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THE DEGREE OF BACHELOR OF ENGINEERING / TECHNOLOGY

OB 1 TITLE AND DURATION OF THE COURSE

OB 1.1 The course shall be called the degree course in Bachelor of Engineering / Technology Course, abbreviated as B.E. / B.Tech.

OB 1.2 The course shall be of four academic years duration divided into eight semesters, each semester having duration of 16 weeks. For evening courses the contact hours are to be satisfied by working extra on afternoons of Saturdays and Sundays.

OB 1.3 The calendar of events in respect of the course shall be fixed by the University from time to time.

OB 1.4 The examination in all the subjects shall be conducted at the end of each semester for all the eight semesters.

OB 2 ELIGIBILITY FOR ADMISSION
(The Government orders issued from time to time in this regard shall prevail)

OB 2.1 Admission to I year / I semester Bachelor Degree in Engineering / Technology shall be open to the candidates who have passed the second year Pre-University or XII standard or equivalent examination recognized by the University.

OB 2.2 In addition to OB 2.1, the candidate shall have secured not less than forty five percent (45%) marks in the aggregate with Physics and Mathematics as compulsory subjects, along with any one of the following subjects, namely, Chemistry, Bio-Technology, Computer Science, Biology and Electronics.

Provided that, the minimum marks for the purpose of eligibility shall be forty percent (40%) in optional subjects in case of candidates belonging to SC/ST and OBC candidates from Karnataka.

Provided further that, the candidate shall have studied and passed English as one of the subjects.

(Refer Annexure 3)

OB 2.3 (a) Admission to II year/ III semester Bachelor Degree in Engineering/ Technology (Lateral Entry) shall be open to the candidates who are holders of a diploma or equivalent qualification as recognized by University who have secured not less than forty five percentage (45%) marks in the final year examination (fifth and sixth semesters) in the appropriate branch of engineering.

Provided that, in case of SC/ST and OBC candidates from Karnataka the minimum marks for eligibility shall be forty percent (40%).

Provided further that, all the candidates seeking lateral entry shall also clear prescribed bridge courses as specified by the University.

OB 2.3 (b) Admission to Evening Course shall be open to a candidate

i) Who on the first day of the term notified by the University for the year of admission has not less than one-year professional experience in the branch of engineering / technology, in which the candidate holds a diploma, after passing diploma course.

Explanation: Professional experience means employment on regular basis

a. in Government, Government undertaking, Public Sector undertaking, Corporations or

b. in a private company registered under the Directorate of Industries and Commerce or the Directorate of Small Scale Industries or

c. in Government, Government recognized institutions as technical staff.

Provided that the period of apprenticeship undergone shall also be treated as professional experience, if sponsored by the Board of Apprenticeship Training, Southern Region Chennai or by any Government, Government undertaking or Public Sector undertaking.

Provided further that employment shall be in an establishment situated within the urban agglomeration of city in which the professional institution is situated.

OB 2.4 Those candidates who have passed a qualifying examination other than the PUC II examination of the Pre-University Education Board of Karnataka, or Engineering Diploma Examinations of the Board of Technical Education of Karnataka, have to obtain eligibility certificate for seeking admission to B.E./B.Tech. Degree Course from Visvesvaraya Technological University, Belgaum or from the Principal of concerned Engineering College of Karnataka State.

OB 3 ATTENDANCE REQUIREMENT

OB 3.1 Each semester is considered as a unit and the candidate has to put in a minimum attendance of 85% in each subject with a provision of condonation of 10% of the attendance by the Vice-Chancellor on the specific recommendation of the Principal of the college where the candidate is studying, showing some reasonable cause such as medical grounds, participation in University level sports, cultural activities, seminars, workshops, paper presentation, etc.

OB 3.2 The basis for the calculation of the attendance shall be the number of periods prescribed by the University by its calendar of events. For the first semester students, the same shall be reckoned from the date of admission to the course as per CET allotment.

OB 3.3 The students shall be informed about their attendance position periodically by the colleges so that the students shall be cautioned to make up the shortage. The Principals of the affiliated Colleges shall submit the list of students who have been detained for shortage of attendance by the end of the semester to the Registrar (Evaluation) with a copy to the Registrar.

Provided that mere omission by the college to inform the student about the shortage of attendance shall not entitle him to appear for examination.

OB 3.4 A Candidate having shortage of attendance in one or more subjects shall have to repeat the whole semester and such candidates shall not be permitted to take admission to next higher semester.

Such students shall take readmission to the same semester in the subsequent academic year.

OB 3.5 **Temporary Discontinuation of course:**

A student, who wishes to temporarily discontinue the course and continue the same subsequently, has to obtain prior permission from the University by applying through the Principal. Such students have to take readmission to the same semester/year in the subsequent academic year. However, the candidate shall complete the course as per OB 6.2.

OB 4 **INTERNAL ASSESSMENT MARKS**

OB 4.1 There shall be a maximum of 25 Internal Assessment Marks in each theory or practical paper. For seminars, the Internal Assessment marks shall be 50.

OB 4.2 The Internal Assessment marks in a theory paper shall be based on two tests generally conducted at the end of 8 and 12 weeks of each semester. An additional test may be conducted for the desirous students before the end of the semester to give an opportunity to such students to improve their Internal Assessment Marks, subject to the provisions of OB 4.13. The test shall be answered in Blue Books with pages serially numbered. These blue books shall be kept in the custody of the Principal of the College until after one month from the date of announcement of the result by the University. These shall be made available to University authorities for verification as per the directions of the Registrar (Evaluation)/ Registrar.

OB 4.3 Average of the better marks obtained from any two tests shall be the Internal Assessment Marks for the relevant subject.

OB 4.4 If a candidate remains absent for all the Internal

Assessment tests conducted, the Internal Assessment Marks shall be marked as A for the subject against the University Seat Number (USN) of the candidate in the marks sheet submitted to the University by the Principal of the College.

OB 4.5 In the case of a Practical, the IA marks shall be based on the laboratory journals/reports and one practical test.

OB 4.6 i) The IA marks for I year Computer Aided Engineering / Drawing:

a) 15 marks for class work (sketching and Computer Aided engineering drawing).

b) 10 marks for test in the same pattern as that of the main examination (better of the two tests)

ii) The IA marks for other Drawings and Design Drawings offered by various branches shall be based on the evaluation of the sheets and one test in the ratio 60:40.

OB 4.7 The IA marks in the case of projects and seminars in the final year shall be based on the evaluation at the end of 8th semester by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the project / seminar guide.

OB 4.8 The final list, incorporating corrections (if any) of IA marks awarded to the students in the Theory/Practical/Project work/ Seminar, shall be displayed on the notice board of the college at least seven days before the closure of the semester and a certified copy of the same shall be sent by the Principals to the University Examination Section within the stipulated date. Every page of the IA marks sheet shall bear the signatures of the concerned Teacher/ Teachers, Head of the Department and Principal.

OB 4.9 Any corrections or over writing of IA marks shall bear the signature(s) of concerned Teacher(s) and in such cases the Head of the Department shall on every sheet indicate the number of corrections and attest it with his signature.