussion for exchange of ideas. Each student, under the guidance of a Faculty, shall choose, preferably, a recent topic of his/her interest relevant to the programme of Specialization & perform the following activities.

(i) Carry out literature survey, systematically organize the content.

(ii) Prepare the report in their own words, avoiding a cut and paste technique.

(iii) Type the matter to acquaint with the use of Micro-soft equation and drawing tools or any such tools.

(iv) Present the seminar topic orally and/or through PowerPoint slides.

(v) Answer the queries and involve in debate/discussion.

(vi) Submit a typed report with a list of references.

The participants shall take part in the discussion to foster a friendly and stimulating environment in which the students are motivated to reach high standards and become self-confident.

Evaluation Procedure: The CIE marks for the seminar shall be awarded (based on the relevance of the topic, presentation skill, participation in the question and answer session, and quality of report) by the committee constituted for the purpose by the Head of the Department.

The committee shall consist of three teachers from the department with the senior-most acting as the Chairman.

Marks distribution for CIE of the course:

- Seminar Report:50 marks Presentation skill:25 marks
- Question and Answer: 25 marks.
- No SEE component for Technical Seminar

List of Professional Electives –I

Sl.N0	Course Code	Course Title
1	21AE5411	Finite Element Analysis
2	21AE5412	Gas Turbine Technology
3	21AE5413	Aircraft system and Instrumentation
4	21AE5414	Gas Dynamics
5	21AE5415	Experimental Aerodynamics
6	21AE5416	Aircraft Materials and Processes

List of Open Electives –I

Sl.N0	Course Code	Course Title
1	21AE5511	Introduction to aerospace engineering
2	21AE5512	Introduction to Rocket propulsion
3	21AE5513	Air traffic control

List of Professional Electives –II

Sl.N0	Course Code	Course Title
1	21AE6511	Aircraft maintenance, repair and overhaul
2	21AE6512	Rockets and missiles
3	21AE6513	Unmanned Aerial Vehicles & applications
4	21AE6514	Space dynamics
5	21AE6515	Aircraft Structures II
6	21AE6516	Heat Transfer

List of Open Electives –II

Sl.N0	Course Code	Course Title
1	21AE6611	Aircraft systems
2	21AE6612	Wind Tunnel Techniques
3	21AE6613	Air-breathing Engines

List of Professional Electives –III

Sl.N0	Course Code	Course Title
1	21AE7211	Flight testing
2	21AE7212	Helicopter dynamics
3	21AE7213	Composite material Structures
4	21AE7214	Guidance Navigation and control
5	21AE7215	Flight Control Engineering
6	21AE7216	Aircraft Systems, Testing and Manufacturing Processes

List of Open Electives –III

Sl.N0	Course Code	Course Title
1	21AE7311	Aircraft Communication systems
2	21AE7312	Airport operations
3	21AE7313	Unmanned Aerial Vehicles

Syllabus of V Semester Courses

Aircraft Performance

Course Code	21AE51	**Course type**	PCC	**Credits L-T-P**	3 – 0- 0
Hours/week: L-T-P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs;P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	Understand the parameters affecting the performance of the Aircraft.
2.	Study lift, drag and other performance parameters of airplane and Understand the thrust requirements of an aircraft.
3.	Recognize the difference between Study and accelerated flight performance.

Pre-requisites: Elements of Aeronautics, Aerodynamics

Unit – I INTRODUCTION TO AIRCRAFT PERFORMANCE	**Contact Hours = 8 Hours**
Overview of aerodynamics, mission profile, International standard Atmosphere, four forces of flight, General equation of motion, Power available and power required curves. Thrust available and Thrust required curves. Conditions for power required and thrust required minimum. Thrust available and maximum velocity, Stall phenomena. Power available and maximum velocity, Altitude effects on power available and power required; thrust available and thrust required.	

Unit – II CRUISE PERFORMANCE:	**Contact Hours = 8 Hours**
Level Flight, Climb & Glide Performance: Equation of motion for Rate of climb- analytical approach - Absolute ceiling, Service ceiling, Time to climb – analytical approach , climb performance graph (hodograph diagram); maximum climb angle and rate of climb Gliding flight, Range during glide, minimum rate of sink and shallowest angle of glide. Effect of wind on climb and decent performance. **Flipped Class Content**: Cruise techniques: constant angle of attack, constant Mach number, constant Mach number methods	

Unit – III AIRPLANE PERFORMANCE PARAMETERS	**Contact Hours = 8 Hours**
Thrust– to–weight ratio, Wing loading, Drag polar and lift-to–drag ratio. Minimum velocity. Aerodynamic relations associated with lift- to-drag ratio. Range And Endurance: Propeller driven Airplane: Physical consideration, Quantitative formulation, Breguet equation for Range and Endurance, Conditions for maximum range and endurance. Tail wind and head wind effects on Range and Endurance Performance. **Flipped Class Content**: Energy height and specific excess power.	

UNIT – IV MANEUVER PERFORMANCE	**Contact Hours = 8 Hours**

Level turn, load factor, Constraints on load factor, Minimum turn radius, Maximum turn rate. Pull-up and Pull-down maneuvers: (Turning rate, turn radius). Performance in accelerated climb from energy point of view, Energy height. Limitations of pull up and push over. Spin phenomena. Maneuver performance of supersonic flights. **Flipped Class content**: Limiting case for large load factor. The V-n diagram.

Unit –V ACCELERATED FLIGHT PERFORMANCE	**Contact Hours = 8 Hours**
Calculation of Ground roll, Calculation of distance while airborne to clear obstacle, Balanced field length. Landing Performance and Accelerated Climb-Calculation of approach distance, Calculation of flare distance, Calculation of ground roll, ground effects. Acceleration in climb. **Flipped Class content**: accelerating climb, turning flight.	

Flipped Classroom Details

Unit No.	**I**	**II**	**III**	**IV**	**V**
No. for Flipped Classroom Sessions	**2**	**2**	**2**	**2**	**2**

Books	
	Text Books:
1.	Anderson, J.D. Jr., —Aircraft Performance and Design‖, International edition McGraw Hill, 1stEdition, 1999, ISBN: 0-07-001971-1.
2.	Eshelby, M.E., —Aircraft Performance theory and Practice‖, AIAA Education Series, AIAA, 2ndEdition, 2000, ISBN: 1-56347-398-4.
	Reference Books:
1.	Shevel, R.S., —Fundamentals of Flight‖, Pearson Education, 2nd Edition, 1989, ISBN: 81-297-0514-1.
2.	McCormick, B. W., Aerodynamics, Aeronautics, and Flight Dynamics, 2nd ed., Wiley (1994).
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://nptel.ac.in/courses/101104007/ Lectures by Prof. A K Ghosh, IIT Kanpur.

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Describe** the influence of atmosphere, Aerodynamics and aircraft configuration on aircraft performance.	Un	1	1
2.	**Calculate t**he Performance parameters of a fixed-wing aircraft with either a jet or a propeller-driven propulsion	AP	1,2	1

	system in straight and level flight and **analyze** the various types of cruise techniques.			
3.	**Analyze** the factors effecting the accelerated Flight performance of the aircraft.	An	1,2,3	1

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25= 50	5* 4 marks = 20	10+10 =20	10	100
OBA- Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass:** Score should be > 35&, however overall score of CIE + SEE should be > 40%
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping(Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	**√**	**√**											**√**	**√**	
2	**√**	**√**	**√**										**√**	**√**	
3	**√**	**√**	**√**										**√**	**√**	
Please Tick at appropriate place															

Sl. No.	**Skill & Competence enhanced after undergoing the course**	**Applicable sectors & domains**	**Job roles students can take up after undergoing the course**
1	**Basic knowledge of Aircraft performance Parameters.**	**Aircraft design**	**Aircraft Design Engineer**
2	**Analysis of Accelerated flight performance**	**Aircraft & Cruise missile Design**	**Design Trainee (HAL)**

Name & Sign of faculty members involved in designing the syllabus	**Name & Sign of faculty members verifying/approving the syllabus**
Prof. Anil Kumar Nakkala	**Prof. I V Patil**

Computational Fluid Dynamics

Course Code	21AE52	**Course type**	**PCC**	**Credits L-T-P**	3 – 0 - 1
Hours/week: L - T- P	3 – 0 – 2			**Total credits**	4
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 10 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	Know the basic of computational techniques in field of engineering
2.	Acquire the knowledge of Discretization and Mathematical modeling
3.	Know the basics of Finite difference method schemes
4.	Understand the various types of grids and its uses.
5.	Understand the various models and its applications.

Pre-requisites : Basic Mathematics, Physics, Fluid Mechanics Basics.

Unit – I : Introduction	**Contact Hours = 8 Hours**
CFD Applications. Continuity, Momentum, and Energy Equations-Derivationin Differential forms. Integral versus Differential form of equations. Comments on governing equations. Physical boundary conditions.	

Unit – II : Mathematical Behavior of Partial Differential Equations	**Contact Hours = 8 Hours**
Classification of partial differential equations. Cramer Rule and Eigen value methods for classification. Hyperbolic, parabolic, and elliptic forms of equations. **Case studies:** steady inviscid supersonic flow, unsteady inviscid flow, steady boundary layer flow, and unsteady thermal conduction, steady subsonic inviscid flow	

Unit – III : Discretization	**Contact Hours = 8 Hours**
Finite differences methods, and difference equations. Explicit and Implicit approaches. Explicit versus Implicit Scheme. Errors and stability analysis. Time marching and space marching.	

Unit – IV : Grid Generation	**Contact Hours = 8 Hours**
Need for grid generation and Body-fitted coordinate system. Structured Grids-essential features. Importance, Structured Vs. Unstructured Grids, Major Tasks of generation, Analytical Transformation, Grid Quality, Concept of Multi-blocking, Adaptive grids, Surface grid generation	

Unit – V : Calculation of fluid flow	**Contact Hours = 8 Hours**

Representation of the pressure - Gradient term and continuity equation – Staggered grid - Momentum equations - Pressure and velocity corrections - Pressure Correction equation - Numerical procedure for SIMPLE algorithm – Boundary conditions for the pressure correction method.

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

List of Experiments

Unit No.	No. of Experiments	Topic(s) related to Experiment
1	**1**	Introduction to fluent
3,4	**2**	Generation of the following grids, Structured and Unstructured.
2	**3**	Flow analysis of Symmetric Aerofoil of Inviscid flow
2	**4**	Heat transfer analysis of rectangular isotropic materials(pin-fins)
5	**5**	Numerical simulation of Supersonic flow over a wedge
5	**6**	2-D Convergent- Divergent Nozzle and Analyses of Flow for Adiabatic Conditions.
5	**7**	Numerical simulation of Flat plate boundary layer
2,5	**8**	Flow analysis of Cambered Aerofoil of viscid flow

Books	
	Text Books:
1.	Computational Fluid Dynamics – The basics and applications, McGraw Hill Education (1 July 2017), ISBN-13: 978-1259025969
2.	An introduction to CFD, H. Versteeg and W. Malalasekra, Pearson; 2 edition (2008), ISBN-13: 978-8131720486.
3.	Introduction to Computational Fluid Dynamics, PradipNiyogi, S.K. ChakrabarthyandM.K. Laha, Pearson Education, 2006.
	Reference Books:
1.	Fletcher, C.A.J., "Computational Techniques for Fluid Dynamics", Springer, Berlin,2nd edition,2002,ISBN-13: 978-3540543046
2.	**E-resources (NPTEL/SWAYAM.. Any Other)- mention links**
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://nptel.ac.in/courses/103106073/: Computational fluid dynamics course at IIT Madras by Prof. Srinivas Jayanti
2.	https://nptel.ac.in/courses/112105045/: Computational fluid Dynamics course at IIT Kharagpur by Dr. Suman Chakraborthy

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)

4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Understand** the need of CFD and its applications	**Un**	1	1,2
2.	**Apply** mathematical knowledge to modeling of physical problems.	**Ap**	1,2	1,2
3.	**Evaluate** the effects of different approaches and boundary conditions	**Ap**	1,2	1,2
4.	**Acquire** the knowledge of grids and its uses	**An**	1,2,5,9,10	1,2,3
5.	**Apply** the concept of fluid flow in CFD and its solving techniques	**An**	1,2,5,9,10	1,2,3

Scheme of Continuous Internal Evaluation (CIE):

For integrated courses, a lab test also will be conducted at the end of the semester. The lab test **(COMPULSORY)** will be part of the CIE. **No SEE for Lab**.

THEORY (60 marks)			**LAB (40 marks)**		Total
IA test 1	IA test 2	Assignment (OBA/Lab Project/ Industry assignment)/ Course project	Conduction	Lab test	
25 marks	25 marks	10 marks	15 marks	25 marks	100 marks
IA Test: 1. No objective part in IA question paper 2. All questions descriptive					
Conduct of Lab: 1. Conducting the experiment and journal: 5 marks 2. Calculations, results, graph, conclusion and Outcome: 5 marks 3. Viva voce: 5 marks					
Lab test: (Batchwise with 15 students/batch) 1. Test will be conducted at the end of the semester 2. Timetable, Batch details and examiners will be declared by Exam section 3. Conducting the experiment and writing report: 5 marks 4. Calculations, results, graph and conclusion: 10 marks 5. Viva voce: 10 marks					
Eligibility for SEE: 1. 40% and above (24 marks and above) in theory component 2. 40% and above (16 marks and above) in lab component 3. **Lab test is COMPULSORY** 4. Not eligible in any one of the two components will make the student **Not Eligible** for SEE					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be ≥35 &, however overall score of CIE+SEE should be ≥40%.

3.	Question paper contains three parts **A,B and C**. Students have to answer 1. From Part A answer any 5 questions each Question Carries 6 Marks. 2. From Part B answer any one full question from each unit and each Question Carries 10 Marks. 3. From Part C answer any one full question and each Question Carries 20 Marks.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓												✓	✓	
2	✓	✓											✓	✓	
3	✓	✓											✓	✓	
4	✓	✓			✓				✓	✓			✓	✓	✓
5	✓	✓			✓				✓	✓			✓	✓	✓
Tick mark the CO, PO and PSO mapping															

	Skill & competence enhanced after undergoing the course	**Applicable Industry Sectors & domains**	**Job roles students can take up after undergoing the course**
1	**Computational method basics**	**CFD**	**CFD Flow analysis Engineer**
2	**Computational flow analysis**	**Automobile sector**	
3	**Multidisciplinary projects handling knowldge**	**Aeronautical Sector**	

Name & Sign of faculty members involved in designing the syllabus	**Name & Sign of faculty members verifying/approving the syllabus**
Prof. D A Ponnaswami	**Prof. A K Nakkala**

Aircraft Propulsion

Course Code	**21AE53**	**Course type**	**PCC**	**Credits L-T-P**	3 - 0 - 2
Hours/week: L - T- P	3 - 0 - 2			**Total credits**	4
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 10 Hrs Total = 50 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	Understand the basic principle and theory of aircraft propulsion.
2.	Learn the purpose of propeller theory and selection of propellers
3.	Gain the knowledge of different inlets and their operations
4.	Understand of a centrifugal, axial compressor, axial and radial turbines.
5	Comprehend the types of combustors, nozzles and their working conditions

Required Knowledge of : Elements of Aeronautics

Unit – I	**Contact Hours = 8 Hours**
Fundamentals of air breathing engines: Classification of jet engines -Brayton Cycle analysis, illustration of working of gas turbine engines and their performance characteristics –thrust equation – Engine performance parameters, specific thrust, specific fuel consumption and specific impulse, thermal efficiency, propulsive efficiency, methods of thrust augmentation. **Propeller Theories & Jet propulsion:** Types of propeller, Propeller thrust: momentum theory, Blade element theories and propeller selection.	

Unit – II	**Contact Hours = 8 Hours**
Subsonic and Supersonic inlets: Internal flow and Stall in Subsonic inlets, Relation between minimum area ratio and external deceleration ratio. Supersonic inlets, Shock swallowing by area variation, Modes of inlet operation. **Nozzles:** Theory of flow in isentropic nozzles, Convergent nozzles and nozzle choking, Nozzle efficiency, Losses in nozzles. Thrust reversal method.	

Unit – III	**Contact Hours = 8 Hours**
Gas Turbine Engine Compressors: Centrifugal compressors: Principle of operation of centrifugal compressors. Work done and pressure rise -Velocity diagrams, Diffuser vane design considerations, problems. **Axial flow compressors:** Elementary theory of axial flow compressor, Velocity triangles, Degree of reaction, Air angle distribution for free vortex and constant reaction designs, problems.	

Unit – IV	**Contact Hours = 8 Hours**

Combustion chambers: Classification of combustion chambers, important factors affecting combustion chamber design, Combustion process, Combustion chamber performance Effect of operating variables on performance – Flame tube cooling. **Turbines:** Introduction, types of turbines, Turbine stage, Multi-staging of turbine, Exit flow conditions, Turbine cooling, Heat transfer in turbine cooling.

Unit – V	**Contact Hours = 8 Hours**
Ramjet Propulsion: Operating principle –Sub critical, critical and supercritical operation – Combustion in ramjet engine –Ramjet performance–Preliminary concepts in supersonic combustion –Integral ram-rocket, Introduction to scram jet engine- working principle **Fundamentals of Rocket Propulsion** Types and Classification of rockets Operating principle – Specific impulse of a rocket –Rocket nozzle classification.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

List of Experiments

Unit No.	No. of Experiments	Topic(s) related to Experiment
1	**2**	Determine the natural and forced heat transfer coefficient
2	**4**	Study the performance of propeller at different speeds and measure the thrust force, Performance studies on two dimensional diffuser for stable flow, Determine the velocity profile or decaying velocity of free jet of different sizes, Determine the pressure distribution and velocity profile of a flow in the convergent nozzle.
3	**2**	Study the pressure distribution on a cascade unit at different incidence angle of an axial compressor blade, Calculation of the Mechanical efficiency of axial compressor- power required, power Available, Compression Ratio
4	**1**	Experimentally determination of the burning velocity of premixed flame by measuring the cone angle,
5	**1**	Study of the flame lift off and blow off phenomenon for various air/fuel ratio premixed flame.

Unit No.	Self-Study Topics
1	Types of propeller, propeller selection
2	Over-expanded and under-expanded nozzles, Ejector and variable area nozzles
3	Diffuser vane design considerations

4	Flame stabilization, Use of flame holders
5	Introduction to scram jet engine- working principle

Books	
	Text Books:
1.	Bhaskar Roy, "Aircraft propulsion", Elsevier (2011), ISBN-13: 9788131214213
2.	V. Ganesan, "Gas Turbines", Tata McGraw-Hill, 2010, New Delhi, India, ISBN: 0070681929, 978007068192
	Reference Books:
1.	Hill, P.G. & Peterson, C.R., "Mechanics & Thermodynamics of Propulsion" Addison – Wesley Longman INC, 1999, ISBN-13: 978-0201146592.
2.	Irwin E. Treager, "Gas Turbine Engine Technology" GLENCOE Aviation Technology Series, 7th Edition, Tata McGraw Hill Publishing Co.Ltd. Print 2003, ISBN-13: 978-0028018287
3.	Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H., "Gas Turbine Theory", Longman, 1989, ISBN 13: 9780582236325.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by: Prof. Bhaskar Roy , Prof. A M Pradeep, IIT Bombay https://nptel.ac.in/courses/101101002/
2.	**NPTEL:** Online Resources: Lecture by: Prof. Vinayak N. Kulkarni , IIT Guwahati https://swayam.gov.in/nd1_noc19_me76/preview

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Open Book Assignments (OBA)/ Lab Project
3.	Flipped Classes	3.	Lab Test
4.	Practice session/Demonstrations in Labs	4.	Semester End Examination
5.	Virtual Labs (if present)		

Course Outcome (COs)

Learning Levels:

Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create

At the end of the course, the student will be able to		Learning Level	PO(s)	PSO(s)
1.	**Apply** the basic principle and theory of aircraft propulsion.	Ap	1,2	1
2.	**Classify** the types of propellers and explain their theories.	Ap	1,2	1
3.	**Describe** the types of inlets and explain their operations.	Ap	1,2	1
4.	**Explain** the functions of centrifugal, axial compressors, axial and radial turbines	Ap	1,2	1
5.	**Analyze** the performance of nozzles and combustion chamber	An	1,2	1

Scheme of Continuous Internal Evaluation (CIE):

For integrated courses, a lab test also will be conducted at the end of the semester. The lab test **(COMPULSORY)** will be part of the CIE. **No SEE for Lab**.

THEORY (60 marks)			**LAB (40 marks)**		Total
IA test 1	IA test 2	Assignment (OBA/Lab Project/ Industry assignment)	Conduction	Lab test	
25 marks	25 marks	10 marks	15 marks	25 marks	100 marks
IA Test: 1. No objective part in IA question paper 2. All questions descriptive					
Conduct of Lab: 1. Conducting the experiment and journal: 5 marks 2. Calculations, results, graph, conclusion and Outcome: 5 marks 3. Viva voce: 5 marks					
Lab test: (Batchwise with 15 students/batch) 1. Test will be conducted at the end of the semester 2. Timetable, Batch details and examiners will be declared by Exam section 3. Conducting the experiment and writing report: 5 marks 4. Calculations, results, graph and conclusion: 10 marks 5. Viva voce: 10 marks					
Eligibility for SEE: 1. 40% and above (24 marks and above) in theory component 2. 40% and above (16 marks and above) in lab component 3. **Lab test is COMPULSORY** 4. Not eligible in any one of the two components will make the student **Not Eligible** for SEE					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass:** Score should be > 35 &, however overall score of CIE + SEE should be > 40%
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (planned)													**CO-PSO Mapping (planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	√	√											√		
2	√	√											√		
3	√	√											√		
4	√	√											√		
5	√	√											√		
Mention the levels: 1, 2, 3															

Sl. No.	Skill & Competence enhanced after undergoing the course	Applicable sectors & domains	Job roles students can take up after undergoing the course
1	Able to understand working of aircraft engine	Aerospace propulsion	Gas turbine engines related jobs
2	Acquire knowledge about each component of engines	Technical publication	Aero Engine Technical Publication Engineer
4	Knowledge of Gas Turbine engines and their functioning	Maintenance	Repair Industrialization Engineer
5	Familiar with gas turbine principles, different modules and functionalities of major parts	Engineering & Manufacturing	Aero Engine Component Design Engineer

Name & Sign of faculty members involved in designing the syllabus	Name & Sign of faculty members verifying/approving the syllabus
Prof. Parameshwar Banakar	Prof. I V Patil

FINITE ELEMENT ANALYSIS

Course Code	**21AE5411**	**Course type**	**PEC**	**Credits L-T-P**	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	Understand the different types of elements and related field problems
2.	Derive and interpret the governing equation of finite element analysis
3.	Acquire the knowledge of implementing different loading and boundary conditions
4.	Apply the knowledge of FEA to structural problems

Pre-requisites : Mechanics of Materials

Unit – I: Introduction	**Contact Hours = 8 Hours**
Brief history of FEA; Introduction to FEA; Processes involved in FEA (flow chart); Applications, advantages and limitations of FEA; Discretization of the domain, Finite elements, nodes and shape functions, types of elements based on geometry, and shape functions; Overview of basic elasticity, Plane stress, plane strain conditions, various energies associated with the elastic body. Matrix operations.	

Unit – II: 1D finite elements	**Contact Hours = 8 Hours**
Elemental equation of 1D elements for various problems. Determination of interpolation/shape functions for various 1D elements. Principal of minimum total potential energy applied to obtain elemental equation to evaluate deformations, stresses and strains of 1D bars. Shape functions, their properties and variations; General process of FEA applied to the solution of structural problems. Implementation of boundary conditions by elimination method and penalty approach. Elemental equation for 2d truss analysis. Elemental equation for heat conduction of 1D problems and associated boundary conditions.	

Unit – III: Problems on 1D elements	**Contact Hours = 8 Hours**
Concept of 1D elements applied to the analysis of stepped and tapered bars subjected to axial loads. 2D truss problems using 1D elements. Heat conduction problems of Insulated fins, infinite plates, walls, un-insulated fins using 1D finite elements.	

Unit – IV: 2D and 3D finite elements	**Contact Hours = 8 Hours**
Two dimensional elements: Triangular, rectangular elements; Linear, quadratic and cubic elements; interpolation functions for all 2D elements using Lagrange equations, concept of global and local/natural coordinate systems applied to determine shape functions of various elements. Three dimensional elements: Introduction to tetrahedral, brick, pyramidal, and wedge elements; Shape functions of linear brick element. Convergence requirements of shape functions and finite elements.	

Unit – V: Applications of 2D elements	Contact Hours = 8 Hours
Two dimensional elements applied for the solution of plane stress and plane strain problems; Numericals using 2D elements. Serendipity elements; Axisymmetric elements; iso-parametric, sub-parametric and super-parametric elements and their formulations; Jacobian matrix and its importance.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	3	1	3	1

Books	
	Text Books:
1.	Chandrupatla T. R. and A. Belagundu, "Finite Elements in engineering", PHI, 3rd edition, 2002, ISBN-13: 978- 8120321069.
2.	Bhavikatti, Finite element Analysis, New Age International,3rd edition, 2015, ISBN-13: 978-8122436716.
3.	S. S. Rao, "The Finite Element Method in Engineering", Elsevier Science & Technology Books, 4th Edition, 2004, ISBN: 0750678283.
	Reference Books:
1.	Zienkiewicz. O.C. - "The Finite Element Method", Elsevier,7th edition, 2013, ISBN-13: 978-9351071587.
2.	J N Reddy, "Introduction to the Finite Element Method", McGraw Hill, 3rd Edition, 2006, ISBN-007-124473-5.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://nptel.ac.in/courses/105106051/: Finite element analysis course at IIT Madras by Dr. B N Rao.
2.	https://nptel.ac.in/courses/112104193/: Finite element analysis course at IIT Kanpur by Prof. Nachiketa Tiwari.

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Explain** the fundamental concepts of finite element methods, basic equations of Stress-strain relations and energy concepts.	Un	1	1

2.	**Derive** and **explain** various elemental equations for various finite elements	Ap	1, 2	1
3.	**Explain** various types of finite elements and the process to **determine** their shape functions.	Ap	1, 2	1
4.	**Evaluate** and **Analyze** various structural problems using concept of finite element analysis	Ev	1, 2, 3, 4, 5, 8, 9, 10, 12	1, 2, 3

Scheme of Continuous Internal Evaluation (CIE): **Theory course**

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass:** Score should be > 35 &, however overall score of CIE + SEE should be > 40%
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	√												√		
2	√	√											√		
3	√	√											√		
4	√	√	√	√	√			√	√	√		√	√	√	√
Please Tick at appropriate place															

Sl. No.	**Skill & Competence enhanced after undergoing the course**	**Applicable sectors & domains**	**Job roles students can take up after undergoing the course**
1	**Discretization of domain**	**Aircraft Structural analysis and Design**	**Stress Analyst**
2	**Application of loads**	**UAV design and Analysis**	**Structural Designer**
3	**Implementation of boundary conditions**	**Aerospace system design and analysis**	**Structure Analyst**
4	**Primary and secondary variables calculations**	**Mechanical system design and analysis**	**-**

Name & Sign of faculty members involved in designing the syllabus	Name & Sign of faculty members verifying/approving the syllabus
Dr. Kamlesh Kulkarni	**Dr. L Chikmath**

Gas Turbine Technology

Course Code	**21AE5412**	**Course type**	**PEC**	**Credits L-T-P**	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	Understand to concepts of Gas turbines
2.	Explain the concepts of the engine performance
3.	Explain and evaluate the concepts underpinning the design of gas turbine combustors and reheat systems for gas turbines
4.	Evaluate the concepts of the combustion and turbines in gas turbines.
5	Understand the concept of overhauling in gas turbines

Pre-requisites :Thermodynamics

Unit – I Fundamental of Gas turbine	**Contact Hours = 8 Hours**
Potential energy, kinetic energy, Newton's laws of motion, Brayton cycle; The relationship between force, work, power, energy, velocity, acceleration; Constructional arrangement and operation of turbojet, turbofan, turbo shaft, turboprop.	

Unit – II Materials	**Contact Hours = 8 Hours**
Materials and Manufacturing: Criteria for selection of materials. Heat ranges of metals, high temperature strength. Surface finishing. Powder metallurgy. Use of composites and Ceramics. Super alloys for Turbines. Systems: Fuel systems and components. Sensors and Controls. FADEC interface with engine. Typical fuel system. Oil system components. Typical oil system. Starting systems. Typical starting characteristics. Various gas turbine starters.	

Unit – III Compressors	**Contact Hours = 8 Hours**
Axial and centrifugal types; Constructional features and operating principles and applications; Fan balancing; Operation: Causes and effects of compressor stall and surge; Methods of air flow control: bleed valves, variable inlet guide vanes, variable stator vanes, rotating stator blades Compressor ratio.	

Unit – IV Nozzle and exhaust system	**Contact Hours = 8 Hours**
Nozzle guide vanes; Causes and effects of turbine blade stress and creep. Constructional features and principles of operation; Convergent, divergent and variable area nozzles; Engine noise reduction; Thrust reversers.	

Unit – V Engine systems.	Contact Hours = 8 Hours
Operation of engine control and fuel metering systems including electronic engine control (FADEC); Systems lay-out and components Operation of engine start systems and components; Ignition systems and components; Maintenance safety requirements. Exhaust Gas Temperature/Inter stage Turbine Temperature; Engine Thrust Indication: Engine Pressure Ratio, engine turbine discharge pressure or jet pipe pressure systems; Oil pressure and temperature; Fuel pressure and flow; Engine speed; Vibration measurement and indication; Torque; Power.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
3.	Irwin E. Treager, "Gas Turbine Engine Technology" GLENCOE Aviation Technology Series, 7th Edition, Tata McGraw Hill Publishing Co.Ltd. Print 2003, ISBN-13: 978-0028018287
4.	P.P Walsh and P. Peletcher, 'Gas Turbine Performance' Blackwell Science, 1998, ISBN0632047843.
	Reference Books:
1.	J P Holman, 'Experimental methods for Engineers ', Tata Mc Graw Hill,7th edition,2007, ISBN13: 978-0070647763
2.	Michael J.Kores, and Thomas W.Wild ,' Aircraft Power Plant', GLENCOE Aviation Technology Series, 7th Edition, Tata Mc Graw Hill Publishing Co.Ltd.2002
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	NPTEL: Online Resources: Lecture by: Prof. Pranab Mondal, IIT Guwahati https://nptel.ac.in/courses/112103262/
2.	

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		Learning Level	PO(s)	PSO(s)
1.	**Identify** the types of engines and describe their applications	3	1,2	1,2,3
2.	**Evaluate** the performance of the engine.	3	1,2	1,2,3
3.	**Evaluate** the performance of specific engine components	3	1,2	1,2,3
4.	**Test** the engine using several types of engine testing methods.	3	1,2	1,2,3

Scheme of Continuous Internal Evaluation (CIE): **Theory course**

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks

Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass:** Score should be > 35 &, however overall score of CIE + SEE should be > 40%
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓											✓	✓	✓
2	✓	✓											✓	✓	✓
3	✓	✓											✓	✓	✓
4	✓	✓											✓	✓	✓
5	✓	✓											✓	✓	✓
Please Tick at appropriate place															

Sl. No.	**Skill & Competence enhanced after undergoing the course**	**Applicable sectors & domains**	**Job roles students can take up after undergoing the course**
1	**Acquire the knowledge of jet engine and its components**	**Aerospace**	**Lead Engineer**
2	**Gain the knowledge about the engine overhauling**	**Thermal**	**Maintenance engineer**

Name & Sign of faculty members involved in designing the syllabus	**Name & Sign of faculty members verifying/approving the syllabus**
Prof. I V Patil	**Prof. P M Banakar**

Aircraft system and Instrumentation

Course Code	21AE5413	**Course type**	**PEC**	**Credits L-T-P**	3 – 0- 0
Hours/week: L-T-P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs;P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	Understand the different aircraft mechanical systems.
2.	Learn various electronic instruments and systems.
3.	Illustrate the operation of engine related and landing gear related systems.
4.	Recognize flight instruments and navigation systems of flight.

Pre-requisites :

Unit – I	**Contact Hours = 8 Hours**
Aircraft systems: Hydraulic systems, Study of typical systems, components, hydraulic systems controllers, pneumatic systems, typical pneumatic power system, brake system, components, landing gear systems, classification of shock absorbers, retractive mechanism. working principles and modes of operation of all systems.	

Unit – II	**Contact Hours = 8 Hours**
Airplane control systems: Conventional Systems, power assisted and fully powered flight controls, power actuated systems, engine control systems, modern control systems, digital fly by wire systems, auto pilot system, active control technology Self-study: push pull rod system	

Unit – III	**Contact Hours = 8 Hours**
Engine systems: FADEC, Fuel systems, piston and jet engines: components, lubricating system,starting, ignition systems, multi-engine fuel systems. Air conditioning and pressurizing system: Basic air cycle systems, vapour cycle systems, boot-strap air cycle system, evaporative vapour cycle systems, evaporation air cycle systems, oxygen systems, fire protection systems, deicing and anti-icing system.	

Unit – IV	**Contact Hours = 8 Hours**
Aircraft Cockpit Instruments and Display: Principle and working- Turn and slip indicator, Heading indicator, artificial horizon, Direction indicator, vertical speed indicator, attitude indicator,magnetic compass, variometer. Display terminology.	

Unit –V	**Contact Hours = 8 Hours**
Aircraft Instruments: Principle and working- Flight instruments and navigation instruments, accelerometers, air speed indicators, Mach meters, altimeters, principles and operation, various types of engine instruments, tachometers, temperature gauges, pressure gauge.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	1	1	1	1	1

Books	
	Text Books:
1.	BaMekinley, J.L. and R.D. Bent, "Aircraft Power Plants", McGraw Hill 1993.ldev Raj, T.
2.	Treager, S., "Gas Turbine Technology", McGraw Hill 1997.
3.	Jayakumar, M. Thavasimuthu "Practical Non-Destructive Testing", Narosa PublishingHouse, 2009.
	Reference Books:
1.	E H J Pallet, "Aircraft instruments", 2nd edition, Pearson, ISBN: 978-8131728130
2.	Mckinley, J.L. and Bent R.D. "Aircraft Maintenance & Repair", McGraw Hill,1993.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-885j-aircraft-systems-engineering-fall-2005/
2.	https://www.cranfield.ac.uk/courses/short/transport-systems/safety-assessment-of-aircraft-systems

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Describe** various types of hydraulics systems and instruments	L2	1,10,12	1,2,3
2.	**Illustrate** the various pneumatic systems.	L2	1,10,12	1,2,3
3.	**Understand** various aircraft measurement systems.	L2	1,10,12	1,2,3
4.	**Recognize** the operations of instruments used in aircraft.	L2	1,10,12	1,2,3
5.	**Learn** the importance and need of various aircraft systems and instruments.	L2	1,10,12	1,2,3

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25= 50	4* 5 marks = 20	10+10 =20	10	100

OBA- Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass:** Score should be > 35&, however overall score of CIE + SEE should be > 40%
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping(Planned)**		
CO	**PO1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓									✓		✓	✓	✓	✓
2	✓									✓		✓	✓	✓	✓
3	✓									✓		✓	✓	✓	✓
4	✓									✓		✓	✓	✓	✓
5	✓									✓		✓	✓	✓	✓
Please Tick at appropriate place															

Sl. No.	**Skill & Competence enhanced after undergoing the course**	**Applicable sectors & domains**	**Job roles students can take up after undergoing the course**
1	Technical Proficiency	Aerospace Industry, Avionics Manufacturing Companies, Airlines and Aviation Operators, Maintenance, Repair and Overhaul (MRO) Facilities, Defense and Military, Research and Development, Flight Simulation Companies, UAV (Unmanned Aerial Vehicle) and Drone Industry, Government Regulatory Agencies	Avionics Technician/Engineer
2	System Troubleshooting		Avionics Integration Specialist
3	System Integration		Avionics System Engineer
4	Communication and Collaboration		Avionics Project Manager
5	Safety Awareness		Avionics Sales Engineer
6	Analytical Skills		Avionics Instructor/Trainer
7	Continuous Learning		Avionics Systems Consultant

Name & Sign of faculty members involved in designing the syllabus	**Name & Sign of faculty members verifying/approving the syllabus**
Prof. P K katti	**Prof. P S Joshi**

Gas Dynamics

Course Code	21AE5414	**Course type**	PEC	**Credits L-T-P**	3 – 0- 0
Hours/week: L-T-P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs;P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	understanding of the basic principles, equations, and laws governing the behavior of compressible fluids
2.	Study and analyze oblique shock waves and expansion waves.
3.	Understand the limitations and constraints of compressible flow.

Pre-requisites: Aerodynamics

Unit – I Introduction to Compressible Flow	**Contact Hours = 8 Hours**
Thermodynamics of Fluid flow, Energy Equation, Entropy equation, Perfect gas equation, Wave propagation, Steady one dimensional flow –Discharge from a reservoir, stream tube area- velocity rule, Supersonic flow generation, Diffuser, pressure coefficient. **Flipped Class Content**: De Laval nozzle.	

Unit – II Hypersonic Shock Waves and Expansion Wave relations	**Contact Hours = 8 Hours**
Introduction, Basic Hypersonic Shock Relations, Hypersonic Shock Relations in Terms of the Hypersonic Similarity Parameter, Hypersonic Expansion-Wave Relations. **Flipped Class Content**: Shock-Expansion Method.	

Unit – III Viscous Flow: Basic Aspects, Boundary Layer Results, and Aerodynamic Heating	**Contact Hours = 8 Hours**
Introduction, Governing Equations for Viscous Flow, Similarity Parameters and Boundary Conditions, Boundary-Layer Equations for Hypersonic Flow, Hypersonic Boundary-Layer Theory, Nonsimilar Hypersonic Boundary Layers **Flipped Class content**: Hypersonic Turbulent Boundary Layer	

Unit – IV Lift and drag in supersonic flow	**Contact Hours = 8 Hours**
Shock expansion theory, Flow field in supersonic flow. Thin airfoil theory, Analytical determination of lift, drag coefficients on flat plate, bi- convex, diamond -shaped profiles in supersonic flow. Supersonic flow past wings. **Potential equation for compressible flows:** Introduction, Crocco's theorem, derivation of basic potential equation for compressible flow, linearization of potential equation & boundary conditions. **Flipped Class content**: Small perturbation theory, application to wavy wall and bodies of revolution.	

Unit –V Measurements in compressible flows;	Contact Hours = 8 Hours
Instruments used in compressible flow; Rayleigh - Pitot-formula, Subsonic, transonic and supersonic wind tunnels- Design and operation of supersonic wind tunnel. Flow visualization by interferometer, schlieren and shadow graph methods. Instrumentation for Hypersonic wind and shock tunnels, Aeroballistic range. **Flipped Class content**: Performance analysis.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	Radakrishnan E. Gas Dynamics, 7th edition, PHI Learning Pvt. Ltd.
2.	P. Murugaperumal, Gas Dynamics and Jet Propulsio, Scitech Publication, Chennai.
	Reference Books:
1.	John D. Anderson, Modern Compressible Flow: With Historical Perspectiv, McGraw-Hill Higher Education
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://nptel.ac.in/courses/101108086 Lectures by Prof. Srisha Rao M V, IISC Bangalore.

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Describe** the fundamental principles of gas dynamics	Un	1	1
2.	**Apply** the principles of conservation laws and governing equations to **analyze** and **solve** problems related to compressible flow.	AP	1,2	1
3.	**Analyze characteristics** of oblique shock waves and expansion waves, including their formation, properties, and interaction with solid surfaces.	An	1,2,3	1,2
4.	**Design** nozzles and diffusers for efficient and effective fluid flow.	An	1,2,3	1,2

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25= 50	5* 4 marks = 20	10+10 =20	10	100
OBA- Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass:** Score should be > 35&, however overall score of CIE + SEE should be > 40%
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping(Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	√	√										√	√	√	
2	√	√							√			√	√	√	
3	√	√										√	√	√	
4	√	√	√		√							√	√	√	
Please Tick at appropriate place															

Sl. No.	**Skill & Competence enhanced after undergoing the course**	**Applicable sectors & domains**	**Job roles students can take up after undergoing the course**
1	**Design and analysis of jet engines, rocket engines Components.**	**Gas turbines & Aerospace propulsion.**	**Propulsion Engineer.**
2	**Compressible flow phenomena**	**National laboratories**	**Research Scientist/Engineer**

Name & Sign of faculty members involved in designing the syllabus	**Name & Sign of faculty members verifying/approving the syllabus**
Prof. Anil Kumar Nakkala	**Prof. D A Ponnaswami**

Experimental Aerodynamics

Course Code	21AE5415	**Course type**	**PEC**	**Credits L-T-P**	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	Describe basic fundamentals of Aerodynamics experiments, their need in comparisonwith numerical computation and theoretical studies.
2.	Develop concepts of flow similarity and evaluate the loss coefficients of wind tunnelcomponents.
3.	Analyze the concept of force and moment measurements using wind tunnel balance andextrapolate it to new balance development.
4.	Summarize various techniques for calculation of pressure, velocity, and flow visualization.

Pre-requisites : Fluid Mechanics and Aerodynamics

Unit – I: Fundamentals of Experiments In Aerodynamics	**Contact Hours = 8 Hours**
Forms of aerodynamic experiments, observations, measurement objectives, model testing, wind tunnel principles, scaling laws. Special tunnels: low turbulence tunnels, high Reynolds number tunnels, environmental tunnels, automobile tunnels, distinctive features, application. Self-learning topics: Wind tunnels: low speed tunnel, high speed tunnels, transonic, supersonic and hypersonic tunnels, shock tubes.	

Unit – II: Wind Tunnel Experimentation Considerations	**Contact Hours = 8 Hours**
principal components. Function, description, design requirements, constraints and loss coefficients. Wind tunnel performance flow quality, power losses, wind tunnel corrections, sources of errors, buoyancy, solid blockage, wake blockage, streamline curvature causes, estimation and correction.	

Unit – III : Wind Tunnel Balance Load measurement	**Contact Hours = 8 Hours**
low speed wind tunnel balances, mechanical & Strain gauge types, null displacement methods & strain method, sensitivity, weigh beams, steelyard type and current balance type, balance linkages, levers and pivots. Model support three point wire support, three point strut support, platform balance, yoke balance, strain gauge, 6- component strain gauge balance, description, application.	

Unit – IV : Measurements techniques	**Contact Hours = 8 Hours**

static pressure, surface pressure orifice, static probes, pitot probe for total pressure, static pressure and transducers, hot wire anemometry, laser doppler anemometry, projection manometer, multi-tube manometers wake rake apparatus to calculate the drag, calibration, measurement, data processing (DAS), applications.

Unit – V : Flow Visualization Techniques	**Contact Hours = 8 Hours**
streamlines, streak lines, path lines, time lines, tufts,china clay, oil film, smoke, hydrogen bubble. Optical methods: density and refractive index, schlieren system, convex lenses, concave mirrors, shadowgraph, interferometry, working principle, description, setting up, operation, observation, recording, interpretation of imagery, relative merits and applications, PIV (particle image velocity)	

Flipped Classroom Details

Unit No.	**I**	**II**	**III**	**IV**	**V**
No. for Flipped Classroom Sessions	**2**	**2**	**2**	**2**	**2**

Books	
	Text Books:
1.	Gorlin S M &Slezinger I I, ―Wind tunnels & Their Instrumentations‖, NASA publications, translated version, 1966.
2.	Rae, W.H. and Pope, A., "Low Speed Wind Tunnel Testing", Wiley India Pvt Ltd; Third edition (16 March 2010) ISBN-13: 978-8126525683
3.	Pope, A., and Goin, L., "High Speed Wind Tunnel Testing", Krieger Pub Co (June 1,1978), ISBN-13: 978-0882757278
4.	Pope, J B Barlow ―low speed wind tunnel testing ― 3 edition j.w publication
	Reference Books:
1.	Jorge C Lerner &UlfilasBoldes, ―Wind Tunnels and Experimental Fluid Dynamics Research‖,InTech, 1st Edition, 2011.
2.	E. Rathakrishnan, Instrumentation, Measurements, and Experiments in Fluids, CRC Press, 2007
3.	Lecture course on "Advanced Flow diagnostic techniques" 17-19 September 2008 NAL, Bangalore
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by: Prof. Job Kurian, IIT Madras https://nptel.ac.in/courses/101106040/

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Apply** the basic knowledge of aerodynamics in experiments in wind tunnel.	**Ap**	1	1,2
2.	**Understand** the various components its functions in wind tunnels.	**Un**	1	1,2
3.	**Understand** the different types measuring techniques used in wind tunnels.	**Un**	1	1,2
4.	**Utilize** the different techniques of measurements in wind tunnels.	**Ap**	1,4	1,2

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓												✓	✓	
2	✓												✓	✓	
3	✓												✓	✓	
4	✓			✓									✓	✓	
Tick mark the CO, PO and PSO mapping															

Sl No	**Skill & competence enhanced after undergoing the course**	**Applicable Industry Sectors & domains**	**Job roles students can take up after undergoing the course**
1	**Design and development of wind Tunnels**	**Experimental Aerodynamics**	**Wind tunnel design Engineer**
2	**Measuring equipment usage And assembly**	**Aeronautical and Automobile sector**	**Aerodynamics shape Quality approver**

Name & Sign of faculty members involved in designing the syllabus	Name & Sign of faculty members verifying/approving the syllabus
Prof. D A Ponnaswami	**Prof. A K Nakkala**

Aircraft Materials & Processes

Course Code	**21AE5416**	**Course type**	**PEC**	**Credits L-T-P**	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	Study the aircraft engineering materials with heat treatment techniques.
2.	Understand the various manufacturing processes and selection of process for suitable applications.
3.	Understand the working principles and applications of conventional and non-conventional machining along with their advantages and disadvantages.
4.	Demonstrate the importance of composites & its applications in different streams of aerospace industry

Pre-requisites : Knowledge of basic engineering mathematics and mechanics

Unit – I	**Contact Hours = 8 Hours**
Aircraft Engineering Materials & Heat treatment: Classification of aircraft materials - Materials used for aircraft components, Heat treatment of carbon steel, aluminium alloys, magnesium alloys and titanium alloys used in aircraft. Types of corrosions - Effect of corrosion on mechanical properties - Protection against corrosion - Corrosion resistant materials used in aircraft.	

Unit – II	**Contact Hours = 8 Hours**
Casting, Welding and Inspection Techniques: General principles of various casting processes Sandcasting, die-casting, centrifugal casting, investment casting, Shell moulding types; Principles and equipment used in arc welding, gas welding, resistance welding, solid, laser welding, and electronbeam welding, soldering and brazing techniques. Need for NDT,	

Unit – III	**Contact Hours = 8 Hours**
Sheet Metal Processes in Aircraft Industry: Sheet metal operations: shearing, punching, super plastic forming; operations in bending like stretch forming spinning drawing. Riveting, types and techniques, fasteners, Different stages of aircraft assembly	

Unit – IV	**Contact Hours = 8 Hours**

Conventional And Unconventional Machining processes: General working principles, applications and operations of lathe, shaper, milling machines, grinding, drilling machine, computer numeric control machining. Working principles and applications of abrasive jet machining, ultrasonic machining, Electric discharge machining and electro chemical machining, laser beam,

Unit – V	**Contact Hours = 8 Hours**
Aircraft Composites: Definition and comparison of composites with conventional monolithic materials, Reinforcing fibers and Matrix materials, Fabrication of composites and quality control aspects, Carbon-Carbon Composites production, properties and applications, inter metallic matrix composites, ablative composites based on polymers, ceramic matrix, metal matrix composites based on aluminum, magnesium.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	S. Kalpakjian, Steven R. Schmid, —Manufacturing Engineering and Technology, Pearson Education; Seventh edition (28 March 2018). ISBN-13: 978-9332587908
2.	S. C. Keshu, K. K Ganapathy, —Aircraft production technology and management, Interline Publishing House, Bangalore, 3rd Edition, 1993.
	Reference Books:
1.	S. C. Keshu, K. K Ganapathy, —Aircraft production techniques, Interline Publishing House, Bangalore, 3rd Edition, 1993.
2.	R. K. Jain, —Production technology, Khanna Publishers; 17th edition edition (2004) ISBN-13: 978-8174090997
3.	Douglas F. Horne, —Aircraft production technology, Cambridge University Press, 1st Edition, 1986.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by: Prof. B S Murty, IIT Kharagpur https://nptel.ac.in/courses/113105057/
2.	**NPTEL:** Online Resources: Lecture by: Prof. Jayanta Das, IIT Kharagpur https://nptel.ac.in/courses/113105081/
3.	**NPTEL:** Online Resources: Lecture by: Prof. R. Velmurugan, IIT Madras https://nptel.ac.in/courses/101106038/
4.	**NPTEL:** Online Resources: Lecture by: Prof. P. M. Mohite, IIT Kanpur https://nptel.ac.in/courses/101104010/

Course delivery methods	Assessment methods

1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Choose** the various Aircraft Engineering Materials & heat treatment processes.	**Ap**	1	1
2.	**Employ** the knowledge of different types of Casting, Welding and Inspection Techniques	**Ap**	1	1
3.	**Demonstrate** the various Sheet Metal operations and its applications	**Ap**	1	1
4.	**Differentiate** Conventional And Unconventional Machining processes	**Ap**	1	1
5.	**Compare** the various Composites materials in aircraft.	**An**	1	1

Scheme of Continuous Internal Evaluation (CIE):

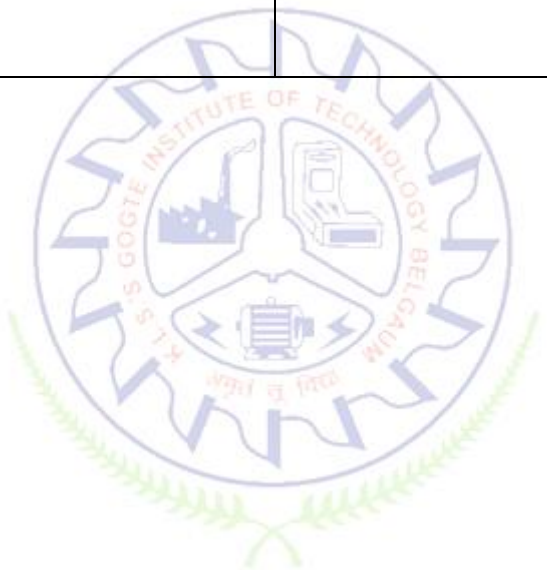
Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	√												√		
2	√												√		
3	√												√		
4	√												√		
5	√												√		
Tick mark the CO, PO and PSO mapping															

Sl No	Skill & competence enhanced after undergoing the course	Applicable Industry Sectors & domains	Job roles students can take up after undergoing the course
1	Acquire the Knowledge about various engineering materials and able to demonstrate various manufacturing processes	Automobile, Mechanical, Product development, Aerospace	Product development Engineer, Process Manufacturing Leader, Manufacturing Engineer Lead – Product Analyst-Manufacturing, Quality Engineer

Name & Sign of faculty members involved in designing the syllabus	Name & Sign of faculty members verifying/approving the syllabus
Prof. P M Banakar	Prof. L Chickmath



Introduction to Aerospace Engineering

Course Code	21AE5511	Course type	OEC	Credits L-T-P	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	Understand the history, basic principle of Aviation and trends in Aerospace industry
2.	Understand the basics of flight & aircraft propulsion
3.	Understand the various controls and dynamics of flight
4.	Understand different systems of aircraft

Pre-requisites: Nil

Unit – I Introduction to Aircraft and Spacecraft	Contact Hours = 8 Hours
History of aviation; Classification of aircraft and space vehicles, Basic components of an aircraft and spacecraft; structural members of aircraft; Helicopters, their parts and functions. Unmanned Air Vehicle and its applications, Introduction to Military variants of Aircraft. Aerospace materials. **Flipped class contents:** History of Indian Aviation sector, Global and Indian aerospace scenario	

Unit – II Basic Aerodynamics	Contact Hours = 8 Hours
International Standard Atmosphere and its properties; Significance of speed of sound: Mach number, Air speed and Ground speed; Bernoulli's theorem and measurement of airspeed; Airfoil nomenclature, Types of Airfoils, Forces acting on an airfoil, Pressure distribution over airfoil, center of pressure, Aerodynamic center, Aspect ratio, Introduction to lift and drag components. Introduction to wind tunnel testing. Introduction to rotary wing aerodynamics. **Flipped class contents: NACA airfoils and their nomenclature**	

Unit – III Aircraft and Space Propulsion	Contact Hours = 8 Hours
History and Classification of Aircraft Power plants. Basic principles of Piston & jet engines and Rocket engines, Overview of Basic Thermodynamics-Zeroth law, First law and second law, Charles law, Boyles law, Gay Lussac law & Gas Equation. Otto cycle and its application to reciprocating engines, Brayton cycle and its application to Gas Turbine engines, SFC, TSFC, Specific impulse, Propulsive efficiency, Thermal efficiency, Overall efficiency, Production of thrust by propellers and jets. Elements of rocket propulsion**.** Introduction to Ramjet Scramjet and pulse jet engines **Flipped class contents:** Launch vehicle dynamics – basic orbital mechanics – satellite applications and orbits – future challenges in aerospace engineering**.**	

Unit – IV Aircraft Performance, Stability and Control	Contact Hours = 8 Hours
Phases of flight, Steady level flight, Stalling speed, High lift devices. Thrust and Power curves. Excess power. Range and endurance. Introduction to maneuver and accelerated flight performance, Aircraft axis system; aircraft motions. Static and dynamic stability. Longitudinal, Lateral and directional static stability. Effect of wings and tail configurations on static stability. Introduction to transonic and supersonic flight. **Flipped class contents:** Thrust and lift augmentation methods. Trim tabs and their role in stability and control.	

Unit – V Aircraft Systems	Contact Hours = 8 Hours
Cockpit instrumentation and displays, Fuel system, Hydraulic and Pneumatic system, Environment Control system and Oxygen system, Navigation and communication system. Aircraft Electrical system **Flipped class contents:** Reentry type space vehicle systems.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	John D Anderson," Introduction to Flight" , McGraw Hill International editions, 2017.
2.	Lalit Gupta and OP Sharma, "Fundamentals of flight Vol-I to Vol- IV" Himalayan Books,2015, ISBN: 81-7002-075-1
3.	H. Cohen, G. F. C. Rogers, H. I. H. Saravanamuttoo "Gas Turbine Theory". Pearson Education,2017. ISBN 978-81-7758-902-3.
4.	Anderson, D. F. and Eberhardt, S., "Understanding Flight", 2nd ed." McGraw-Hill (2009).
	Reference Books:
1.	Turner, M. J. L., "Rocket and Spacecraft Propulsion: Principles, Practice and New Developments" 3rd ed., Springer (2009).
2.	Sutton G.P. " Rocket propulsion elements" John Wiley, New York ,VIII edition,1998. ISBN 111-81-7420-008-3
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	Lectures by Prof Rajesh Kumar pant of IIT Bombay
2.	

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Explain** types of aircraft and history of aviation	L2(Understand)	1,12	1,2,3
2.	**Estimate** various Aerodynamic forces and compare various atmospheric layer properties	L3(Apply)	1,2,12	1,2,3
3.	**Interpret** Air breathing & Non air breathing engines and their components	L2(Understand)	1,12	1,2,3
4.	**Illustrate** the basics of flight dynamics, aircraft performance and maneuverability	L2(Understand)	1,12	1,2,3
5.	**Demonstrate** various systems of aircraft	L2(Understand)	1,9,12	1,2,3

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25 = 50	5* 4 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass:** Score should be > 35 &, however overall score of CIE + SEE should be > 40%
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	√											√	√	√	√
2	√	√										√	√	√	√
3	√											√	√	√	√
4	√											√	√	√	√
5	√											√	√	√	√
Please Tick at appropriate place															

Sl. No.	Skill & Competence enhanced after undergoing the course	Applicable sectors & domains	Job roles students can take up after undergoing the course
1	All-round basic knowledge about aircraft and flying theory	Aviation and Defence	Would contribute to skill set in acquiring job as maintenance engineer in airlines or Indian Armed Forces.

Name & Sign of faculty members involved in designing the syllabus	Name & Sign of faculty members verifying/approving the syllabus
Prof. P S Joshi	Prof. D A Ponnaswami

Introduction to Rocket Propulsion

Course Code	**21AE5512**	**Course type**	**OEC**	**Credits L-T-P**	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	Describe various types of propulsion system with their merits of challenges.
2.	Understand the solid propellant rocket system
3.	Understand the liquid propellant rocket system
4.	Understand the hybrid propellant rocket system
5.	Comprehend the basic requirements of the test facilities for rocket propulsion system.

Pre-requisites: Introduction to Aeronautical Engineering

Unit – I	**Contact Hours = 8 Hours**
Fundamentals of Rocket Propulsion: History and evolution of rockets. Rocket equation, Definitions. Performance parameters, Staging and Clustering, Classification of rockets. Rocket nozzle and performance, Nozzle area ratio, conical nozzle and contour nozzle, Under and over expanded nozzles. Flow separation in nozzles, unconventional nozzles. Mass flow rate, Characteristic velocity, Thrust coefficient, Efficiencies, Specific impulse. Numerical problems.	

Unit – II	**Contact Hours = 8 Hours**
Chemical Propellants: Molecular mass, specific heat ratio, Energy release during combustion, Stoichiometry and mixture ratio, Criterion for choice of propellant, requirement. **Solid Propellant Rockets:** Application and Classification of Solid Propellant Rocket Motors; Propellants and Characteristics; Ingredients and Processing; Propellant Burning Rate; Propellant Grains and Grain Configurations.	

Unit – III	**Contact Hours = 8 Hours**
Liquid Propulsion Systems: Classifications- Booster stage and upper stage rockets. Hardware components and functions. Thrust chamber and its cooling, injectors and types, Propellant feed systems. Turbo pumps. Bi – propellant rockets. Mono propellant thrusters, Cryogenic propulsion system, special features of cryogenic systems. Numerical problems.	

Unit – IV	**Contact Hours = 8 Hours**

Hybrid Propellant Rocket Motors; Gaseous Propellant Rocket Motors and Reaction Control Systems, structure of Hybrid Rocket, types of propellant and oxidizers and applications. **Advance Propulsion Techniques:** Hybrid propellants and gelled propellants. Electrical rockets, types and working principle. Nuclear rockets, Solar sail, Concepts of some advance propulsion systems. Numerical problems.

Unit – V	**Contact Hours = 8 Hours**
Rocket Testing: Types of Tests; Test Facilities and Safeguards; Safety and Environmental Concerns; Monitoring and Control of Toxic Materials and Exhaust Gases; Instrumentation and Data Management; Reliability and Quality Control; Flight Testing.	

Flipped Classroom Details

Unit No.	**I**	**II**	**III**	**IV**	**V**
No. for Flipped Classroom Sessions	**2**	**2**	**2**	**2**	**2**

Books	
	Text Books:
1.	Rocket Propulsion Elements, Sutton, G.P., Biblarz, O., 7thEd. John Wiley & Sons, Inc., New York, 2001.
2.	Rocket Propulsion, Barrere, M., Jaumotte, A., Fraeijs de Veubeke, B.,Vandenkerckhove J., Elsevier Publishing Company, 1960
	Reference Books:
1.	Terry Wohler‘s —Wohler’s Report 2000‖- Wohler‘s Association 2000
2.	Rocket and Spacecraft Propulsion: Principle, Practice and New Developments, Turner, M. J. L., SpringerVerlag. 2000
3.	Understanding Chemical Rocket Propulsion, Mukunda, H.S., I K International Publishing House, 2017.
4.	Rocket Propulsion, Ramamurthi, K., 2ndEdition, Trinity Press of Laxmi Publications Private Limited, India, 2016.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by: Prof. D P Mishra, IIT Kanpur https://nptel.ac.in/courses/101104078/
2.	**NPTEL:** Online Resources: Lecture by: Prof. K Ramamurthi, IIT Madras https://nptel.ac.in/courses/112106073/

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Analyze** the propulsion system along with the advanced propulsion system.	3	1,2	1
2.	**Understand and examine** various parameters used in solid rocket motor.	3	1,2	1
3.	**Explain** the liquid propellant rocket system	2	1,2	1
4.	**Comprehend and illustrate** the working of hybrid rocket	2	1,2	1
5.	**Relate** the significance of test facilities and their associated parameters	3	1,2	1

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass:** Score should be > 35 &, however overall score of CIE + SEE should be > 40%
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	√	√											√		
2	√												√		
3	√	√											√		
4	√	√											√		
5	√												√		
Please Tick at appropriate place															

Sl. No.	**Skill & Competence enhanced after undergoing the course**	**Applicable sectors & domains**	**Job roles students can take up after undergoing the course**

1	**Acquire Knowledge about various propulsive systems and propellants used in rockets**	**Aerospace propulsion**	**Scientist at space related industries**

Name & Sign of faculty members involved in designing the syllabus	Name & Sign of faculty members verifying/approving the syllabus
Parameshwar Banakar	**Prof. I V Patil**

Air Traffic Control

Course Code	**21AE5513**	**Course type**	**OEC**	**Credits L-T-P**	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	Understand Air traffic control systems.
2.	Learn Flight information system.
3.	Identify the Aerodrome systems.
4.	Compare the Navigation systems

Pre-requisites : Elements of Aeronautics

Unit – I	**Contact Hours = 8 Hours**
Objectives of air traffic control systems - Parts of ATC services, Visual flight rules (VFR) & Instrument flight rules (IFR) operations, Classification of Air traffic services (ATS) air spaces, Various kinds of separation, Altimeter setting, procedures, Establishment, designation and Identification of units providing ATS, Division of responsibility of control.	

Unit – II	**Contact Hours = 8 Hours**
Air traffic system: Area control service, assignment of cruising levels, minimum flight altitude, ATS routes and significant points, area navigation (RNAV) and required navigation performance (RNP), Vertical, lateral and longitudinal separations based on time / distance, ATC clearances, Flight plans, position report	

Unit – III	**Contact Hours = 8 Hours**
Flight Information systems: Radar service, Basic radar terminology, Identification procedures using primary / secondary radar, performance checks, use of radar in area and approach control services, assurance control and coordination between radar / non radar control, emergencies, Flight information and advisory service, Alerting service, Co-ordination and emergency procedures, Rules of the air.	

Unit – IV	**Contact Hours = 8 Hours**
Aerodrome Data: Aerodrome data, Aerodrome reference code, Aerodrome reference point, Aerodrome elevation, Aerodrome reference temperature, Instrument runway, physical characteristics; length of primary / secondary runway, Width of runways, Minimum distance between parallel runways etc. obstacles restriction.	

Unit – V	**Contact Hours = 8 Hours**
Navigation and Other services: Visual aids for navigation Wind direction indicator, Landing direction indicator, Location and characteristics of signal area, Markings, general requirements, Various markings, Lights, general requirements, Aerodrome beacon, identification beacon, Simple approach lighting system and various lighting systems, visual approach slope indicator (VASI) & precision approach path indicator (PAPI), Visual aids for denoting obstacles; object to be marked and lighter, Emergency and other services	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	AIP (India) Vol. I & II, "The English Book Store", 17-1, Connaught Circus, New Delhi.
2.	Aircraft Manual (India) Volume I", 1st Edition, The English Book Store, 17-1 Connaught Circus, New Delhi
	Reference Books:
1.	"PANS RAC ICAO DOC 4444", Latest Edition, The English Book Store, 17-1, Connaught Circus, New Delhi.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://ocw.mit.edu/courses/aeronautics-and-astronautics/16-72-air-traffic-control-fall-2006/
2.	https://www.atc-network.com/atc-courses

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Illustrate basic concepts of Air Traffic Control.	2	1,2	1,2,3
2.	Compare the various air traffic systems.	2	1,2	1,2,3
3.	Describe flight information systems and subsystems.	2	1,2	1,2,3
4.	Quantify Aerodrome Data.	2	1,2	1,2,3
5.	Recognize Navigation and other services of aircraft systems.	2	1,2	1,2,3

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100

OBA - Open Book Assignment
Minimum score to be eligible for SEE: 40 OUT OF 100

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.

2.	**Minimum marks required in SEE to pass:** Score should be > 35 &, however overall score of CIE + SEE should be > 40%
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓										✓	✓	✓	✓
2	✓	✓										✓	✓	✓	✓
3	✓	✓										✓	✓	✓	✓
4	✓	✓										✓	✓	✓	✓
5	✓	✓										✓	✓	✓	✓
Please Tick at appropriate place															

Sl. No.	**Skill & Competence enhanced after undergoing the course**	**Applicable sectors & domains**	**Job roles students can take up after undergoing the course**
1	**Acquire knowledge about air traffic control, Airport data and flight information.**	**Airlines**	**Aircraft Maintainance Engineer**
2		**Aviation**	**Airport Instructor**
3		**Airport Authority of India**	**Air Traffic controller**
4			

Name & Sign of faculty members involved in designing the syllabus	**Name & Sign of faculty members verifying/approving the syllabus**
Prof. I V Patil	**Prof. P K Katti**

RESEARCH METHODOLOGY & IPR

Course Code	21AE57	Course type	AEC	Credits L-T-P	1 – 0 - 0
Hours/week: L - T- P	1 – 0 – 0			Total credits	1
Total Contact Hours	L = 15 Hrs; T = 0 Hrs; P = 0 Hrs Total = 15 Hrs			CIE Marks	50
Flipped Classes content	3 Hours			SEE Marks	50

Course learning Objectives	
1.	Understand the basic concepts of research and its methodologies
2.	Identify and select the appropriate research/sampling design methods.
3.	CreatetheawarenessaboutIntellectualPropertyRightsfortheprotectionofinventions.

Required Knowledge of : Probability & Statistics.

Unit–I	5 Hours

Research Methodology: Introduction

Meaning, Objectives, types, Research Approaches. Significance of Research, Research Methods versus Methodology, Research and scientific method, research Process, Criteria of good research, Problems encountered by researchers.

Research Problem:

Defining a research problem, Selecting a research problem, necessity and techniques involved in defining the research problem.

Unit–II	5 Hours

Data Collection Methods:

Collection of Primary Data, Observation Method, Interview Method, Questionnaires, Schedules, Other Methods of Data Collection, Collection of Secondary Data, Case study method.

Processing and Analysis of Data

Processing operations, Elements/ types of analysis, Statistics in research- measures of central tendency or statistical averages, measures of dispersion, measures of asymmetry (skewness), measures of relationship, Simple regression analysis

Unit–III	5 Hours

Intellectual Property Rights – IPR- Invention and Creativity- Intellectual Property- Importance and Protection of Intellectual Property Rights (IPRs)- A brief summary of: Patents, Copyrights, Trademarks, Industrial Designs- Integrated Circuits-Geographical Indications-Establishment of WIPO-Application and Procedures. Research ethics, Plagiarism, Prior art search.

Flipped Classroom Details

Unit No.	I	II	III
No. for Flipped Classroom Sessions	1	1	1

Self-Study Topics	
Unit No.	**Topic description**
I	Significance of Research Methodology.
II	Limitations of test of hypothesis.
III	Other measures-Index numbers, Time series analysis.

Books	
	Text Books:
1.	C R. Kothari, Research Methodology, New Age International Publishers, 2nd edition, 2007.
	Reference Books:
1.	Panneer Selvam, Research Methodology, PHI Learning Pvt. Ltd., 2007.
2.	Dr. B.L. Wadhera -Intellectual Property Rights, Universal Law Publishing Co. Ltd.. 2002
	William G Zikmund, Business Research Methods, Indian edition, South western Publishers, 8th Indian Reprint – 2009.
	E-resourses (NPTEL/SWAYAM. Any Other)- mention links
1.	https://onlinecourses.swayam2.ac.in/cec20_ge37 (Research Methodology)

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Research Activity
3.	Flipped Classes	3.	Semester End Examination

Course Outcome (COs)

Learning Levels:

Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create

At the end of the course, the student will be able to		Learning Level	PO(s)	PSO(s)
1.	Identify and select an appropriate methodology for research.	Un	1,2,9,10	1
2.	Analyze and interpret data collected	Ap	1,2,9,10	1

3.	Discuss the significance of Intellectual Property Rights & report writing	Ap	1,2,3,9,10	1,2,3

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Research Activity	Total Marks
Marks	20+20=40	10	50

IAs and Assignments: Minimum score to be eligible for SEE: 20 OUT OF 50

The weightage of Continuous Internal Evaluation (CIE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50).

Scheme of Semester End Examination (SEE):	
1.	The pattern of the **question paper is MCQ** (multiple choice questions). The time allotted for SEE is **01 hour.**
2.	SEE paper shall be set for **50 questions, each of the 01 mark**.
3.	The weightage for Semester End Exam (SEE) is 50%. The minimum passing mark for the SEE is 35% of the maximum marks (18 marks out of 50).
4.	A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to the subject/ course if the student secures not less than 35% (18 Marks out of 50) in the semester-end examination (SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together.

CO-PO Mapping (planned)													**CO-PSO Mapping (planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓							✓	✓			✓		
2	✓	✓							✓	✓			✓		
3	✓	✓	✓						✓	✓			✓	✓	✓
Tick mark the CO, PO and PSO mapping															

Employability Skills I

Course Code	21AECAE58	Course type	AEC	Credits L-T-P	1– 0 - 0
Hours/week: L - T- P	1 – 0 – 0			Total credits	1
Total Contact Hours	L = 20 Hrs; T = 0 Hrs; P = 0 Hrs Total = 20 Hrs			CIE Marks	100

Course learning objectives	
1.	Skill development is/are personal attributes that influence how well an individual works or interacts with others.
2.	Skill development is/are personal attributes that influence how well an individual works or interacts with others.
3.	In essence, they are essential for individual success in the workplace, their company's success, and their personal life also

Pre-requisites :

Unit – I	Contact Hours = 4 Hours
General Aptitude 1.1: **Understanding Quantitative Aptitude : Number System, Averages,Ratio and Proportion Partnership**	

Unit – II	Contact Hours = 4 Hours
:General Aptitude 1.2: **Understanding Quantitative Aptitude : Percentages, Profit and Loss , Time and Work, Ages**	

Unit – III	Contact Hours = 4 Hours
General Aptitude 1.3: **Understanding Quantitative Aptitude : Number and Letter Series, Coding and Decoding and DST, Analogy and Blood Relations**	

Unit – IV	Contact Hours = 4 Hours
General Aptitude 1.4: **Understanding Quantitative Aptitude : Reading Comprehension, Sentence Correction, Ordering of Sentences**	

Unit – V	Contact Hours = 4 Hours
Improve Sense of Belongingness:Body Language, Grooming and Etiquette, Group Discussions	

Books	
	Text Books:
	Name of the author(s), Title of the Book, Publisher, Edition/Year _____ and onwards
1.	The Aptitude Triad , BIZOTIC
	Reference Books:
	Name of the author(s), Title of the Book, Publisher, Edition/Year _____ and onwards
1.	How to prepare for Quantitative Aptitude for CAT & other Management Examinations, Arun Sharma, McGraw Hill Education(India) Private Limited, 4th Edition, 2018.

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
		3	Internal Assessments

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Clear the Aptitude round of recruiters during placements	L2	10	
2.	Perform confidently during the Interview process	L2	12	
3.	Develop Resumes that are grammatically correct	L2	10	
4.	Develop behaviors that are appropriate for a professional	L2	12	

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total Marks

Marks	25+25 = 50	10	15+15 =30	10	100
> Writing 2 IA tests is compulsory **> Minimum score to be eligible for SEE: 40 OUT OF 100**					

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1										✓		✓			
2										✓		✓			
3										✓		✓			
4										✓		✓			
5										✓		✓			
Tick mark the CO, PO and PSO mapping															

Sl No	**Skill & competence enhanced after undergoing the course**	**Applicable Industry Sectors & domains**	**Job roles students can take up after undergoing the course**
1	**Logical Thinking**	**IT Industry**	**Software Engineer**
2	**Problem Solving**	**Automotive**	**Developer**
3	**Communication Skills**	**Education Sector**	**Project Manager**

Environmental Studies

Course Code	21AE59	Course type	HSMS	Credits L-T-P	1– 0 - 0
Hours/week: L - T- P	1 – 0 – 0			Total credits	1
Total Contact Hours	L = 1Hrs; T = 0 Hrs; P =0 Hrs Total = 20 Hrs			CIE Marks	50
Flipped Classes content	10 Hours			SEE Marks	50

Course learning objectives	
1.	To understand the scope of Environmental Engineering.
2.	Identify the Environmental impact due to Human activities.
3.	To understand the concept of Disaster Management.
4.	Identify the renewable and non renewable sources of energy.
5.	Identify the various Legal aspects in Environmental Protection.

Pre-requisites:--

Unit – I	Contact Hours = 4 Hours
Definition of Environment, Ecology and Ecosystem, Structure and functions of ecosystem, balanced ecosystem, Introduction to Environmental Impact Assessment Natural Resources: Material Cycles - Oxygen, Carbon, Nitrogen and Hydrological cycle. Importance of water quality, Water borne diseases, Water induced diseases, Significance of Fluoride in drinking water	

Unit – II	Contact Hours = 4 Hours
Energy - Different types of energy, Conventional and Non - Conventional sources – Advantages and Limitations of Wind Mills, Hydro Electric, Fossil fuel, Nuclear, Solar, Biomass and Biogas, Geothermal energy	

Unit – III	Contact Hours =4 Hours
Disasters - Natural Disasters: Meaning and nature of natural disasters, their types and effects (Floods, drought, cyclone, earthquakes, Tsunami). Man Made Disasters: Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution and marine pollution	

Unit – IV	Contact Hours = 4 Hours
Disaster Management: International strategy for disaster reduction. Concept of disaster management and national disaster management framework	

Unit – V	Contact Hours = 4 Hours
Environmental Protection: Role of Government, Legal aspects, Initiatives by Non - Governmental Organizations (NGO), Environmental Education, Women Education. E waste and solid waste management rules	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	Benny Joseph, **"Environmental Studies",** Tata McGraw - Hill Publishing Company Limited (2005).
2.	Ranjit Daniels R.J. and Jagdish Kirshnaswamy, **"Environmental Studies",** Wiley India Private Ltd., New Delhi (2009).
3.	Sanjay K. Sharma, **"Environment Engineering and Disaster Management",** USP (2011).
4.	Harsh K. Gupta, **"Disaster Management",** Universities Press (India) Pvt. Ltd (2003).
	Reference Books:
1.	Meenakshi P., **"Elements of Environmental Science and Engineering",** Prentice Hall of India Private Limited, New Delhi (2006).
2.	Tyler Miller Jr. G., **"Environmental Science – Working with the Earth",** Tenth Edition, Thomson Brooks/Cole (2004).
	E-resources (NPTEL/SWAYAM/Any Other)- mention links
1.	–

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcomes (COs)				
At the end of the course, the student will be able to:		Learning Level	PO(s)	PSO(s)
1.	Explain the importance of the Environment	Un	1,6,7	1
2.	Evaluate Environmental disasters caused by human activities	Un	1,6,7	1
3.	Outline the water problems and energy crisis in the present era	Un	1,6,7	1
4.	Explain and classify the Renewable and Non-Renewable sources of energy	Un	1,6,7	1
5.	Summarize the various Legislations related to Environment	Un	1,6,7	1

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Addition of two Assignments	Total Marks
Marks	15+15 = 30	10+10 =20	50
Writing the IA test is Compulsory **Minimum marks required to be eligible for SEE: 20 out of 50**			

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 50 marks of 1 hour duration.
2.	**Minimum marks required in SEE to pass: 20 out of 50**
3.	Question paper contains multiple choice questions.

CO-PO Mapping (Planned) [tick mark relevant ones]													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✔					✔	✔						✔		
2	✔					✔	✔						✔		
3	✔					✔	✔						✔		
4	✔					✔	✔						✔		

Communicative English

Course Code:	21EDIPAE51	Course type	MNC	Credits L-T-P	1– 0 - 0
Hours/week: L - T- P	1 – 0 – 0			Total credits	1
Total Contact Hours	L = 15 Hrs, T = 0 Hrs P = 0 Hrs Total = 15 Hrs			CIE Marks	50
Flipped Classes content	3 Hours			SEE Marks	Nil

Course learning objectives	
1.	Enhance pronunciation and fluency for better communication skills.
2.	Augment English vocabulary and grammar for better communication skills.
3.	Impart basic language skills [LSRW].
4.	Achieve better writing skills for employment.
5.	Understand the importance of Non-verbal communication

Pre-requisites: Conversant with basic English Grammar and able to understand spoken English.

Unit – I Introduction to Listening Skills	Contact Hours = 2 Hours
Content of the Unit: Introduction to Listening Comprehension, Hearing and Listening, Listening Process, Types of Listening, Barriers of Listening, Effective and Passive Listening, Reasons and Disadvantages of Poor Listening.	

Unit – II Introduction to Speaking Skills	Contact Hours = 3 Hours
Content of the Unit: Introduction to Phonetics of English Vowel and Consonant sounds, Phonetic Transcription [IPA/RP], English Syllables, Rules for Word Accent -Stress Shift, Intonation, Silent and Non-silent Letters.	

Unit – III Introduction to Reading Skills	Contact Hours = 2 Hours
Content of the Unit: Reading Meaning and Stages, Importance of Reading, Types of Reading, Characteristics of Reading, Process of Reading, Approaches and Factors Influencing Reading, Techniques or Strategies of Reading.	

Unit – IV Introduction to Writing Skills	Contact Hours = 3 Hours
Content of the Unit: Introduction Writing Paragraphs, Parts of the paragraph, Importance of Proper Punctuation, Creating Coherence and Cohesion in Writing, Precise writing, Importance of Summarizing and Paraphrasing. Types of Writing,	

Unit – V Introduction to Non- Verbal communication	Contact Hours = 2 Hours
Content of the Unit: Introduction to Nonverbal Communication, Importance of NVC, Types of NVC- Gestures, Postures, Haptics, Proxemics, Chronemics and Paralanguage.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	**	Grammar-I	**	Grammar-II	Grammar III

Books	
	Text Books:
1.	A Textbook of English Language Communication Skills, Infinite Learning Solutions– (Revised Edition) 2021.
	Reference Books:
1.	Communication Skills by Sanjay Kumar and Pushp Lata, Oxford University Press - 2019.
2.	English for Engineers by N.P.Sudharshana and C.Savitha, Cambridge University Press – 2018.
	E-resources (NPTEL/SWAYAM. Any Other)- mention links
1.	Technical English for Engineers course Swayam/ NPTEL https://onlinecourses.nptel.ac.in/noc22_hs34/preview
2.	ESOL Courses: Listening & Grammar free online video lesson https://www.esolcourses.com/

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	CIE assignments
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Course seminar
4.	Online classes, if required.	4.	

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	To understand and identify the Common Errors in Writing and Speaking.	Re		

2.	2. To Achieve better technical writing and Presentation skills.	Un		
3.	3. To read technical proposals properly and make them Write good technical reports.	Ap		
4.	4. Acquire Employment and Workplace communication skills.	An		

Scheme of Continuous Internal Evaluation (CIE):

Components	Assignments	Course Seminar	Quizzes	Total Marks
Marks	10+10 = 20	10	10x2=20	50

Scheme of Semester End Examination (SEE): No SEE component	
1.	NA
2.	**Minimum marks required in SEE : NA**
3.	The weightage of Continuous Internal Evaluation (CIE) is 100%

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1										√					
2										√					
3										√					
4										√					
5										√					
Tick mark the CO, PO and PSO mapping															

Airport Planning and Management

Course Code	**21AE61**	**Course type**	**HSMS**	**Credits L-T-P**	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	Gain the knowledge of airport and its systems
2.	Understand the components of airport
3.	Learn the management of airport operations and finance
4.	Impart the knowledge of airport capacity and delay

Pre-requisites:

Unit – I: Airports and Airport Systems	**Contact Hours = 8 Hours**
Introduction: Airport management on an international level; The national plan of integrated airport systems; The nation's airport system plan; The rules that govern airport management; Organizations that influence airport regulatory policies; A historical and legislative perspective: Introduction the formative period of aviation and airports.	

Unit – II: Components of the Airport	**Contact Hours = 8 Hours**
The components of an airport. The airfield. Navigational aids (NAVAIDS) located on airfields; Air traffic control and surveillance facilities located on the airfield; Weather reporting facilities located on airfields; Security infrastructure on airfields; Airspace and Current and future enhancements to air traffic control; Airport terminals and ground access, Runways and its operations.	

Unit – III: Airport Operations:	**Contact Hours = 8 Hours**
Airport operations management: Introduction, pavement management, aircraft rescue and firefighting (ARFF); Snow and ice control, safety inspection programs. Bird and wildlife hazard management; Airport security: Security at commercial service airports, security at general aviation airports; The future of airport security	

Unit – IV: Airport Financial Management	**Contact Hours = 8 Hours**

Airport financial accounting, revenue strategies at commercial airports, pricing of airport facilities and services, variation in the sources of operating revenues, rise in airport financial burdens

Unit – V: Airport Capacity And Delay	**Contact Hours = 8 Hours**
Defining capacity, factors affecting capacity and delay, estimating capacity, analytical estimates of delay: The queuing diagram; The future of airport management: Introduction, restructuring of commercial air carriers, new large aircraft, small aircraft transportation systems.	

Flipped Classroom Details

Unit No.	**I**	**II**	**III**	**IV**	**V**
No. for Flipped Classroom Sessions	**2**	**3**	**1**	**3**	**1**

Books	
	Text Books:
1.	Alexander T Wells, Ed. D Seth Young, —Airport P lanning and Management, 6th Edition, 2011.
2.	Norman J. Ashford, H. P. Martin Stanton, Clifton A. Moore, Pierre Coutu, —Airport Operations, McGraw Hill, 3rd Edition, 2013.
3.	Alexander T Wells, Ed. D Seth Young, —Airport planning and Management, 6th Edition, 2011.
	Reference Books:
1.	Robert M. Horonjeff, Francis X. McKelvey, William J Sproule, Seth Young, "Planning and Design of Airports", fifth edition, McGraw Hill Professional, 2010.
	E-resources (NPTEL/SWAYAM any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by: Manoj Kumar Mondal, IIT Kharagpur https://swayam.gov.in/nd1_noc20_ge08/preview
2.	**NPTEL:** Online Resources: Lecture by: Prof. Mukesh Kumar Barua, IIT Roorkee https://nptel.ac.in/courses/110/107/110107081/
3.	**NPTEL:** Online Resources: Lecture by: Prof. Rajat Agrawal and Vinay Sharma, IIT Roorkee https://nptel.ac.in/courses/110/107/110107094/

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Identify** the capacity of the airport and delay factors	Un	1, 2	1
2.	**Recognize** the airport and its operations	Ap	1, 2	1
3.	**Explain** the different airport systems and their components	Ap	1, 2	1
4.	**Illustrate** the management skills in airport operations and finance	An	1, 2, 3, 5, 8, 9, 10	1, 2

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass:** Score should be > 35 &, however overall score of CIE + SEE should be > 40%
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**	**PSO1**	**PSO2**	**PSO3**
1	√	√											√		
2	√	√											√		
3	√	√	√		√			√	√	√			√	√	
Please Tick at appropriate place															

Sl. No.	Skill & Competence enhanced after undergoing the course	Applicable sectors & domains	Job roles students can take up after undergoing the course
1	All-round basic knowledge about airport operations	Aerospace	Project Manager, Executive Officer, Airport Engineer, Operational Manager

Name & Sign of faculty members involved in designing the syllabus	Name & Sign of faculty members verifying/approving the syllabus
Dr. L. Chikmath	Prof. P. P. Katti

Avionics and Instrumentation System

Course Code	21AE62	Course type	PCC	Credits L-T-P	3 – 0- 0
Hours/week: L-T-P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs;P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	Understand the role of avionics systems in aircraft operations and their impact on flight safety and efficiency.
2.	Familiarize yourself with the principles and operation of aircraft instrumentation systems
3.	Recognize the importance of display systems in aircraft, including HUD systems, MFDs, EFIS, PFD, ND, and CVR systems.
4.	Gain knowledge of flight control systems, including fly-by-wire and autopilot systems, flight control laws, stability analysis, and control augmentation systems.
5.	Understand the principles and components of MIL-STD-1553B and ARINC 429, including bus components, cable construction and properties, and cable connectors.

Pre-requisites :Elements of Aeronautics

Unit – I	Contact Hours = 8 Hours
power distribution system: Overview of avionics systems and their role in aircraft operations, Avionics system architecture and integration, bus bar, split bus bar system, special purpose cables, electrical diagram and identification. Overview of Aircraft Instrumentation System, Functions and Importance of Instrumentation System , Basic Aircraft Instruments and Cockpit Layout, Instrumentation System Architecture , Instrumentation System Components and Sensors	

Unit – II	Contact Hours = 8 Hours
Airspeed Indication System, Altimetry and Altitude Measurement Systems ,Attitude and Heading Reference Systems ,Vertical Speed Indication System , Gyroscopic Instruments and Heading Systems ,Turn and Slip Indicators Tachometers and RPM Indicators ,Engine Pressure and Temperature Indicators , Fuel Quantity and Flow Indicators , Engine Monitoring Systems ,Engine Fire Detection and Protection Systems ,Engine Control Systems	

Unit – III	Contact Hours = 8 Hours

Display Systems: Head-Up Display (HUD) Systems, Multi-Function Displays (MFD), Integration of MFDs with avionics systems, Electronic Flight Instrument Systems (EFIS), Primary Flight Display (PFD) and Navigation Display (ND), Cockpit Voice Recorder (CVR) Systems.

Unit – IV	**Contact Hours = 8 Hours**
Flight Control Systems Fly-by-wire, Autopilot systems, Flight Control Laws, Stability analysis and control augmentation systems, Stability Augmentation Systems [SAS],Adaptive and predictive control in SAS, redundancy and failure survival, common mode failures and effect analysis.	

Unit –V	**Contact Hours = 8 Hours**
MIL-STD-1553B-principle,bus components, cable construction & properties, cable connectors, ARINC 429 – principle, bus components, cable construction & properties, cable connectors. TCAS, ILS, MLS .	

Flipped Classroom Details

Unit No.	**I**	**II**	**III**	**IV**	**V**
No. for Flipped Classroom Sessions	**2**	**2**	**2**	**2**	**2**

Books	
	Text Books:
1.	Cary R. Spitzer Book , Avionics: Elements, Software, and Functions Publisher: CRC Press ,3rd Edition Year: 2014
2.	Author: George W. Stimson , Introduction to Airborne Radar Publisher: SciTech Publishing ,3rd Edition , 2018
3.	Roger W. Pratt , Flight Control Systems: Practical Issues in Design and Implementation , CRC , 2nd , 2000
	Reference Books:
1.	Alfred Leick , GPS Satellite Surveying Publisher: Wiley Edition: 4th Edition Year: 2014
2.	Christopher Jekeli , Inertial Navigation Systems with Geodetic Applications Publisher: Walter de Gruyter Edition: 1st Edition Year: 2001
3.	Cary R. Spitzer , Digital Avionics Handbook Publisher: CRC Press Edition: 3rd Edition Year: 2014
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	Global navigation satellite systems and applications,iit roorkee,prof arun k. saraf,https://nptel.ac.in/courses/105107194
2.	

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests

2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Understand the principles and importance of avionics systems and navigation systems in aircraft operations.	Un	1,10,12	1,2,3
2.	Apply knowledge of aircraft instruments to analyze their impact on aircraft operations.	Ap	1,10,12	1,2,3
3.	Understand, operate, and integrate Head-Up Display (HUD) Systems, Multi-Function Displays (MFD), Electronic Flight Instrument Systems (EFIS), and Cockpit Voice Recorder (CVR) Systems in aviation environments.	Re	1,10,12	1,2,3
4.	Develop an understanding of Avionics Systems and Control	Ev	1,10,12	1,2,3
5.	Comprehensive understanding of the principles, components, cable construction and properties, cable connectors, and their applications in the aviation industry.	Un	1,10,12	1,2,3

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25= 50	4* 5 marks = 20	10+10 =20	10	100

OBA- Open Book Assignment
Minimum score to be eligible for SEE: 40 OUT OF 100

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass:** Score should be > 35&, however overall score of CIE + SEE should be > 40%
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													CO-PSO Mapping(Planned)		
CO	**PO1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	√									√		√	√	√	√
2	√									√		√	√	√	√
3	√									√		√	√	√	√
4	√									√		√	√	√	√
5	√									√		√	√	√	√
Please Tick at appropriate place															

Sl. No.	**Skill & Competence enhanced after undergoing the course**	**Applicable sectors & domains**	**Job roles students can take up after undergoing the course**
1	Technical Proficiency	Aerospace Industry,Avionics Manufacturing Companies, Airlines and Aviation Operators,Maintenance, Repair and Overhaul (MRO) Facilities,Defense and Military,Research and Development,Flight Simulation Companies,UAV (Unmanned Aerial Vehicle) and Drone Industry,Government Regulatory Agencies	Avionics Technician/Engineer
2	System Troubleshooting		Avionics Integration Specialist
3	System Integration:		Avionics System Engineer
4	Communication and Collaboration		Avionics Project Manager
5	Safety Awareness:		Avionics Sales Engineer
6	Analytical Skills:		Avionics Instructor/Trainer
7	Continuous Learning		Avionics Systems Consultant

Name & Sign of faculty members involved in designing the syllabus	**Name & Sign of faculty members verifying/approving the syllabus**
Prof. P P Katti	**Prof. P S Joshi**

Aircraft Stability and Control

Course Code	21AE63	**Course type**	**PCC**	**Credits L-T-P**	3 - 0- 1
Hours/week: L-T-P	3 - 0 - 2			**Total credits**	4
Total Contact Hours	L = 40Hrs; T = 0Hrs; P = 20Hrs Total = 60Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	Understand the basic principles of aircraft stability like equilibrium, stability and control
2.	Study the aerodynamic forces and moments acting on an aircraft during the flight.
3.	Understanding how disturbances can induce unwanted aircraft motions and how pilots can mitigate these effects.
4.	Analyze and design control systems using Classical control techniques.

Required Knowledge of : Theory of Machines ,Engineering Mechanics

Unit – I Introduction	**Contact Hours = 8 Hours**
Review of system dynamics, Coordinate systems, Euler angles and transformations, Degree of freedom of a system, equilibrium condition - Static and dynamic stability - Need for stability in airplanes - Purpose of controls.	

Unit – II Longitudinal Static Stability and Control	**Contact Hours = 8 Hours**
Contribution of wing and tail and elevator to pitching moments - Effect of fuselage and nacelles - Effects of centre of gravity location - Power effects - Stabilizer setting and centre of gravity location – Elevator power– Elevator to trim. Trim gradients. Control fixed static stability – Control fixed neutral point. Stability margins-Stick Free neutral point, Manoeuvre point and Margin.	

Unit – III Lateral-Directional Static Stability and Control	**Contact Hours = 8 Hours**
Definition of directional and roll stability, static directional stability rudder fixed, estimation of dihedral effect, wing sweep,flaps and power, balancing the aileron, contribution of airframe components, directional control, rudder power, stick-free directional stability, requirements for directional control, rudder lock, Dorsal fin, in operation condition.	

Unit – IVDynamic Stability:	**Contact Hours = 8 Hours**
dynamic longitudinal stability, typesof modes of motion, airplane equation for longitudinal motion, derivation of rigid bodyequation, orientation of position of plane, small disturbance theory, factorsaffecting period and damping of oscillations, effects of wind shear, flying qualities in	

pitch,cooper Harper scale, aileron step function response, Dutch roll and spiral instability, Auto-rotation and spin, roll-pitch-yaw inertial coupling.

Unit –V Introduction to Aircraft Control Systems	**Contact Hours = 8 Hours**
Time Response of feedback control systems,Stability analysis- Routh stability criterion, Introduction to Root-Locus Techniques, Correlation between time and frequency response, Bode Plots. Introduction to Stability Augmented System and Pitch Attitude hold Autopilot.	

Flipped Classroom Details

Unit No.	**I**	**II**	**III**	**IV**	**V**
No. for Flipped Classroom Sessions	**2**	**2**	**2**	**2**	**2**

List of Experiments

Unit No.	**No. of Experiments**	**Topic(s) related to Experiment**
1	**1**	Time Response Modeling of a Spring- Mass-Damper system.
2	**2**	Effect of speed on Glide Performance Effect of Velocity on Climb Rate
3	**2**	Simulation of Longitudinal Stability Modes on Advanced Flight simulator. Simulation of Lateral-Directional Stability Modes Advanced Flight simulator.
4	**2**	Simulation of Aircraft Longitudinal modes and Analyze the Response Simulation of Lateral directional modes Analyze the Response
5	**3**	Frequency response for spring mass system, simulation of the oscillations. Simulation of poles and zeros of a transfer function. Stability analysis using root locus using MATLAB

Unit No.	**Self-Study Topics**
1	Reference Frames, Eigen values and Vectors and Differential Equations
2	Ground effect on Stability margins
3	Weather cocking effect, adverse yaw effects.
4	Cooper-Harper Scale, Flight Handling Qualities.
5	Altitude hold Autopilot

Books	
	Text Books:

1.	Bernard Etkin, “Dynamics of flight stability and control”, John Wiley and Sons, Second edition, 1982.
2.	Nelson R. C., “Flight Stability and Automatic Control”, McGraw Hill Education; 2 edition (1 July 2017), ISBN-13: 978-0070661103.
3.	Nandan K. Sinha and N. Ananthkrishnan “Advanced Flight Dynamics with Elements of Flight Control” CRC Press 2017.
	Reference Books:
1.	Bandu N. Pamadi, “Performance Stability, Dynamics and Control of Airplanes”, AIAA, 2004.
2.	Barnes W. McMormick, “Aerodynamics, Aeronautics and Flight Mechanics”, John Wiley & Sons, Inc. 1995.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	NPTEL: Online Resources: Lecture by: Prof. E G Tulapurkara, IIT Madras https://nptel.ac.in/courses/101106043/
2.	NPTEL: Online Resources: Lecture by: Prof. A K Ghosh, IIT Kanpur https://nptel.ac.in/courses/101104062/

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Open Book Assignments (OBA)/ Lab Project
3.	Flipped Classes	3.	Lab Test
4.	Practice session/Demonstrations in Labs	4.	Semester End Examination
5.	Virtual Labs (if present)		

Course Outcome (COs)

Learning Levels:

Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create

At the end of the course, the student will be able to		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Explain the importance of System dynamics and Describe the necessity of stability for dynamic systems like Aircraft.	Un	1	1
2.	Apply the rigid body dynamics to aircraft for representing aircraft in mathematical model.	Ap	1,2	1
3.	Estimate the longitudinal and directional parameters with the help of the linearized equations of aircraft motion.	An	1,2	1,2
4.	Analyze the different type of modes in longitudinal, lateral and directional motion of aircraft, and recovery from those modes by using recovery control systems.	An	1,2,3,5	1,2

Scheme of Continuous Internal Evaluation (CIE):

For integrated courses, a lab test also will be conducted at the end of the semester. The lab test **(COMPULSORY)**will be part of the CIE. **No SEE for Lab**.

THEORY (60 marks)	**LAB (40 marks)**	Total

IA test 1	IA test 2	Assignment (OBA/Lab Project/ Industry assignment)	Conduction	Lab test	
25 marks	25 marks	10 marks	15 marks	25 marks	100 marks

IA Test:

1. No objective part in IA question paper
2. All questions descriptive

Conduct of Lab:

1. Conducting the experiment and journal: 5 marks
2. Calculations, results, graph, conclusion and Outcome: 5 marks
3. Viva voce: 5 marks

Lab test: (Batchwise with 15 students/batch)

1. Test will be conducted at the end of the semester
2. Timetable, Batch details and examiners will be declared by Exam section
3. Conducting the experiment and writing report: 5 marks
4. Calculations, results, graph and conclusion: 10 marks
5. Viva voce: 10 marks

Eligibility for SEE:

1. 40% and above (24 marks and above) in theory component
2. 40% and above (16 marks and above) in lab component
3. **Lab test is COMPULSORY**
4. Not eligible in any one of the two components will make the student **Not Eligible** for SEE

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass:** Score should be > 35&, however overall score of CIE + SEE should be > 40%
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping(Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	√												√		
2	√	√											√		
3	√	√											√	√	
4	√	√	√		√			√	√	√		√	√	√	
Please Tick at appropriate place															

Sl. No.	Skill & Competence enhanced after undergoing the course	Applicable sectors & domains	Job roles students can take up after undergoing the course
1	Mathematical Modelling of Dynamic systems.	Aircraft system modelling and simulation	System Engineer , Vehicle Dynamics Engineer
2	Stability Analysis of Dynamic systems.	UAV and space vehicles stability analysis	Flight dynamics Engineer
3	Estimation Of Stability derivatives.	Flight testing, Parameter Estimation	Flight test performance Engineer, Test Engineer.
4	Controller design (Root locus Method)	UAV , Space vehicles and aircraft	Flight Control Engineer

Name & Sign of faculty members involved in designing the syllabus	Name & Sign of faculty members verifying/approving the syllabus
Prof. Anil Kumar Nakkala	**Prof. I V Patil**

Vibration and Aero-elasticity

Course Code	**21AE64**	**Course type**	**PCC**	**Credits L-T-P**	3 – 0 - 1
Hours/week: L - T- P	3 – 0 – 2			**Total credits**	4
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 20 Hrs Total = 60 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives

The course will introduce the student to;

1. Basic concepts of vibrations
2. The need for vibration analysis in aircraft structural systems
3. Merits and de-merits of vibrations
4. Applications of different solution methods to vibrational problems

Pre-requisites: Calculus, Mechanics of Materials, Aircraft Structures

Unit – I	**Contact Hours = 8 Hours**

Introduction to vibration, Elements of a vibrating system, causes, requirements, desirable and undesirable effects, natural frequency, Resonance, **degrees of freedom**, classification of vibration, types of damping, single degree, two degrees and multiple degrees of freedom systems, formulation of equations of motion using different approaches.

Unit – II	**Contact Hours = 8 Hours**

Free and Forced Vibrations, basics of damped and undamped vibration systems. Free vibration of undamped and damped single DoF systems: force equilibrium, Energy, Rayleigh's and Lagrange's method. Critical, over, under-damped systems, damping ratio, logarithmic decrement.

Unit – III	**Contact Hours = 8 Hours**

Forced vibration of undamped and viscously damped single DoF systems with harmonic excitation; two-degree of freedom system- coordinate coupling, principal coordinates, eigenvalue problem, natural frequencies and mode shapes, normal modes. Introduction of multi-degrees of freedom problems.

Unit – IV	**Contact Hours = 8 Hours**

Vibration of continuous system: vibrations of strings; free vibrations of prismatic bars; Ritz and Galerkin methods. Experimental techniques of vibration measurement and analysis methods. Seismic instruments, vibrometer, accelerometer, vibration absorbers

Unit – V	**Contact Hours = 8 Hours**

Introduction to aeroelasticity, Historical background, static and dynamic aeroelastic phenomenon, Collar's aeroelastic triangle, the definition of flutter, divergence, control effectiveness and control reversal: derivation and numerical

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	01	02	02	03	02

List of Experiments

Unit No.	No. of Experiments	Topic(s) related to Experiment
2	3	1. Free longitudinal vibrations of spring mass system
		2. Damped and Undamped forced vibration of spring mass system
		3. Undamped forced vibration of spring mass system
3	2	4. Balancing of rotating masses setup for static balancing at a plane
		5. Gyroscopic couple on motorized gyroscope
4	3	6. Critical speed or whirling speed of a rotating shaft
		7. Damped torsional vibrating system
		8. Principles of SDOF system to determine the acceleration due to gravity, spring stiffness and radius of gyration

Unit No.	Self-Study Topics
I	Isolation: Vibration isolation and transmissibility
II	Stability criterion: Self excited vibrations; criterion of stability; effect of friction on stability.
III	Free and forced vibration of multi-degree of freedom systems with and without viscous damping
IV	Review of vibrations; Harmonically excited vibration; Vibration isolation, resonance, critical speeds of shafts
V	Flutter analysis with quasi-steady and unsteady aerodynamic loads

Books	
	Text Books:
1.	Rao, S.S., "Mechanical Vibrations", 4th Ed., Pearson Education, 2007
2.	Grover, G. K., "Mechanical Vibrations", 8th Ed., Nem Chand & Brothers, 2009
3.	Dowell, E. H., "A Modern Course in Aeroelasticity: Solid Mechanics and Its Applications", 5th Ed. Springer, 2014
	Reference Books:
1.	Meirovitch, L., Fundamentals of Vibration Analysis, 3rd Ed. McGraw-Hill, 2001.
2.	Das, J. B. K. and Srinivasa Murthy, P. L., "Mechanical Vibrations", Sapna publishers, 2008
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	NPTEL course: Introduction to Mechanical Vibrations, by Dr. Anil Kumar IIT Roorkee. https://nptel.ac.in/courses/ 112107212
2.	Mechanical Vibrations, Prof. S.K. Dwivedy, and Prof. Rajiv Tiwari from IIT Guwahati http://www.nptelvideos.com/course.php?id=835

Course delivery methods	Assessment methods

1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Open Book Assignments (OBA)/ Lab Project
3.	Flipped Classes	3.	Lab Test
4.	Practice session/Demonstrations in Labs	4.	Semester End Examination
5.	Virtual Labs (if present)		

Course Outcome (COs)
Learning Levels:
Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr – Create

At the end of the course, the student will be able to	**Learning Level**	**PO(s)**	**PSO(s)**
1. Understand single and multiple degrees of freedom vibrating systems.	UN	1,2,3,8,9,10	1
2. Discuss vibration measuring instruments for vibration testing	AN	1, 2	1
3. Describe experimental techniques using equipment employed in industry.	AP	1, 2	1
4. Implement vibration analysis theories to modern machineries, automobiles, airfoil sections and landing gears.	EV	1, 2, 3,8,9,10	1

Scheme of Continuous Internal Evaluation (CIE):
For integrated courses, a lab test also will be conducted at the end of the semester. The lab test **(COMPULSORY)** will be part of the CIE. **No SEE for Lab**.

THEORY (60 marks)			**LAB (40 marks)**		Total
IA test 1	IA test 2	Assignment (OBA/Lab Project/ Industry assignment)	Conduction	Lab test	
25 marks	25 marks	10 marks	15 marks	25 marks	100 marks

IA Test:
1. No objective part in IA question paper
2. All questions descriptive

Conduct of Lab:
1. Conducting the experiment and journal: 5 marks
2. Calculations, results, graph, conclusion and Outcome: 5 marks
3. Viva voce: 5 marks

Lab test: (Batchwise with 15 students/batch)
1. Test will be conducted at the end of the semester
2. Timetable, Batch details and examiners will be declared by Exam section
3. Conducting the experiment and writing report: 5 marks
4. Calculations, results, graph and conclusion: 10 marks
5. Viva voce: 10 marks

Eligibility for SEE:
1. 40% and above (24 marks and above) in theory component
2. 40% and above (16 marks and above) in lab component
3. **Lab test is COMPULSORY**
4. Not eligible in any one of the two components will make the student **Not Eligible** for SEE

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass: 40 out of 100**
3.	Question paper contains two questions from each unit each carrying 20 marks. Students have to answer one full question from each unit.

CO-PO Mapping (planned)													**CO-PSO Mapping (planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	√	√	√					√	√	√			√		
2	√	√											√		
3	√	√											√		
4	√	√	√					√	√	√			√		

Sl. No.	**Skill & Competence enhanced after undergoing the course**	**Applicable sectors & domains**	**Job roles students can take up after undergoing the course**
1	**Operations and Failure Mechanism of Structural Components in different engineering fields**	**Mechanical Sciences**	**Design Engineer Stress Analyst Stress Engineer Safety Engineer**

Name & Sign of faculty members involved in designing the syllabus	**Name & Sign of faculty members verifying/approving the syllabus**
Dr. L. Chikmath	**Dr. K. V. Kulkarni**

Aircraft Maintenance, Repair and Overhaul

Course Code	21AE6511	**Course type**	PEC	**Credits L-T-P**	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	Understand the maintenance, repair and overhaul process.
2.	Learn different departments merged to function as maintenance team.
3.	Recognize different types of checks and servicing on aircraft.
4.	Study assembly and rigging process of aircraft components.
5.	Learn safety measures of aircrafts and inspection process.

Pre-requisites: Elements of Aeronautics

Unit – I Introduction to Aircraft Maintenance Engineering	**Contact Hours = 8 Hours**
Aircraft design philosophy—Safe life and fail-safe principles. Stages of aircraft design and development. Necessity for development of an aircraft maintenance program. History leading to development of FAA, ICAO and DGCA. Introduction to Indian Aircraft act 1934 and Aircraft rules 1937.Rules and Regulation of Civil Aviation. Overview of Maintenance, Repair and Overhaul of aircraft. Zones of aircraft, soft life components, Hard Time Components, consumables. Definition of common terms used in Aircraft MRO. **Flipped Class content**: Various sections of CAR as per DGCA, various parts of Indian aircraft rules	

Unit – II Aircraft Maintenance philosophy, Checks and allied departments	**Contact Hours = 8 Hours**
Aircraft Maintenance philosophy: Flying Hours based, Calendar based, landing based, on condition etc. Maintenance sections: Daily Servicing Section or line maintenance team and Technical servicing section. Type of daily servicing—First Line or O Level (FFS, TRS &TRS), Second Line or I Level, Third Line and Fourth Line or D level. Checks: A-type, B-type, C-type and D-type servicing. Allied Maintenance Allied Departments: Planning (Maintenance Control Center), Logistics, Quality, Ground Equipment maintenance team. **Flipped Class Content**: Aviation certification requirements.	

Unit – III Layout of work place and actions prior to servicing	Contact Hours = 8 Hours
Typical layout of an aircraft servicing hangar – Clean room, Tool Crib, Aircraft servicing bay, Hydraulic Bay, Avionics servicing bay, Battery Charging room, Tyre Bay, painting bay, Refueling Bay, specialist power supply bay, Technical library, Servicing crew rest room and Marshalling crew section. Aircraft Jacking, Airplane Rigging and weighing, Balancing of control surfaces. Helicopter flight controls. Tracking and balancing of main rotor. **Flipped Class content**: Aircraft Health monitoring.	

Unit – IV Review of Aircraft systems and trouble shooting	Contact Hours = 8 Hours
Overview of Aircraft systems--- Electrical system, Instrumentation system, Control system, Fuel system, Hydraulic system, Pneumatic system and Environment control system. Inspection and maintenance of auxiliary systems – Fire protection systems – Ice protection system – Rain removal system – Position and warning system – Auxiliary Power Units (APUs) Trouble shooting procedure for aircraft systems and aircraft documentation. **Flipped Class content**: Aircraft documentation.	

Unit – V Safety precautions in Aircraft MRO	Contact Hours = 8 Hours
Precautions against Human Error Servicing, Precaution against fire and use of inspection lamps, Safety precautions against electrical shock due to static electricity, precautions against loose articles in aircraft servicing, Precautions in Monsoon seasons, Safety precaution against radar radiations. Practices in Hazardous materials storage and handling, Aircraft furnishing practices. **Flipped Class content**: Quality checks on aircraft Fuel and Hydraulic fluid.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	Kroes, Watkins, Delp, “Aircraft Maintenance and Repair”, Mcgraw-Hill, New York 1992.
2.	Brimm D.J. Bogges H.E., “Aircraft Maintenance”, Pitman Publishing Corp. New York, 1940.
3.	Friend, C.H., Aircraft maintenance Management . Longman, 1992
4.	
	Reference Books:
1.	Kinnison, H.A , Aviation Maintenance Management, Mc Graw – Hill – 2004
2.	Mc Kinley, J.L. Bent, R.D ., Maintenance and Repair of Aerospace Vehicles, Northrop Institute of Technology, Mc Graw Hill, 1967.

	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	Lectures by Vipul Mathur of IIT Kanpur
2.	

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Explain** the maintenance, repair and overhaul process.	Un	1,12	1,2,3
2.	**Discuss** different departments merged to function as maintenance team.	Ap	1,9,12	1,2,3
3.	**Demonstrate** different types of checks and servicing on aircraft.	Ap	1,12	1,2,3
4.	**Illustrate** assembly and rigging process of aircraft components.	Ap	1,12	1,2,3
5.	**Elucidate** safety measures of aircrafts and inspection process.	An	1,12	1,2,3

Scheme of Continuous Internal Evaluation (CIE): **Theory course**

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25 = 50	5* 4 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass:** Score should be > 35 &, however overall score of CIE + SEE should be > 40%
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													CO-PSO Mapping (Planned)		
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	√											√	√	√	√
2	√								√			√	√	√	√
3	√											√	√	√	√
4	√											√	√	√	√
5	√											√	√	√	√
Please Tick at appropriate place															

Sl. No.	Skill & Competence enhanced after undergoing the course	Applicable sectors & domains	Job roles students can take up after undergoing the course
1	Basic knowledge about aircraft servicing, repair and overhaul.	Civil Aviation and Defense	Aircraft maintenance engineer in MRO industry or airlines.

Name & Sign of faculty members involved in designing the syllabus	Name & Sign of faculty members verifying/approving the syllabus
Prof. P S Joshi	Prof. P M Banakar

Rockets and Missiles

Course Code	**21AE6512**	**Course type**	**PEC**	**Credits L-T-P**	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	To compute and analyze the various forces and moments acting on a rocket
2.	To understand the design, performance and testing aspects
3.	To formulate the equations of motions for flight and separation phases
4.	To understand the combustion and propulsion systems in rocket

Pre-requisites :

Unit – I Introduction	**Contact Hours = 8 Hours**
Classification of launch vehicles and missiles, Rocket systems, Airframe components, Forces and moments acting on a rocket, propulsion, aerodynamics, gravity, inertial and non-inertial frames, coordinate transformation of rockets, Equations of motion for three-dimensional motion through atmosphere and vacuum, earth's atmosphere, numerical problems	

Unit – II Solid Propulsion	**Contact Hours = 8 Hours**
Solid propellant rockets, classification, components and their design considerations, propellant grain design, grain mechanical properties, ballistics and burn rate design issues, igniter design - types of nozzles and thrust vector control, pyrotechnic devices and systems, classification, mechanisms and application of pyrotechnic devices in rockets and missiles. Design problems in rocket systems.	

Unit – III Liquid Propulsion	**Contact Hours = 8 Hours**
Liquid propellant rockets, classification and components, thrust chamber, feed systems, propellant tanks, turbo-pumps, types of valves and applications and their design considerations. Different bipropellant systems like cryogenics and their characteristics, pogo and slosh engine gimbal systems and thrusters for control. Spacecraft propulsion and control systems-Design problems	

Unit – IV Multi-Staging and Separation Dynamics	Contact Hours = 8 Hours
Multi-Staging of Rocket and Separation Dynamics: Navigation and guidance systems in rockets and missiles, aerodynamic control systems of missiles, multi-staging of rockets, vehicle optimization techniques, stage separation system, dynamics, separation techniques, rocket flight dispersion, numerical problems.	

Unit – V Design, Materials and Testing of Rockets	Contact Hours = 8 Hours
Design requirements and selection, performance evaluation and assessment, space environment on the selection of materials for rockets and spacecraft, material selection for specific requirements, advance materials-super alloys and composite materials. Qualification of rocket and missile systems, types of testing and evaluation of design and function.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	Ramamurthi.K.: Rocket Propulsion. Macmillan Publishers India first edition. 2010.
2.	Sutton, G.P., ―Rocket Propulsion Elements‖ John Wiley & Sons Inc., New York, 7th Edition, 2010.
3.	Cornelisse, J.W, Schoyer H F R, and Wakker K F, "Rocket Propulsion and Space Dynamic", Pitman Publishing Co., 1979
4.	
	Reference Books:
1.	"Fundamentals of Guided Missiles",by S. R. Mohan. Publisher : Defence Re-search and Development Organisation.
2.	Mathur, M.L., and Sharma, R.P., ―Gas Turbine, Jet and Rocket Propulsion‖, Standard Publishers and Distributors, Delhi, 1988.
3.	Jack N Neilson, 'Missile Aerodynamics', AIAA, 1st edition, 1988,ISBN-13:780962062902.
4.	George M. Siouris, Missile Guidance and Control Systems, Springer-Verlag New York, 2000
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	NPTEL: Online Resources: Lecture by: Prof. D P Mishra, IIT Kanpur https://nptel.ac.in/courses/101104078/
2.	**NPTEL:** Online Resources: Lecture by: Prof. K Ramamurthi, IIT Madras https://nptel.ac.in/courses/112106073/

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)

4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Describe** the types of space launch vehicles and missiles.	3	1,2	1,2,3
2.	**Compare** the solid and liquid propellant system.	3	1,2	1,2,3
3.	**Analyze** the aerodynamics characteristics of missiles	3	1,2	1,2,3

Scheme of Continuous Internal Evaluation (CIE): **Theory course**

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass:** Score should be > 35 &, however overall score of CIE + SEE should be > 40%
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓											✓	✓	✓
2	✓	✓											✓	✓	✓
3	✓	✓											✓	✓	✓
Please Tick at appropriate place															

Sl. No.	**Skill & Competence enhanced after undergoing the course**	**Applicable sectors & domains**	**Job roles students can take up after undergoing the course**

1	Acquire the knowledge about the space propulsion	ISRO	Laboratory technician
2	Gain the knowledge about the materials, design and testing of rockets.	DRDL	Quality control scientist
3		DRDO	Mechanical design engineer

Name & Sign of faculty members involved in designing the syllabus	Name & Sign of faculty members verifying/approving the syllabus
Prof. I V Patil	**Prof. A K Nakkala**

Unmanned Aerial Vehicle and its Application

Course Code	**21AE6513**	**Course type**	**PEC**	**Credits L-T-P**	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	Comprehend the basic aviation history and UAV systems.
2.	Acquire the knowledge of basic aerodynamics, performance, stability and control.
3.	Understand the propulsion, loads and structures.
4.	Describe the importance of controller design for unmanned aerial vehicles.

Pre-requisites :

Unit – I Introduction	**Contact Hours = 8 Hours**
The systemic basis of UAS-system composition; Conceptual phase; Preliminary design; Selection of the system; Some applications of UAS.	

Unit – II Aerodynamics and airframe components	**Contact Hours = 8 Hours**
Long-endurance, long-range role aircraft; Medium-range, tactical aircraft; Close-range / battlefield aircraft; MUAV types; MAV and NAV types; UCAV; Novel hybrid aircraft configurations; Research UAV.	

Unit – III Characteristic of aircraft types	**Contact Hours = 8 Hours**
Lift-induced Drag; Parasitic Drag; Rotary-wing aerodynamics; Response to air turbulence; Airframe configurations scale effects; Packaging density; Aerodynamics; Structures and mechanisms; Selection of power-plants; Modular construction; Ancillary equipment.	

Unit – IV Communication	**Contact Hours = 8 Hours**
Communication media; Radio communication; Mid-air collision (MAC) avoidance; communications data rate and bandwidth usage; Antenna Types NAVSTAR Global Positioning System (GPS) - TACAN - LORAN C - Inertial Navigation - Radio Tracking - Way-point Navigation.	

Unit – V control and stability	**Contact Hours = 8 Hours**

HTOL Aircraft - Helicopters - OTE/OTE/SPH - Convertible Rotor Aircraft - Payload Control -Sensors –culmon filter- Autonomy.

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	Paul Gerin Fahlstrom , Thomas James Gleason, Introduction To UAV Systems, 4th Edition, Wiley Publication, 2012 John Wiley & Sons, Ltd
2.	Landen Rosen, Unmanned Aerial Vehicle, and Publisher: Alpha Editions, ISBN13: 9789385505034.
3.	Reg Austin., Unmanned Aircraft Systems, John Wiley and Sons., 2010.
	Reference Books:
1.	Unmanned Aerial Vehicles: DOD's Acquisition Efforts, Publisher: Alpha Editions, ISBN13: 9781297017544.
2.	Valavanis, Kimon P., Unmanned Aerial Vehicles, Springer, 2011.
3.	Valavanis**,** K., Vachtsevanos, George J., Handbook of Unmanned Aerial Vehicles, Springer, 2015.
4.	Smart autonomous aircraft Stables, K.J. and Rolfe, J.M. "Flight Simulation", Cambridge University Press, 1998
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://nptel.ac.in/courses/101104073

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Interpret** the mission planning and control of UAV	1,2	1,2,3	1,2,3
2.	**Understand** the basic aerodynamics, performance, stability and control required for UAV	1,2	1,2,3	1,2,3
3.	**Select** the propulsion system and material for structures	1,2	1,2,3	1,2,3

4.	**Apply** the basic concepts of control theory to design classical controls for UAV	1,2	1,2,3	1,2,3

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass:** Score should be > 35 &, however overall score of CIE + SEE should be > 40%
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓											✓	✓	✓
2	✓	✓											✓	✓	✓
3	✓	✓											✓	✓	✓
4	✓	✓											✓	✓	✓
5															
Please Tick at appropriate place															

Sl. No.	**Skill & Competence enhanced after undergoing the course**	**Applicable sectors & domains**	**Job roles students can take up after undergoing the course**
1	**Acquire the knowledge in the drones, piloting and maintenance**	**Aerospace**	**Drone pilot**
2		**Agriculture**	**Drone Technician**
3		**Mining**	**UAV System Engineer**
4		**Construction**	**Lead UAV Test Engineer**
		Data Analytics	**Drone Instructor**

		Data	

Name & Sign of faculty members involved in designing the syllabus	**Name & Sign of faculty members verifying/approving the syllabus**
Prof. I V Patil	**Prof. A K Nakkala**

Space Dynamics

Course Code	21AE6514	**Course type**	PEC	**Credits L-T-P**	3 – 0- 0
Hours/week: L-T-P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs;P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	Understand the Have knowledge about Solar system and launching of the satellite
2.	Learn different general trajectory geometry and Understand the low-thrust trajectories.
3.	Recognize different types of interplanetary missions.

Pre-requisites: Elements of Aeronautics

Unit – I Introduction to Space dynamics	**Contact Hours = 8 Hours**
BASIC CONCEPTS: The solar system, Reference frames and coordinate systems, The celestial sphere, The ecliptic, Motion of vernal equinox, Sidereal time, Solar Time, Standard Time, The earth‘s atmosphere. THE GENERAL N-BODY PROBLEM: The many body problem, Lagrange-Jacobi identity. The circular restricted three-body problem, Libration points, Relative Motion in the N-body proble	

Unit – II THE TWO-BODY PROBLEM	**Contact Hours = 8 Hours**
Equations of motion-General characteristics of motion for different orbits-Relations between position and time for different orbits, Expansions in elliptic motion, Orbital Elements. Relation between orbital elements and position and velocity. **THE LAUNCHING OF A SATELLITE:** Launch vehicle ascent trajectories, General aspects of satellite Injection. Dependence of orbital parameters on in-plane injection parameters. **Flipped Class Content**: Launch vehicle performances, Orbit deviations due to injection errors	

Unit – III PERTURBED SATELLITE ORBITS	**Contact Hours = 8 Hours**
Special and general perturbations- Cowell‘s Method, Encke‘s method. Method ofvariations of orbital elements, General perturbations approach INTERPLANETARY TRAJECTORIES: Two-dimensional interplanetary trajectories, Fast interplanetary trajectories, Three-dimensional interplanetary trajectories. Launch of interplanetary spacecraft. **Flipped Class content**: Trajectory about the target planet.	

Unit – IV BALLISTIC MISSILE TRAJECTORIES	**Contact Hours = 8 Hours**

The boost phase, the ballistic phase, Trajectory geometry, optimal flights. Time of flight, Re-entry phase. The position of the impact point. **Flipped Class content**: Influence coefficients.

Unit –V LOW-THRUST TRAJECTORIES	**Contact Hours = 8 Hours**
Equations of Motion. Constant radial thrust acceleration, Constant tangential thrust (Characteristics of the motion), Linearization of the equations of motion. **Flipped Class content**: Performance analysis.	

Flipped Classroom Details

Unit No.	**I**	**II**	**III**	**IV**	**V**
No. for Flipped Classroom Sessions	**2**	**2**	**2**	**2**	**2**

Books	
	Text Books:
1.	William E. Wiesel, Spaceflight Dynamics, 3rd edition, McGraw-Hill, New Delhi, 2010.
2.	. W. Cornelisse , Rocket Propulsion and Spaceflight Dynamics, Pitman Publishing, London, 1979.
	Reference Books:
1.	Charles D. Brown, Spacecraft Mission Design, 2nd Edition, AIAA Education Series, USA, 1998.
2.	David A. Vellado, Fundamentals of Astrodynamics and Applications, 3rd Edition, Springer, Germany, 2007.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://archive.nptel.ac.in/courses/101/105/101105083/ Lectures by Pro.Manoranjan Sinha, of IIT Kharagpur.

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)			
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create	**Learning Level**	**PO(s)**	**PSO(s)**

1.	**Explain** the general trajectory geometry and N body problem	Un	1	1
2.	**Solve** Two body equations of motion.	AP	1,2	1
3.	**Demonstrate** different types of interplanetary Trajectories and analyze Low thrust trajectories.	An	1,2,3	1

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25= 50	5* 4 marks = 20	10+10 =20	10	100
OBA- Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass:** Score should be > 35&, however overall score of CIE + SEE should be > 40%
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping(Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	√											√	√	√	√
2	√								√			√	√	√	√
3	√											√	√	√	√
Please Tick at appropriate place															

Sl. No.	**Skill & Competence enhanced after undergoing the course**	**Applicable sectors & domains**	**Job roles students can take up after undergoing the course**
1	**Basic knowledge Space Mechanics and Orbital Transfer**	**Space Sector**	**Space craft Dynamics Engineer**

Name & Sign of faculty members involved in designing the syllabus	Name & Sign of faculty members verifying/approving the syllabus
Prof. Anil Kumar Nakkala	**Prof. I V Patil**

Aircraft Structures II

Course Code	21AE6515	Course type	PEC	Credits L-T-P	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	Understand basic concepts of elasticity
2.	Introduce students to the various plate theories and plate analyses
3.	Identify and analyze determinate and indeterminate structures
4.	Understand the process in the structural design of aircrafts

Pre-requisites : Mechanics of Materials, Aircraft Structures

Unit – I: Introduction to Elasticity	Contact Hours = 8 Hours
Basic elasticity; Stresses, strains and their types; Stress and strain tensor; Equations of Equilibrium for stresses; Stresses on inclined plane; Hydrostatic stresses, Octahedral stresses; Linear and Non-linear strain-displacement relations; compatibility conditions for strains; Generalized Hooke's law.	

Unit – II: Thin walled structures	Contact Hours = 8 Hours
Thin plate theories: Classical Plate theory, First order shear deformation theory; Navier Solution; Pure bending of plates, Analysis of thin plates subjected to bending with various boundary conditions under UDL and bi-sinusoidal load; Analysis of thin and thick shells; Stress concentration, Analysis of thin plate with cutouts.	

Unit – III: Indeterminate structures	Contact Hours = 8 Hours
Introduction to determinate & Indeterminate structures; Static Indeterminacy, Kinematic indeterminacy, External and Internal indeterminacy; Analysis of continuous beams; Analysis of Beam-columns; Analysis of Indeterminate trusses.	

Unit – IV: Analysis of Joints	Contact Hours = 8 Hours
Types of joints: Riveted, bolted joints, Welded joints, Adhesive joints, Lap join, butt joint; Types of rivets; Rivet shear, bearing pressure, plate failure in tension, shear failure in plate; Joint efficiency; Group riveted joints; Eccentrically loaded rivet joints; Splices and gusset joints;	

Unit – V: Design of aircraft structures	Contact Hours = 8 Hours
Structural design criteria; Steps involved in designing aircraft structures; External loads on aircraft structures; Weight distribution and balance; Flight loads, Ground loads; Dynamic loads; Pressurization loads; wing fuel pressure load; Miscellaneous loads.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	Megson, T.M.G., "Aircraft Structures for Engineering Students"' Elsevier India (2005), ISBN-13: 978-9382291053.
2.	Michael C-Y Niu, "Airframe Stress Analysis & Sizing", Hongkong Conmilit Press Ltd., 2nd edition, 1999, ISBN: 962-7128-08-2
3.	L. S. Srinath, "Advanced Mechanics of Solids", McGraw Hill, 3rd Edition, 2009, ISBN: 10: 0-07-13988-1
	Reference Books:
1.	Peery, D.J., and Azar, J.J., "Aircraft Structures", McGraw Hill Education, 2013, ISBN-13: 978-9332902602.
2.	Bruhn. E.H. "Analysis and Design of Flight Vehicles Structures", Tri-state off set company, USA, 1985.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://nptel.ac.in/courses/101105084 Aircraft Structures I, Course by Prof. Anup Ghosh IIT Kharagpur
2.	https://onlinecourses.nptel.ac.in/noc20_ce42/preview Theory of Elasticity By Prof. Amit Shaw, Prof. Biswanath Banerjee, IIT Kharagpur

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		Learning Level	PO(s)	PSO(s)
1.	**Explain** and **Calculate** the concepts of stress, strains, and deformations for three dimensional elastic body.	Ap	1, 2	1
2.	**Explain** the process of design and analysis of aircraft structures and joints	Ap	1, 2	1
3.	**Explain** the process and **Analyze** various determinate and indeterminate aircraft structures under various loads.	An	1, 2, 3, 5, 8, 9, 10	1, 2

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass:** Score should be > 35 &, however overall score of CIE + SEE should be > 40%
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	√	√											√		
2	√	√											√		
3	√	√	√		√			√	√	√			√	√	
Please Tick at appropriate place															

Sl. No.	**Skill & Competence enhanced after undergoing the course**	**Applicable sectors & domains**	**Job roles students can take up after undergoing the course**
1	**Basic Elasticity**	**Aircraft Structural analysis and Design**	**Stress Analyst**

2	**Analysis of Indeterminate structures**	**UAV design and Analysis**	**Structural Designer**
3	**Design of joints**	**Aerospace system design and analysis**	**Structure Analyst**
4	**Design of aircraft structural elements**	**Mechanical system design and analysis**	**-**

Name & Sign of faculty members involved in designing the syllabus	Name & Sign of faculty members verifying/approving the syllabus
Dr. Kamlesh Kulkarni	**Dr. L Chikmath**

Heat Transfer

Course Code	21AE6516	Course type	PEC	Credits L-T-P	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	Understand the fundamentals of heat and mass transfer
2.	Understand the conduction process with equations
3.	Understand the concept of free convection and forced convection over plates and pipes
4.	Impart the knowledge of heat transfer through radiation
5.	Impart the knowledge of heat transfer problems in combustion chambers.

Pre-requisites : Thermodynamics

Unit – I	Contact Hours = 8 Hours
Conduction: Different modes of heat transfer and mass and momentum transfer, General Differential Equation Of Heat Conduction– Cartesian And Polar Coordinates – One Dimensional Steady State Heat Conduction –– Plane And Composite Systems – heat transfer through composite structures, Concept of the critical radius, Unsteady Heat Conduction – Lumped Analysis –Semi Infinite And Infinite Solids – Use Of Heisler‟S Charts.	

Unit – II	Contact Hours = 8 Hours
Convection: Concepts of Continuity, Momentum and Energy Equations. Dimensional analysis-Buckingham's Pi Theorem -Application for developing non-dimensional correlation for convective heat transfer. Free Convection: Development of Hydrodynamic and thermal boundary layer along a vertical plate, Use of empirical relations for Vertical plates and pipes. Natural convection on horizontal pipes	

Unit – III	Contact Hours = 8 Hours
Forced Convection: External Flows, Concepts of hydrodynamic and thermal boundary layer and use of empirical correlations for Flat plates and Cylinders. Calculation of pumping power, drag force, use of empirical correlations for Horizontal Pipe Flow and annulus flow.	

Unit – IV	Contact Hours = 8 Hours

Radiation Heat Transfer **:** Emission characteristics, Laws of black-body radiation, Irradiation, Total and Monochromatic quantities, Laws of Planck, Wien, Kirchhoff, Lambert, Stefan and Boltzmann, Heat exchange between two black bodies, concepts of shape factor, Emissivity, heat exchange between grey bodies, radiation shields, electrical analogy for radiation networks. Application in Space Engineering

Unit – V	**Contact Hours = 8 Hours**
Heat and Mass Transfer Problems in Aerospace Engineering: Heat transfer problems in gas turbine combustion chambers - Rocket thrust chambers - Aerodynamic heating -Ablative heat transfer. Mass Transfer**:** Introduction, Ficks law, Species conservation equation, Introduction to convective and diffusive mass transfer.	

Flipped Classroom Details

Unit No.	**I**	**II**	**III**	**IV**	**V**
No. for Flipped Classroom Sessions	**2**	**2**	**2**	**2**	**2**

Books	
	Text Books:
1.	Yunus A. Cengel, —Heat Transfer- A Practical Approach‖, Tata McGraw hill Education (P) Ltd, New Delhi, India. 4th Edition, 2012.
2.	R. C. Sachdeva, —Fundamentals of Engineering, Heat and Mass Transfer, New Age, New Delhi, India, 3rd edition, 2012
	Reference Books:
1.	Holman, —Heat Transfer Tata McGraw Hill education (P) Ltd, New Delhi, India. 10 Edition, 2012.
2.	M.N. Ozisik, 'Heat Transfer, A Basic Approach', McGraw Hill Publishers, International edition, 1985.
3.	S.P. Sukhatme, 'A Text Book on Heat Transfer', Universities Press, 4th Edition, 2005.
4.	C.P. Kothandaraman and S. Subramanyan, 'Heat and Mass Transfer Data Book', New Age International Publishers, 8th Edition, 2016
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	Heat and Mass Transfer, by Prof. Pradip Dutta, IISc Bangalore https://nptel.ac.in/courses/112108149
2.	Heat Transfer, by Dr. Anil Verma, IIT Guwahati https://nptel.ac.in/courses/103103032

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Describe the fundamentals of heat and mass transfer.	Un	1,2	1
2.	Analyse the process of conduction process convection and radiation	Ap	1,2	1
3.	Analyse the process of free and forced convection	Ap	1,2	1
4.	Analyze the problems due to heat transfer in several areas	An	1,2,3,5,8,9	1,2

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass:** Score should be > 35 &, however overall score of CIE + SEE should be > 40%
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	√	√											√		
2	√	√											√		
3	√	√											√		
4	√	√	√		√			√	√				√	√	
Please Tick at appropriate place															

Sl. No.	Skill & Competence enhanced after undergoing the course	Applicable sectors & domains	Job roles students can take up after undergoing the course
1	Heat transfer processes	Aerospace	Lead Engineer
2		Thermal	Maintenance engineer
3			
4			

Name & Sign of faculty members involved in designing the syllabus	Name & Sign of faculty members verifying/approving the syllabus
Prof. K V Kulkarni	Prof. P M Banakar

Aircraft systems

Course Code	21AE6611	Course type	OEC	Credits L-T-P	3 – 0- 0
Hours/week: L-T-P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs;P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	Understand the fundamental principles and concepts of aircraft systems, including their mechanical, electrical, hydraulic, pneumatic, and avionics subsystems integration.
2.	Comprehend the importance of aircraft system integration and its impact on the overall performance, safety, and efficiency of the aircraft.
3.	Apply knowledge of aircraft system regulations and safety considerations to ensure compliance and mitigate risks in aircraft operation and maintenance.
4.	Demonstrate the ability to analyze and evaluate the interdependencies and interactions between different aircraft systems.
5.	Apply theoretical knowledge to practical scenarios and problem-solving related to aircraft systems integration, operation, and maintenance

Pre-requisites :Elements of Aeronautics

Unit – I	Contact Hours = 8 Hours
Aircraft control systems-Cockpit controls,connecting linkages,mechanisms to control aircraft, primary and secondary systems, flight control systems (FCS), Flight control computer(FCC),Autopilotsystems, Introduction to Aircraft Systems ,Types of Aircraft Systems (Mechanical, Electrical, Hydraulic, Pneumatic, etc.) ,Aircraft System Integration ,Aircraft System Safety and Regulations ,Maintenance and Inspection Procedures for Aircraft Systems	

Unit – II	Contact Hours = 8 Hours
Overview of Aircraft Electrical Systems, Aircraft Electrical Power Generation and Distribution ,Electrical Loads and Circuit Protection ,Batteries and Power Sources,Electrical Wiring and Connectors , Troubleshooting and Maintenance of Electrical Systems	

Unit – III	Contact Hours = 8 Hours
Introduction to Aircraft Hydraulic Systems ,Hydraulic Fluids and Filters , Hydraulic Power Generation and Distribution, Hydraulic Actuators and Components, Hydraulic System Maintenance and Troubleshooting ,Emergency Hydraulic Systems	

Unit – IV	Contact Hours = 8 Hours
Overview of Aircraft Pneumatic Systems ,Pneumatic Power Generation and Distribution , Pneumatic Components and Controls ,Cabin Pressurization Systems , Pneumatic System Maintenance and Troubleshooting	

Unit –V	Contact Hours = 8 Hours
Introduction to Aircraft Environmental Control Systems (ECS) ,Air Conditioning and Heating Systems ,Ventilation and Pressurization Systems ,Avionics Cooling Systems ,ECS Maintenance and Troubleshooting	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	"Aircraft Systems: Mechanical, Electrical, and Avionics Subsystems Integration" by Ian Moir and Allan Seabridge
	Reference Books:
1.	Alfred Leick , GPS Satellite Surveying Publisher: Wiley Edition: 4th Edition Year: 2014
2.	Christopher Jekeli , Inertial Navigation Systems with Geodetic Applications Publisher: Walter de Gruyter Edition: 1st Edition Year: 2001
3.	Cary R. Spitzer , Digital Avionics Handbook Publisher: CRC Press Edition: 3rd Edition Year: 2014
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	Global navigation satellite systems and applications,iit roorkee,prof arun k. saraf,https://nptel.ac.in/courses/105107194

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		Learning Level	PO(s)	PSO(s)
1.	Gain a comprehensive understanding of aircraft systems, including their integration, operation, and maintenance, encompassing mechanical, electrical, hydraulic, pneumatic, and avionics subsystems.	Un	1	1,2,3
2.	Apply knowledge of aircraft system regulations, safety considerations, and problem-solving techniques to ensure safe and efficient aircraft operation and maintenance.	Ap	1	1,2,3
3.	Demonstrate proficiency in analyzing, evaluating, and troubleshooting aircraft systems, fostering effective communication and teamwork skills in aircraft system-related tasks	An	1	1,2,3

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25= 50	4* 5 marks = 20	10+10 =20	10	100
OBA- Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass:** Score should be > 35&, however overall score of CIE + SEE should be > 40%
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													CO-PSO Mapping(Planned)		
CO	**PO1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓												✓	✓	✓
2	✓												✓	✓	✓
3	✓												✓	✓	✓
Please Tick at appropriate place															

Sl. No.	Skill & Competence enhanced after undergoing the course	Applicable sectors & domains	Job roles students can take up after undergoing the course
1	Technical Proficiency	Aerospace Industry, Avionics Manufacturing Companies, Airlines and Aviation Operators, Maintenance, Repair and Overhaul (MRO) Facilities, Defense and Military, Research and Development, Flight Simulation Companies, UAV (Unmanned Aerial Vehicle) and Drone Industry, Government Regulatory Agencies	Avionics Technician/Engineer
2	System Troubleshooting		Avionics Integration Specialist
3	System Integration:		Avionics System Engineer
4	Communication and Collaboration		Avionics Project Manager
5	Safety Awareness:		Avionics Sales Engineer
6	Analytical Skills:		Avionics Instructor/Trainer
7	Continuous Learning		Avionics Systems Consultant

Name & Sign of faculty members involved in designing the syllabus	Name & Sign of faculty members verifying/approving the syllabus
Prof. P K Katti	**Prof. P S Joshi**

Wind Tunnel Techniques

Course Code	21AE6612	Course type	OEC	Credits L-T-P	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	Learn the basic concept of Wind tunnel and its principles
2.	Understand the various types of wind tunnels and its operational functions
3.	Analyze the flow through calibration and measurement techniques.
4.	Learn the advanced types of wind tunnel.

Pre-requisites : Basic knowledge of Fluid Mechanics & Aerodynamics

Unit – I : WIND TUNNELS	Contact Hours = 8 Hours
Introduction to Wind Tunnels &Principles of Model Testing, Wind Tunnels and its functional parts**,** Non dimensional numbers, Scale effect, Geometric Kinematic and Dynamic similarities. Types of wind tunnels – continuous and intermittent – closed circuit and open circuit – applications.	

Unit – II : CHARACTERISTICS OF MEASUREMENTS	Contact Hours = 8 Hours
Characteristic features, operation and performance of low speed, transonic, supersonic and special tunnels - Power losses in a wind tunnel – Instrumentation of wind tunnels – Turbulence- Wind tunnel balance –principles, types and classifications	

Unit – III : MEASUREMENT TECHNIQUES	Contact Hours = 8 Hours
Forces, moments and Reference Frames – Balances – Internal and External - Requirements and Specifications, Intrusive and Non- intrusive methods, Pitot – static tube characteristics – Velocity measurements – Hot-wire anemometry – Constant current and Constant temperature Hot-Wire anemometer – Pressure measurement techniques – Pressure transducers – Temperature measurements.	

Unit – IV : SPECIAL WIND TUNNEL TECHNIQUES	Contact Hours = 8 Hours
Intake tests, store carriage and separation tests, Unsteady force and pressure measurements, Non-Intrusive Flow Diagnostics, Laser – Doppler Anemometry. Particle Image Velocimetry. Laser Induced Fluorescence.	

Unit – V : Fundamentals of wind tunnel design	Contact Hours = 8 Hours
Introduction, general considerations, general design procedure, main design criteria, wind tunnel component specification, design of various components of wind tunnel – test chamber, contraction, settling chamber, diffuser, power plant, turning vane, fan and drive system, safety net design	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	Rae, W.H. and Pope, A., "Low Speed Wind Tunnel Testing", Wiley India Pvt Ltd; Third edition (16 March 2010) ISBN-13: 978-8126525683
2.	Pope, A., and Goin, L., "High Speed Wind Tunnel Testing", Krieger Pub Co (June 1,1978), ISBN-13: 978-0882757278
3.	Pope, J B Barlow —low speed wind tunnel testing — 3 edition j.w publication
	Reference Books:
1.	NAL-UNI Lecture Series 12:" Experimental Aerodynamics", NAL SP 98 01 April 1998
2.	E. Rathakrishnan, Instrumentation, Measurements, and Experiments in Fluids, CRC Press, 2007
3.	Lecture course on "Advanced Flow diagnostic techniques" 17-19 September 2008 NAL, Bangalore
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://nptel.ac.in/courses/101106040

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Understand** the concepts of aerodynamics and types of wind tunnels	**Un**	1	1
2.	**Examine** the wind tunnel through the calibrations and its functions used in wind tunnels	**An**	1	1
3.	**Distinguish** the different approaches of measurements in **Understand**ing the function of Wind tunnel.	**Ap**	1	1
4.	**Apply** the concept of aerodynamics in designing the wind tunnels.	**Ap**	1	1

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass:** Score should be > 35 &, however overall score of CIE + SEE should be > 40%
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓												✓		
2	✓												✓		
3	✓												✓		
4	✓												✓		
Please Tick at appropriate place															

Sl. No.	Skill & Competence enhanced after undergoing the course	Applicable sectors & domains	Job roles students can take up after undergoing the course
1	Understanding basic principle of operations of wind tunnel.	Aeronautical sector	Experimental aerodynamics Engineer
2	Measurement equipment used	Automobile sector	Wind tunnel designer
3	Designing fundamental basics		Aerodynamics Engineer

Name & Sign of faculty members involved in designing the syllabus	Name & Sign of faculty members verifying/approving the syllabus
Prof. Dharmendra A Ponnaswami	Prof. A K Nakkala

Air-breathing Engines

Course Code	21AE6613	Course type	OEC	Credits L-T-P	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	Understand the basic principle of IC engines.
2.	Gain the knowledge of gas turbine and their working principle
3.	Understand the working principle of aircraft power plants
4.	Learn the theory behind gas turbine working
5.	Acquire the knowledge about various material used in air breathing engines.

Pre-requisites : Thermodynamics

Unit – I	Contact Hours = 8 Hours
Classification, I.C. Engines parts, 2 and 4 stroke petrol and 4-stroke diesel engines. P-V diagrams of Otto and Diesel cycles. Simple problems on indicated power, brake power, indicated thermal efficiency, brake thermal efficiency, mechanical efficiency and specific fuel consumption	

Unit – II	Contact Hours = 8 Hours
Gas turbines: Classification, Working principles and Operations of Open cycle and closed cycle gas turbines. Aircraft power plants, classification based on power plant and location and principle of operation. **Materials** used in IC engines, gas turbine engines, applications of super alloys; nickel alloys, titanium alloys and ceramics, composites.	

Unit – III	Contact Hours = 8 Hours
Aircraft power plants – basic principles of piston, & jet engines; radial piston engines, turbojet engine, turboprop engine, turbofan engine, turbo shaft engine, ram jet and scram jet. **Brayton cycle** and its application to gas turbine engines; use of propellers and jets for production of thrust, Advance engines and simple problems.	

Unit – IV	Contact Hours = 8 Hours
Gas Turbine: Induction, exhaust and cooling systems, anti-icing of engine, engine mountings, thrust augmentation. Compressor surge and stall, bleed control system. Principles of operation, general constructional details and functions of fuel and oil systems, ignition and starting systems and their components. Engine controls of various types, including Full Authority Digital Electronic Control Engine instruments. Power augmentation devices, thrust reversers and auxiliary power units.	

Unit – V	Contact Hours = 8 Hours
Engine Maintenance: Piston/Gas Turbines: Periodical servicing procedures, engine installation checks, control rigging, ground running checks, priming, bleeding and performance checks. Engine on condition maintenance. Trouble shooting and rectification. Inspection after shock landing. Crack detection. Procedure for long and short terms storage of engine and accessories, engine preservation and depreservation.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	Bhaskar Roy, "Aircraft propulsion", Elsevier (2011), ISBN-13: 9788131214213
2.	V. Ganesan, "Gas Turbines", Tata McGraw-Hill, 2010, New Delhi, India, ISBN: 0070681929, 978007068192
3.	H Cohen, G F C Rogers and H I H Sarvanmutto, Gas Turbine Theory, John Wiely
4.	Irwin E. Treager, "Gas Turbine Engine Technology" GLENCOE Aviation Technology Series, 7th Edition, Tata McGraw Hill Publishing Co.Ltd. Print 2003, ISBN-13: 978-0028018287
	Reference Books:
1.	Hill, P.G. & Peterson, C.R., "Mechanics & Thermodynamics of Propulsion" Addison – Wesley Longman INC, 1999, ISBN-13: 978-0201146592.
2.	Michacl J. Krose Thomas W.Wild, Bent, Aircraft Power Plants, McGraw Hill 1994
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	**NPTEL:** Online Resources: Lecture by: Prof. Bhaskar Roy , Prof. A M Pradeep, IIT Bombay https://nptel.ac.in/courses/101101002/
2.	**NPTEL:** Online Resources: Lecture by: Prof. Vinayak N. Kulkarni , IIT Guwahati

	https://swayam.gov.in/nd1_noc19_me76/preview

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Explain** the basic principle of IC engines and illustrate the working principle of gas turbine	**Ap**	1	1
2.	**Describe** the working principle of aircraft power plants and compare various material used in air breathing engines.	**Ap**	1	1
3.	**Demonstrate** Periodical servicing procedures of Engine Maintenance	**Ap**	1	1
4.	**Explain** various systems of gas turbine engines	**Un**	1	1

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass:** Score should be > 35 &, however overall score of CIE + SEE should be > 40%
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													CO-PSO Mapping (Planned)		
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	√												√		
2	√												√		
3	√												√		
4	√												√		
Please Tick at appropriate place															

Sl. No.	Skill & Competence enhanced after undergoing the course	Applicable sectors & domains	Job roles students can take up after undergoing the course
1	Acquire Knowledge about Gas turbine and IC engines	Maintenance, Propulsion	Maintenance engineer, Service Engineer, Technical Publication consultant

Name & Sign of faculty members involved in designing the syllabus	Name & Sign of faculty members verifying/approving the syllabus
Prof. Parameshwar Banakar	Prof. I V Patil

Employability Skills II

Course Code	**21AECAE68**	**Course type**	**AEC**	**Credits L-T-P**	1 – 0 - 0
Hours/week: L - T- P	1 – 0 – 0			**Total credits**	1
Total Contact Hours	L = 20 Hrs; T = 0 Hrs; P = 0 Hrs Total = 20 Hrs			**CIE Marks**	100

Course learning objectives	
1.	Skill development is/are personal attributes that influence how well an individual works or interacts with others.
2.	These skills make it easier to form relationships with people, create trust and dependability, and lead teams.
3.	In essence, they are essential for individual success in the workplace, their company's success, and their personal life also

Pre-requisites :

Unit – I	**Contact Hours = 4 Hours**
General Aptitude 1.1: **Understanding Quantitative Aptitude:** Time, Speed, and Distance, Trains, Boats, and Streams	

Unit – II	**Contact Hours = 4 Hours**
General Aptitude 1.2: **Understanding Quantitative Aptitude:** Permutation and Combination, Probability, Data Interpretation, and Simple and Compound Interest	

Unit – III	**Contact Hours = 4 Hours**
General Aptitude 1.3: **Understanding Quantitative Aptitude:** Change of Speech & Voice, Sentence Completion, and Critical Reasoning	

Unit – IV	**Contact Hours = 4 Hours**
General Aptitude 1.4: **Understanding Quantitative Aptitude:** Allegation and Mixtures, Syllogisms, Seating Arrangement, Data Arrangement, Clocks & Calendars, and Data Sufficiency	

Unit – V	Contact Hours = 4 Hours
Improve Sense of Belongingness: Interview Skills and Resume Writing	

Books		
	Text Books:	
	Name of the author(s), Title of the Book, Publisher, Edition/Year _____ and onwards	
1	The Aptitude Triad , BIZOTIC	
	Reference Books:	
	Name of the author(s), Title of the Book, Publisher, Edition/Year _____ and onwards	
1	How to prepare for Quantitative Aptitude for CAT & other Management Examinations, Arun Sharma, McGraw Hill Education(India) Private Limited, 4th Edition, 2018.	

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
		3.	Internal Assessments

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Clear the Aptitude round of recruiters during placements	L2	10	
2.	Perform confidently during the Interview process	L2	12	
3.	Develop Resumes that are grammatically correct	L2	10	
4.	Develop behaviors that are appropriate for a professional	L2	12	

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Assignment	Class Performance	Total Marks
Marks	25+25 = 50	10	15+15 =30	10	100

> Writing 2 IA tests is compulsory
> Minimum score to be eligible for SEE: 40 OUT OF 100

CO-PO Mapping (Planned)													CO-PSO Mapping (Planned)		
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1										✓		✓			
2										✓		✓			
3										✓		✓			
4										✓		✓			
5										✓		✓			
Tick mark the CO, PO and PSO mapping															

Sl No	Skill & competence enhanced after undergoing the course	Applicable Industry Sectors & domains	Job roles students can take up after undergoing the course
1	Logical Thinking	IT Industry	Software Engineer
2	Problem Solving	Automotive	Developer
3	Communication Skills	Education Sector	Project Manager

Flight vehicle design

Course Code	21AE71	**Course type**	PCC	**Credits L-T-P**	3 – 0- 0
Hours/week: L-T-P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs;P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	Performance of different flights can be estimated
2.	Sizing of different components of aircraft can be done.
3.	Understand the different phases of Aircraft design process.

Pre-requisites: Aircraft Performance, Aircraft Stability and control

Unit – I DESIGN PROCESS OVERVIEW AIRFOIL AND GEOMETRY SELECTION	**Contact Hours = 8 Hours**
Phases of aircraft design. Aircraft conceptual design process, project brief / request for proposal, problem definition information retrieval, aircraft requirements, configuration options Integrated product development and aircraft design. empty weight estimation –historical trends, fuel fraction estimation, mission profiles, mission segment weight fractions. Airfoil selection, airfoil design, design lift coefficient, stall, airfoil thickness ratio airfoil considerations. Wing geometry and wing vertical location, wing tip shapes Tail geometry and arrangements. Thrust to weight ratio - statistical estimation, thrust matching. Wing loading.	

Unit – II INITIAL SIZING & CONFIGURATION LAYOUT	**Contact Hours = 8 Hours**
Sizing with fixed engine and with rubber engine. Geometry sizing of fuselage, wing, tail, control surfaces. Development of configuration lay out from conceptual sketch. The inboard profile drawing, wetted area, volume distribution and fuel volume plots Lofting- definition, significance and methods, flat wrap lofting. **Flipped Class content**: Special consideration in configuration lay out.	

Unit – III CREW STATION,PASSENGERS & PAYLOAD Design	**Contact Hours = 8 Hours**
Fuselage design- crew station, passenger compartment, cargo provisions, weapons carriage, gun installation Landing gear arrangements, guidelines for lay out. Shock absorbers – types, sizing, stroke determination, gear load factors. Gear retraction geometry. Aircraft subsystems, significance to configuration lay out. The baseline design layout and report of initial specifications aircraft loads, Flight loads- atmospheric, maneuver- construction of flight envelope. Wing loads, Empennage loads, Fuselage loads. Propulsion system selection, jet engine integration, engine dimensions, Nozzle integration. **Flipped Class content**: Aircraft materials, design data- allowable, allowable bases. Failure theory.	

Unit – IV PERFORMANCE AND CONSTRAINT ANALYSIS REFINED SIZING & TRADE STUDIES	Contact Hours = 8 Hours
The aircraft operating envelope. Take off analysis, balanced field length Landing analysis. Fighter Performance measures of merit. Effects of wind on aircraft performance. Initial technical report of baseline design analysis and evaluation. Refined baseline design and report of specifications. Elements of life cycle cost, cost estimating method, RDT&E and production costs, operation and maintenance costs, fuel and oil costs, crew salaries Refined conceptual sizing methods. **Flipped Class content**: Trade studies - design trades, requirement trades, growth sensitivities	

Unit –V STABILITY, CONTROL & HANDLING QUALITIES	Contact Hours = 8 Hours
Longitudinal static stability and control, aerodynamic center estimation, wing and tail lift and elevator, Estimation of wing, fuselage and nacelle pitching moment, thrust effect, trim analysis, take-off rotation, velocity stability, Lateral & directional stability and control, lateral directional derivatives, aircraft dynamic characteristics, steady roll, pull up, inertia coupling. **Flipped Class content**: Introduction to handling qualities (Cooper harper rating scale).	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	Raymer ,D.P., Aircraft Design : A Conceptual Approach, 3rd edn., AIAA Education series, AIAA, 1999,ISBN: 1-56347-281-0
2.	Howe, D., Aircraft Conceptual Design Synthesis, Professional Engineering Publishing,London,2000,ISBN:1-86058-301-6
	Reference Books:
1.	Ajoy Kumar Kunda, “Aircraft Design”, Cambridge University Press, UK, 2010
2.	E. H Bruhn, “Analysis and Design of Flight Vehicles Structures”, Jacobs Publishing House, USA, New Edition, 1973.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://archive.nptel.ac.in/courses/101/105/101105083/ Lectures by Pro.Manoranjan Sinha, of IIT Kharagpur.

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar

		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Describe** the Phases of the flight design process, Configuration layout and Trade studies.	Un	1	1,2
2.	**Estimate** take-off gross weight of simple cruise mission profile for calculating the empty weight fraction.	AP	1,2,3	1,2
3.	**Analyze** the design performance parameters of an aircraft for a given application.	An	1,2,3	1,2

Scheme of Continuous Internal Evaluation (CIE): Theory course

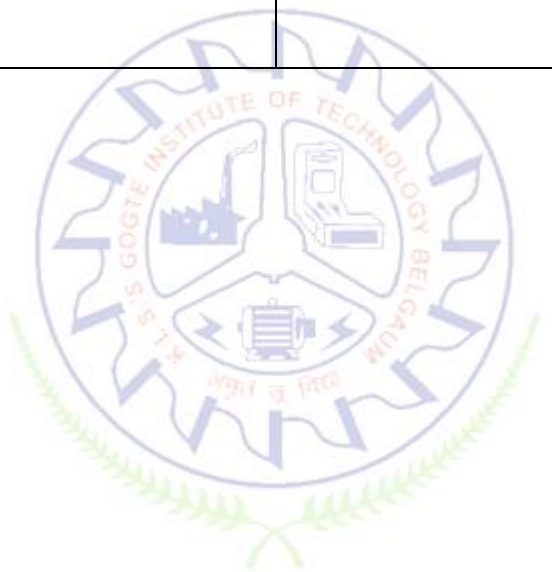
Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25= 50	5* 4 marks = 20	10+10 =20	10	100
OBA- Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass:** Score should be > 35&, however overall score of CIE + SEE should be > 40%
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping(Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	√												√	√	
2	√	√	√										√	√	
3	√	√	√										√	√	
Please Tick at appropriate place															

Sl. No.	Skill & Competence enhanced after undergoing the course	Applicable sectors & domains	Job roles students can take up after undergoing the course
1	Knowledge about Aircraft Design.	Aircraft Sector	Mass properties Engineer
2	Design and Stability analysis of Flight Vehicles.	Fixed Wing UAV sector	UAV Design Engineer

Name & Sign of faculty members involved in designing the syllabus	Name & Sign of faculty members verifying/approving the syllabus
Prof. Anil Kumar Nakkala	Prof. I V Patil



Flight Testing

Course Code	21AE71	**Course type**	PEC	**Credits L-T-P**	3 – 0- 0
Hours/week: L-T-P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs;P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	Comprehend the basic concepts of flight test instrumentation.
2.	Impart the knowledge of performance flight testing and stability control.
3.	Impart the knowledge of stability control of flight in different method.
4.	Understand the flying qualities and hazardous flight testing.

Pre-requisites: Aircraft Performance, Aircraft Stability and control, Flight Vehicle Design

Unit – I Introduction	**Contact Hours = 8 Hours**
Sequence, Planning and governing regulations of flight testing, DGCA Regulations. Aircraft weight and center of gravity, flight testing tolerances. Method of reducing data uncertainty in flight test data sources and magnitudes of error, avoiding and minimizing errors. Flight test instrumentation: Planning flight test instrumentation, Measurement of flight parameters. **Flipped Class content:** Onboard and ground based data acquisition system. Radio telemetry.	

Unit – II Performance flight testing - range, endurance and climb:	**Contact Hours = 8 Hours**
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. Performance flight testing - take-off, landing, turning flight: Maneuvering performance estimation. Take-off and landing methods, procedures and data reduction **Flipped Class content**: Take-off and landing methods, procedures and data reduction.	

Unit – III Stability and control - longitudinal and maneuvering	**Contact Hours = 8 Hours**
Static & dynamic longitudinal stability: - methods of flight testing and data reduction techniques. Stick free stability methods. Maneuvering stability methods & data reduction.	

Unit – IV Stability and control - lateral and directional:	**Contact Hours = 8 Hours**
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. **Flipped Class content**: test techniques and method of data reduction.	

Unit –V Flying qualities:	Contact Hours = 8 Hours
MIL and FAR regulations. Cooper-Harper scale Pilot Rating. Flight test procedures. Hazardous flight testing: Stall and spin- regulations, test and recovery techniques. Test techniques for Flutter, vibration and buffeting. Simulate the Flight tests to estimate stick free and fixed, neutral and maneuvering points, **Flipped Class content**: Simulate Static Longitudinal, Lateral and Directional Stability derivatives F-18 Aircraft.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	0	2	4

Books	
	Text Books:
1.	Ralph D Kimberlin, Flight Testing of Fixed Wing Aircraft, AIAA educational Series, 2003.
2.	Benson Hamlin, Flight Testing- Conventional and Jet Propelled Airplanes, Mac Millan,1946.
	Reference Books:
1.	Ajoy Kumar Kunda, "Aircraft Design", Cambridge University Press, UK, 2010
2.	A. Filippone, Flight Performance of Fixed and Rotary Wing Aircraft, AIAA Series, 2006.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://archive.nptel.ac.in/courses/101/105/101105083/ Lectures by Pro.Manoranjan Sinha, of IIT Kharagpur.

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Describe** the FAA and DGCA Regulations of Flight Testing.	Un	1	1,2
2.	**Estimate** the performance of flight by using Flight testing methods.	AP	1,2,3	1,2
3.	**Analyze** the design performance parameters of an aircraft for a given application.	An	1,2,3	1,2

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25= 50	5* 4 marks = 20	10+10 =20	10	100
OBA- Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass:** Score should be > 35&, however overall score of CIE + SEE should be > 40%
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping(Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	√												√	√	
2	√	√	√										√	√	
3	√	√	√										√	√	
Please Tick at appropriate place															

Sl. No.	**Skill & Competence enhanced after undergoing the course**	**Applicable sectors & domains**	**Job roles students can take up after undergoing the course**
1	**Knowledge about Aircraft Design.**	**Aircraft Sector**	**Mass properties Engineer**
2	**Design and Stability analysis of Flight Vehicles.**	**Fixed Wing UAV sector**	**UAV Design Engineer**

Name & Sign of faculty members involved in designing the syllabus	**Name & Sign of faculty members verifying/approving the syllabus**
Prof. Anil Kumar Nakkala	**Prof. I V Patil**

Helicopter dynamics

Course Code	21AE7212	**Course type**	**PEC**	**Credits L-T-P**	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	Comprehend the basic concepts of helicopter dynamics.
2.	Acquire the knowledge of critical speed and rotor bearing system.
3.	Understand the turbo rotor system and blade vibration. List the performance parameter of helicopter.
4.	Comprehend the basic concepts of helicopter dynamics.

Pre-requisites : Fluid Mechanics and Aerodynamics

Unit – I: Introduction	**Contact Hours = 8 Hours**
History of helicopter flight. Fundamentals of Rotor Aerodynamics; Momentum theory analysis in hovering flight. Disc loading, power loading, thrust and power coefficients. Figure of merit, rotor solidity and blade loading coefficient. Blade Element Analysis: Blade element analysis in hovering and forward flight. Rotating blade motion. Types of rotors. Concept of blade flapping, lagging and coning angle. **Self-learning topics**: lagging and coning angle	

Unit – II: Rotor Airfoil Aerodynamics	**Contact Hours = 8 Hours**
Rotor airfoil requirements, effects of Reynolds number and Mach number. Airfoil shape definition, Airfoil pressure distribution. Pitching moment. Maximum lift and stall characteristics, high angle of attack range.	

Unit – III : Rotor Wakes and Blade Tip Vortices	**Contact Hours = 8 Hours**
Characteristics of rotor wake in hover, and forward flight. Other characteristics of rotor wake. Flow visualization techniques of Rotor Wakes and Blade Tip Vortices.	

Unit – IV : Basic Helicopter Performance	**Contact Hours = 8 Hours**

Forces acting on helicopters in forward flight. Methods of achieving translatory flight. Controlling cyclic pitch: Swash-plate system. Lateral tilt wit and without conning. Lateral and longitudinal asymmetry of lift in forward flight.

Unit – V : Helicopter Stability and Control	**Contact Hours = 8 Hours**
Forward speed disturbance, vertical speed disturbance, pitching angular velocity disturbance, side-slip disturbance, yawing disturbance. Static stability of helicopters: longitudinal, lateral directional and directional. **Self-learning topics**: Dynamic stability aspects. Main rotor and tail rotor control	

Flipped Classroom Details

Unit No.	**I**	**II**	**III**	**IV**	**V**
No. for Flipped Classroom Sessions	**2**	**2**	**2**	**2**	**2**

Books	
	Text Books:
1.	J. Gordon Leishman, Principles of Helicopter Aerodynamics, Cambridge University Press; 2nd edition (15 December 2016), ISBN-13: 978-1107013353.
2.	George H. Saunders, Dynamics of Helicopter Flight, John Wiley & Sons (1 January 1975), ISBN-13: 978-0471755098.
	Reference Books:
1.	W Z Stepniewski and C N Keys, Rotary Wing Aerodynamics, Dover Publications, Inc, New York, 1984.
2.	ARS Bramwell, George Done, and David Balmford, Helicopter Dynamics, 2nd Edition, Butterworth-Heinemann Publication, 2001
3.	John, M. Seddon and Simon Newman, Basic Helicopter Aerodynamics, Wiley, 2011.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	Online Resources: Lecture by: Prof. C Venkatesan, IIT Kanpur https://nptel.ac.in/courses/101104017/

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Explain** the basic concepts of helicopter	**Ap**	1	1,2
2.	**Analyze** the aerodynamics of Rotor Airfoil	**An**	1	1,2
3.	**Interpret** the **Flow visualization of** blade tip vortices	**Ap**	1	1,2
4.	**Summarizing** the performance of helicopter	**Ap**	1	1,2
5.	**Infer** the helicopter stability and control	**An**	1	1,2

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓												✓	✓	
2	✓												✓	✓	
3	✓												✓	✓	
4	✓												✓	✓	
Tick mark the CO, PO and PSO mapping															

Sl No	Skill & competence enhanced after undergoing the course	Applicable Industry Sectors & domains	Job roles students can take up after undergoing the course
1	Design and development of Helicopter	Helicopter Overhaul division	Aerodynamics Design Engineer
2		Helicopter and Drones Industry	MRO Engineer in Helicopter sector

Name & Sign of faculty members involved in designing the syllabus	Name & Sign of faculty members verifying/approving the syllabus
Prof. D A Ponnaswami	Prof. A K Nakkala

Composite Materials Structures

Course Code	21AE7214	Course type	PEC	Credits L-T-P	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	To understand the basics of composite materials
2.	Equip students with knowledge on composite strengthening addition of components and their production routes.
3.	Familiarize students about the properties and responses of composite structures subjected to mechanical loading

Pre-requisites: Mechanics of Materials, Matrix Algebra

Unit – I	Contact Hours = 8 Hours
Introduction to Aircraft materials, their properties and selection criteria. Adhesives and sealants – their applications in aircraft. Composite Materials: Definition and comparison of composites with conventional materials, Properties of composites in comparison with standard materials. Classification of composite materials. Overview of the application of composites in aerospace engineering. Manufacture of laminated reinforced composite materials; layup and curing.	

Unit – II	Contact Hours = 8 Hours
Types of reinforcements and matrices. Metal, ceramic and polymer matrix composite fibers. Whiskers and particulates, Nano-fillers used in polymer composites. Commonly used Matrices (Metal matrix, Polymer matrix, Ceramic matrix, Inter-metallic matrix, Carbon-Carbon composites), Basic Requirements in the selection of constituents. Mechanical Properties -Stiffness and Strength: Geometrical aspects – volume and weight fraction. Unidirectional continuous fibre, discontinuous fibers, Short fiber systems, woven reinforcement.	

Unit – III	Contact Hours = 8 Hours
Macromechanical behavior of lamina. Stress relation for anisotropic materials, Engineering constants for anisotropic, orthotropic and isotropic materials. Restriction of engineering constants. Stress-strain relation for orthotropic materials in plane stress condition. Micromechanical behaviour of lamina: Introduction to finding out the stiffness.	

Unit – IV	Contact Hours = 8 Hours
Laminates: Plate Stiffness and Compliance, Assumptions, Types of Laminates -, Symmetric Laminates, Anti-symmetric Laminate, Balanced Laminate, Quasi-isotropic Laminates, Cross-ply Laminate, Angle-ply Laminate. Orthotropic Laminate. Classical lamination theory.	

Unit – V	Contact Hours = 8 Hours
Defects in composite structures. Strength criterion for orthotropic laminates. Maximum stress failure criterion, maximum strain failure criterion, Tsai Hill failure criterion, Hoffman failure criterion, Tsai-wu tensor failure criterion. Recent developments in composites.	

Flipped Classroom Details

Unit No.	**I**	**II**	**III**	**IV**	**V**
No. for Flipped Classroom Sessions	**2**	**2**	**2**	**2**	**2**

Books	
	Text Books:
1.	Robert M Jones, Mechanics of Composite Materials, 2nd Ed., 1998, Taylor and Francis
2.	Krishnan K Chawla, Composite Materials, 3rd Ed., 2012, Springer
3.	S C Sharma, Composite Materials, 2000, Narosa Publishing House
	Reference Books:
1.	C G Krishnadas Nair, Handbook of Aircraft materials, 1993, Interline publishers
2.	Horst Buhl, Advanced Aerospace Materials, 2012, Springer.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	Prof. Nachiketa Tiwari-IIT Kanpur, Introduction to composites, NPTEL https://nptel.ac.in/courses/112104229
2.	Prof. R. Velumurgan-IIT Madras, Composite Materials, NPTEL https://nptel.ac.in/courses/101106038

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Select materials for aerospace vehicles	UN	1, 2, 3	1
2.	Identify critical properties and applications of PMCs, MMCs and Carbon-Carbon composites used in aerospace vehicles	AP	1, 2	1
3.	Analyze the macromehancial behaviour of composite materials	AN	1, 2	1
4.	Predict the failure of composite materials	EV	1, 2, 3,8,9,10	1, 2

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	√	√	√										√		
2	√	√											√		
3	√	√											√		
4	√	√	√					√	√	√			√	√	
5															
Tick mark the CO, PO and PSO mapping															

Sl. No.	**Skill & Competence enhanced after undergoing the course**	**Applicable sectors & domains**	**Job roles students can take up after undergoing the course**
1	**Knowledge on application composites in various fields of engineering**	**Mechanical sciences**	**Stress Analyst** **Stress Engineer** **Design Engineer**

Name & Sign of faculty members involved in designing the syllabus	**Name & Sign of faculty members verifying/approving the syllabus**
Dr. L. Chikmath	**Dr. K. V. Kulkarni**

Guidance navigation and control

Course Code	21 AE 7215	**Course type**	PEC	**Credits L-T-P**	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	Understand the basic principles of aircraft guidance systems and their role in flight control.
2.	Gain knowledge of global navigation satellite systems (GNSS) and their integration with other navigation systems.
3.	Explore the functionalities of flight management systems (FMS) and their integration with avionics systems.
4.	Familiarize yourself with advanced guidance systems and emerging trends in aircraft navigation.
5.	Develop proficiency in aviation navigation techniques, including VFR and IFR navigation, utilizing aeronautical charts, navigation instruments, and flight planning procedures.

Pre-requisites:Elements of Aeronautics

Unit – I Introduction	**Contact Hours = 8 Hours**
Introduction to Guidance Systems: Overview of Guidance Systems in Aviation, Basic Principles of Aircraft Guidance, Role of Guidance Systems in Flight Control, Principles of Inertial Navigation, INS Components: Accelerometers, Gyroscopes, and Inertial Measurement Units, INS Error Sources and Error Compensation Techniques, Calibration and Alignment Procedures for INS, INS Integration with Other Navigation Systems	

Unit – II	**Contact Hours = 8 Hours**
Global Navigation Satellite Systems (GNSS): Introduction to GNSS: GPS, Galileo, GLONASS, etc.,GNSS Operation Principles and Signal Processing,GNSS Error Sources and Accuracy Considerations,Differential GNSS and Real-Time Kinematic Techniques,Integration of GNSS with other Navigation Systems Flight Management Systems (FMS): FMS Overview and Components, Flight Planning and Route Optimization, Performance Management and Aircraft Systems Integration, Automatic Flight Guidance and Control, FMS Integration with Avionics Systems	

Unit – III	**Contact Hours = 8 Hours**

Advanced Guidance Systems and Future Trends: Enhanced Vision Systems (EVS) and Synthetic Vision Systems (SVS), Automatic Dependent Surveillance-Broadcast (ADS-B), Terrain Awareness and Warning Systems (TAWS), Introduction to Unmanned Aerial Systems (UAS), Emerging Trends and Future Developments in Aircraft Guidance Systems

Unit – IV	**Contact Hours = 8 Hours**
Introduction to Aviation Navigation:Introduction to Aircraft Navigation,Navigation Terminology and Concepts,Aeronautical Charts and Publications,Navigation Instruments and Equipment,Basic Navigation Techniques and Procedures VFR Navigation:Visual Flight Rules (VFR) Navigation Basics,Pilotage and Dead Reckoning Techniques,Understanding Sectional Charts and Navigation Logs,Using Pilot Navigation Tools and Instruments,VFR Navigation Flight Planning and Execution	

Unit – V	**Contact Hours = 8 Hours**
IFR Navigation:Instrument Flight Rules (IFR) Navigation Fundamentals,Understanding Instrument Approach Charts,Radio Navigation Aids: VOR, NDB, DME, and GPS,RNAV and RNP Navigation Concepts,IFR Flight Planning and Execution	

Flipped Classroom Details

Unit No.	**I**	**II**	**III**	**IV**	**V**
No. for Flipped Classroom Sessions	**2**	**2**	**2**	**2**	**2**

Books	
	Text Books:
1.	Thomas R. Yechout, Steven L. Morris, and David E. Bossert"Introduction to Aircraft Flight Mechanics: Performance, Static Stability, Dynamic Stability, and Classical Feedback Control" # 2003 by the American Institute of Aeronautics and Astronautics
2.	Paul D. Groves"Principles of GNSS, Inertial, and Multisensor Integrated Navigation Systems" 31 March 2013
3.	"Aviation Weather Services: AC 00-45H" by Federal Aviation Administration (FAA)
4.	"Visual Flight Rules (VFR) Flight Handbook" by Federal Aviation Administration (FAA)
5.	"Instrument Flying Handbook: FAA-H-8083-15B" by Federal Aviation Administration (FAA)
	Reference Books:
1.	Myron Kayton and Walter R Fried, 'Avionics Navigation Systems', John Wiley & Sons Inc., Second Edition, 1997.
2.	Manuel Fernadez and George R. Macomber, 'Inertial Guidance Engineering', Prentice-Hall, Inc., Engle Wood Cliffs, New Jersey, 1962
3	M .I. Skolnik: Introduction to Radar Systems, Tata McGraw-Hill, 2007

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs) At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)				
Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	Explain the principles and significance of guidance systems in aviation, including the basic principles of aircraft guidance, role of guidance systems in flight control, and integration of inertial navigation systems (INS) with other navigation systems.	UN	1,12	1,2,3
2.	Apply knowledge of global navigation satellite systems (GNSS), including GPS, Galileo, and GLONASS, to understand their operation principles, signal processing, and integration with other navigation systems.	AP	1,12	1,2,3
3.	Demonstrate proficiency in aviation navigation, including understanding navigation terminology, utilizing aeronautical charts and publications, operating navigation instruments and equipment, and implementing basic navigation techniques and procedures.	EV	1,12	1,2,3

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25 = 50	5* 4 marks = 20	10+10 =20	10	100
OBA- Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass:** Score should be > 35 &, however overall score of CIE + SEE should be > 40%

3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													CO-PSO Mapping (Planned)		
CO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2	PSO 3
1	√											√	√	√	√
2	√											√	√	√	√
3	√											√	√	√	√
4	√											√	√	√	√
5	√											√	√	√	√
Please Tick at appropriate place															

Sl. No.	Skill & Competence enhanced after undergoing the course	Applicable sectors & domains	Job roles students can take up after undergoing the course
1	Problem Solving and Decision Making	Commercial Aviation	Aircraft Systems Engineer
2	Integration and Integration Management	Aerospace Engineering	Flight Operations Officer
3	Emerging Trends and Future Developments	Aviation Technology and Innovation	Avionics Engineer
4		Air Traffic Management	Air Traffic Controller
		Unmanned Aerial Systems (UAS)	Unmanned Aircraft Systems (UAS) Operator
		Aviation Safety and Regulation	Aviation Safety Inspector
			Navigation Specialist

Name & Sign of faculty members involved in designing the syllabus	Name & Sign of faculty members verifying/approving the syllabus
Prof. P S Joshi	PURSHOTHAM .P.KATTI

Flight Control Engineering

Course Code	21AE7216	**Course type**	**PEC**	**Credits L-T-P**	3 – 0- 0
Hours/week: L-T-P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs;P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	Understand the different types of control systems and analyze the effect of feedback in improving system performance and stability.
2.	Derive and solve differential equations representing physical systems and establish their dynamic behavior.
3.	Apply block diagrams and signal flow graphs to represent control systems and determine their transfer functions and signal flow paths.
4.	Analyze the stability of control systems using stability concepts and criteria, such as the Routh stability criterion and relative stability analysis.
5.	Understand the different types of control systems and analyze the effect of feedback in improving system performance and stability.

Pre-requisites :

Unit – I	**Contact Hours = 8 Hours**
Introduction to Control Systems: Types of Control Systems, Effect of Feedback Systems, Differential equation of Physical Systems – Mechanical Systems, Electrical Systems, Analogous Systems. Block diagrams and signal flow graphs: Transfer functions, Block diagram algebra and Signal Flow graphs.	

Unit – II	**Contact Hours = 8 Hours**
Time Response of feedback control systems: Standard test signals, Unit step response of First and Second order Systems. Time response specifications, Time response specifications of second order systems, steady state errors and error constants. Introduction to PI, PD and PID Controllers (excluding design).	

Unit – III	**Contact Hours = 8 Hours**
Stability analysis: Concepts of stability, Necessary conditions for Stability, Routh stability criterion, and Relative stability analysis: more on the Routh stability criterion, Introduction to Root-Locus Techniques, The root locus concepts, Construction of root loci.	

Unit – IV	Contact Hours = 8 Hours
Correlation between time and frequency response, Bode Plots, Experimental determination of transfer function. Introduction to Polar Plots, (Inverse Polar Plots excluded) Mathematical preliminaries, Nyquist Stability criterion, (Systems with transportation lag excluded) Introduction to lead, lag and lead-lag compensating networks (excluding design).	

Unit –V	Contact Hours = 8 Hours
Introduction to Digital Control System: Introduction, Spectrum Analysis of Sampling process, Signal reconstruction, Difference equations. Introduction to State variable analysis: Introduction, Concept of State, State variables & State model, State model for Linear Continuous & Discrete time systems, Diaganolisation.	

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	J.Nagarath and M.Gopal, " Control Systems Engineering", New Age International (P) Limited, Publishers, Fifth edition-2005, ISBN: 81-224-2008-7
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://archive.nptel.ac.in/courses/108/106/108106098/

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

	Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create	**Learning Level**	**PO(s)**	**PSO(s)**
1.	Apply the principles of control systems to analyze and design solutions for various engineering problems.	AP	1,2,3	1

2.	Evaluate the performance and stability of control systems using time and frequency domain analysis techniques.	EV	1,2,3	1
3.	Design and implement basic control strategies, such as PI, PD, and PID controllers, to achieve desired system behavior.	AP	1,2,3	1
4.	Understand the concept of state variable analysis and develop state models for linear continuous and discrete-time systems.	AP	1,2,3	1

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total Marks
Marks	25+25= 50	4* 5 marks = 20	10+10 =20	10	100
OBA- Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

Rubrics:Levels	**Target**
1(Low)	**60% of the students score Less than 50 % of the total marks.**
2(Medium)	**60% of the students score 50 – 70 % of the total marks.**
3(High)	**60% of the students score More than 70 % of the total marks.**

Sl No	**Skill & competence enhanced after undergoing the course**	**Applicable Industry Sectors & domains**	**Job roles students can take up after undergoing the course**
1	Flight Dynamics and Control	Aerospace Manufacturing	Flight Control Engineer
2	Control System Design	Aircraft Maintenance and Repair	Systems Engineer
3	System Identification	Research and Development	Flight Test Engineer
4	Aircraft Stability and Control Analysis	Aerospace Systems Integration	Aerospace Researcher
5	Flight Control Algorithms	Flight Test and Evaluation	Avionics Engineer
6	Autopilot Systems	Defense and Military Aviation	Flight Dynamics Engineer

7	Fault Detection and Diagnosis:	Space Exploration	Autonomous Systems Engineer

CO-PO Mapping (Planned)													**CO-PSO Mapping(Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO1**	**PSO 2**	**PSO 3**
1	**√**	**√**	**√**										**√**		
2	**√**	**√**	**√**										**√**		
3	**√**	**√**	**√**										**√**		
4	**√**	**√**	**√**										**√**		
Tick mark the CO, PO and PSO mapping															

Name & Sign of faculty members involved in designing the syllabus	**Name & Sign of faculty members verifying/approving the syllabus**
Prof. P P Katti	**Prof. A K Nakkala**

Aircraft Communication systems

Course Code	21AE7311	Course type	OEC	Credits L-T-P	3 – 0- 0
Hours/week: L-T-P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs;P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	Understand the fundamentals of the radio frequency spectrum, electromagnetic waves, frequency, and wavelength.
2.	Explain the principles of radio wave propagation in the atmosphere, including the effects of the ionosphere and space weather.
3.	Familiarize with satellite communications (SATCOM) and its application in aircraft communication systems.
4.	Gain an understanding of communication systems and equipment used in aviation, such as CPDLC, ADS-B, flight-deck audio systems, and weather radar

Pre-requisites :

Unit – I	Contact Hours = 8 Hours
Introduction: The radio frequency spectrum, Electromagnetic waves, Frequency and wavelength, The atmosphere, Radio wave propagation, The ionosphere, MUF and LUF, Silent zone and skip distance, Space weather, Satellite communications (SATCOM), Communication systems integration and management	

Unit – II	Contact Hours = 8 Hours
The isotropic radiator, The half-wave dipole, Impedance and radiation resistance, Radiated power and efficiency, Antenna gain, The Yagi beam antenna, Directional characteristics, Other practical antennas, Feeders, Connectors, Standing wave ratio, Waveguide	

Unit – III	Contact Hours = 8 Hours
Transmitters and receivers: A simple radio system, Modulation and demodulation, AM transmitters, FM transmitters, Tuned radio frequency receivers, Superhet receivers, Selectivity, Image channel rejection, Automatic gain control, Double superhet receivers, Digital frequency synthesis, A design example	

Unit – IV	Contact Hours = 8 Hours

VHF communications: VHF range and propagation, DSB modulation, Channel spacing, Depth of modulation, Compression, Squelch, Data modes, ACARS, VHF radio equipment, **HF communications**: HF range and propagation, SSB modulation, SSB modulation, SELCAL, HF datalink, HF radio equipment, HF antennas and coupling units

Unit –V	**Contact Hours = 8 Hours**
CPDLC - Controller-Pilot Data Link Communication, ADS-B - Automatic Dependent Surveillance-Broadcast,Flight-deck audio systems,Emergency locator transmitters, Distance measuring equipment, Instrument landing system, Microwave landing system, Weather radar, surveillance radar	

Flipped Classroom Details

Unit No.	**I**	**II**	**III**	**IV**	**V**
No. for Flipped Classroom Sessions	**2**	**2**	**2**	**2**	**2**

Books	
	Text Books:
1.	**Mike** Tooley And **David Wyatt,Aircraft Communications And Navigation Systems** Second Edition Published 2018 By Routledge
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://archive.nptel.ac.in/courses/101/108/101108056/

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		**Learning Level**	**PO(s)**	**PSO(s)**
1.	**Explain the fundamental concepts of the radio frequency spectrum, electromagnetic waves, and the frequency/wavelength relationship.**	UN	1	1

2.	**Analyze the principles of radio wave propagation in the atmosphere, including the effects of the ionosphere and space weather.**	EV	1,2	1
3.	**Explain the principles and applications of satellite communications (SATCOM) in aircraft communication systems.**	AP	1,3	1

Scheme of Continuous Internal Evaluation (CIE):

Components	Addition of two IA tests	Online Quiz	Addition of two OAs/ Course project	Course Seminar	Total Marks
Marks	25+25= 50	4* 5 marks = 20	10+10 =20	10	100
OBA- Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration.
2.	**Minimum marks required in SEE to pass:** Score should be $\geq$ 35%, however overall score of CIE + SEE should be $\geq$ 40%.
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping(Planned)**		
CO	**PO1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO1 0**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	**√**												**√**		
2	**√**	**√**											**√**		
3	**√**		**√**										**√**		
Tick mark the CO, PO and PSO mapping															

Sl No	**Skill & competence enhanced after undergoing the course**	**Applicable Industry Sectors & domains**	**Job roles students can take up after undergoing the course**
1	Knowledge of Radio Frequency Communication	Aviation Industry	Avionics Engineer
2	Understanding of Radio Wave Propagation	Aerospace Engineering	Communication Systems Engineer
3	Proficiency in Satellite Communications	Defense and Military.	Systems Integration Engineer
4	Antenna Design and Analysis	Communications and Telecommunications	Flight Operations Engineer

5	Transmitter and Receiver Operation	Research and Development	Air Traffic Control Specialist
6	Familiarity with Communication Systems and Equipment	Consulting and Engineering Services	Technical Support Engineer
7	Knowledge of Navigation and Landing Systems	Government and Regulatory Bodies	Research and Development Engineer
8	Problem-solving and System Design	Air Traffic Control	Aircraft Maintenance Engineer

Name & Sign of faculty members involved in designing the syllabus	**Name & Sign of faculty members verifying/approving the syllabus**
Prof. P P Katti	**Prof. P S Joshi**

Airport Operations

Course Code	21AE7312	Course type	OEC	Credits L-T-P	3 – 0 - 0
Hours/week: L - T- P	3 – 0 – 0			Total credits	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs; P = 0 Hrs Total = 40 Hrs			CIE Marks	100
Flipped Classes content	10 Hours			SEE Marks	100

Course learning objectives	
1.	Understand the airport and its operations
2.	Acquire the knowledge of Ground Handling and Baggage Handling
3.	Understand the various Operations and Technical Services
4.	Acquire the knowledge of Operational Administration and Performance

Pre-requisites :

Unit – I (Airport Operational System)	Contact Hours = 8 Hours
Elements of airport master planning, Managing the environment, The future of airports, Airport as an operational system, Airport emergencies, Airport security, Safety management system for airports, Extreme weather operations, collaborative airport decision making	

Unit – II (Airport and Ground Operations)	Contact Hours = 8 Hours
Collaborative Decision Making(CDM) to develop efficient airport and ground operations processes, Key issues associated with A-CDM, Building trust with airport partners, A-CDM business case, Identifying the processes involved, Trajectory based operations on the airside, landside and even in the terminal, Defining the business services and business rules, Developing an effective A-CDM implementation project, The foundations of even more advanced A-CDM concept applications	

Unit – III (Emergency Planning and Response for Airports)	Contact Hours = 8 Hours
Regulatory requirements, Basics of aviation emergency management, Roles and responsibilities of Airports and GSP, Emergency response leadership skills, Tasks – actions – workplaces, Notification – alarm – alarm plans, Special assistance team / humanitarian response, Communication during crisis, The 'Toolbox' of responsible staff, Drafting a plan, Training and exercises, Business continuity, Transportation of Dangerous Goods	

Unit – IV (Aviation Security Operations)	Contact Hours = 8 Hours
Aviation security background and current threats, International legislative aspects of aviation security, Introduction to risk management, Threat analysis and quality control, Aircraft, airport and cargo security, Risk assessment and contingency planning, Emerging technologies and techniques, Command and control of response to major incidents, Air mail security, Improvised Explosive Devices (IEDs) and concealed weapons recognition, IOSA security standards and compliance	

Unit – V (Operational Administration and Performance)	Contact Hours = 8 Hours

Strategic context; Tactical approach to administration of airport operations; Managing operational performance, Key success factors for high Performance; Airport operations control centers: airport operations control system; The airport operations consideration; Airport performance monitoring, human resources considerations.

Flipped Classroom Details

Unit No.	I	II	III	IV	V
No. for Flipped Classroom Sessions	2	2	2	2	2

Books	
	Text Books:
1.	Norman J. Ashford, H. P. Martin Stanton, Clifton A. Moore, Pierre Coutu, —Airport Operations‖,McGraw Hill, 3rd Edition, 2013.
2.	R. Horonjeff, F. X. McKelvey, W. J. Sproule, S. B. Young, —Planning and Design of Airports‖,McGraw Hill, 5th Edition, 2010.
	Reference Books:
1.	A. Kazda, R. E. Caves, —Airport Design and Operation‖, Elsevier, 2nd Edition, 2007.
2.	A. T. Wells, S. B. Young, —Airport Planning and Management‖, McGraw Hill, 6th Edition, 2011.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	
2.	

Course delivery methods		Assessment methods	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		Learning Level	PO(s)	PSO(s)
1.	**Acquire** the knowledge of the Airport Operations	3	1,2,3	1,2,3
2.	**Understand** the various Handling techniques in airport	3	1,2,3	1,2,3
3.	**Recognize** the need Technical Services in airport**.**	2	1,2,3	1,2,3
4.	**Acquire** the knowledge Operational Administration	3	1,2,3	1,2,3
5.				

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25 = 50	4* 5 marks = 20	10+10 =20	10	100
OBA - Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass:** Score should be > 35 &, however overall score of CIE + SEE should be > 40%
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping (Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO 10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	✓	✓											✓	✓	✓
2	✓	✓											✓	✓	✓
3	✓	✓											✓	✓	✓
4	✓	✓											✓	✓	✓
Please Tick at appropriate place															

Sl. No.	**Skill & Competence enhanced after undergoing the course**	**Applicable sectors & domains**	**Job roles students can take up after undergoing the course**
1	**Acquire the knowledge in the drones, piloting and maintenance**	**Aerospace, Agriculture Mining Construction Data Analytics**	**Drone pilot, Drone Technician UAV System Engineer Lead UAV Test Engineer Drone Instructor**

Name & Sign of faculty members involved in designing the syllabus	**Name & Sign of faculty members verifying/approving the syllabus**
Prof. I V Patil	**Prof. P M Banakar**

Unmanned Aerial Vehicles

Course Code	21AE7313	**Course type**	OEC	**Credits L-T-P**	3 – 0- 0
Hours/week: L-T-P	3 – 0 – 0			**Total credits**	3
Total Contact Hours	L = 40 Hrs; T = 0 Hrs;P = 0 Hrs Total = 40 Hrs			**CIE Marks**	100
Flipped Classes content	10 Hours			**SEE Marks**	100

Course learning objectives	
1.	Comprehend the detailed overview of Fixed Wing UAV design.
2.	Impart the knowledge of Aerodynamic and control design of UAVs.
3.	Impart the knowledge of stability control of UAV by different approaches.
4.	Understand the Payload and communication system design.

Pre-requisites: Aircraft Performance, Aircraft Stability and control, Flight Vehicle Design

Unit – I Introduction	**Contact Hours = 8 Hours**
Introduction, UAV Classifications, Review of a Few Successful UAVs ,Design Project Planning Decision Making ,Design Criteria, Objectives, and Priorities ,Feasibility Analysis ,Design Groups , Design Process Systems Engineering Approach , UAV Conceptual Design ,UAV Preliminary Design , UAV Detail Design Design Review, Evaluation, Feedback ,UAV Design Steps. **Flipped Class content:** Onboard and ground based data acquisition system.	

Unit – II Aerodynamic Design	**Contact Hours = 8 Hours**
Introduction, Fundamentals of Aerodynamics, Wing Design, Tail Design, Vertical Tail Design-Parameters, Vertical Tail Location, Vertical Tail Moment Arm, Planform Area Incidence, Other Vertical Tail Parameters, Vertical Tail Design Technique, and Fuselage Design. **Flipped Class content**: Aerodynamic Design of Quadcopters	

Unit – III Dynamic Modeling	**Contact Hours = 8 Hours**
Modeling Technique, Fundamental Model, Transfer Function, State-Space Representation, Aerodynamic Forces and Moments, Simplification Techniques of Dynamic Models, Fixed-Wing UAV Dynamic Models and Dynamic Model Approximation. **Flipped Class content**: Quadcopter (Rotary-Wing) Dynamic Model.	

Unit – IV Control System Design	**Contact Hours = 8 Hours**

Fundamentals of Control Systems, Flight Control Requirements, and Control Modes. Controller Design- PID Controller, Optimal Control – LQR, Gain Scheduling Robust Control Digital Control. **Flipped Class content**: Autonomy.

Unit –V Guidance and Navigation System Design:	**Contact Hours = 8 Hours**
Fundamentals, Guidance Laws, Command Guidance Law, PN Guidance Law Pursuit Guidance Law Waypoint Guidance Law, Sense and Avoid. Inertial Navigation System, Kalman Filtering, Position Fixing Navigation, Navigation in Reduced Visibility Conditions, Navigation Disturbances and Navigation System Design. **Flipped Class content**: GPS, Inertial Navigation Sensors.	

Flipped Classroom Details

Unit No.	**I**	**II**	**III**	**IV**	**V**
No. for Flipped Classroom Sessions	**2**	**2**	**2**	**2**	**2**

Books	
	Text Books:
1.	Mohammad H Sadraey, Design of Unmanned Aerial systems, Wiley, 2020.
2.	Reg Austin, "Unmanned Air Systems: UAV Design, Development and Deployment", First Edition,Wiley Publishers, 2015.
	Reference Books:
1.	Mirosaw Adamski, "Power units and power supply systems in UAV", New Edition, Taylor and Francis Group publishers, 2014.
2.	Skafidas, "Microcontroller Systems for a UAV", KTH, TRITA-FYS 2002:51 ISSN 0280-316X. 34, 2002.
	E-resourses (NPTEL/SWAYAM.. Any Other)- mention links
1.	https://archive.nptel.ac.in/courses/101/105/101105083/ Lectures by Pro.Manoranjan Sinha, of IIT Kharagpur.

Course delivery methods		**Assessment methods**	
1.	Chalk and Talk	1.	IA tests
2.	PPT and Videos	2.	Online Quizzes (Surprise and Scheduled)
3.	Flipped Classes	3.	Open Book Tests (OBT)
4.	Online classes	4.	Course Seminar
		5.	Semester End Examination

Course Outcome (COs)

At the end of the course, the student will be able to (Highlight the **action verb** representing the learning level.)

Learning Levels: Re - Remember; Un - Understand; Ap - Apply; An - Analysis; Ev - Evaluate; Cr - Create		Learning Level	PO(s)	PSO(s)
1.	**Describe** the Design process, Control Navigation and Guidance systems in UAVs.	Un	1	1,2
2.	**Solve** 6DOF Equation of motion and **Design** the Uav components.	AP	1,2,3	1,2
3.	**Analyze** the design performance parameters of Controller and guidance systems of UAV.	An	1,2,3,5	1,2

Scheme of Continuous Internal Evaluation (CIE): Theory course

Components	Addition of two IA tests	Online Quiz	Addition of two OBAs	Course Seminar	Total Marks
Marks	25+25= 50	5* 4 marks = 20	10+10 =20	10	100
OBA- Open Book Assignment **Minimum score to be eligible for SEE: 40 OUT OF 100**					

Scheme of Semester End Examination (SEE):	
1.	It will be conducted for 100 marks of 3 hours duration. It will be reduced to 50 marks for the calculation of SGPA and CGPA.
2.	**Minimum marks required in SEE to pass:** Score should be > 35&, however overall score of CIE + SEE should be > 40%
3.	Question paper contains 3 parts - A,B & C, wherein students have to answer any 5 out of 7 questions in part A, 5 out of 10 questions choosing 1 question from each unit in part B & 1 out of 2 questions in part C.

CO-PO Mapping (Planned)													**CO-PSO Mapping(Planned)**		
CO	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PO 7**	**PO 8**	**PO 9**	**PO10**	**PO 11**	**PO 12**	**PSO 1**	**PSO 2**	**PSO 3**
1	√	√											√		
2	√	√	√										√	√	
3	√	√	√		√								√	√	
Please Tick at appropriate place															

Sl. No.	**Skill & Competence enhanced after undergoing the course**	**Applicable sectors & domains**	**Job roles students can take up after undergoing the course**
1	**Knowledge about UAV Systems Design.**	**UAV Sector**	**UAV Design Engineer,**

2	**Design and Analysis of Control systems for Flight vehicles**	**UAV, Aircraft and Space sector**	**Control system Engineer**

Name & Sign of faculty members involved in designing the syllabus	Name & Sign of faculty members verifying/approving the syllabus
Prof. Anil Kumar Nakkala	**Prof. D A Ponnaswami**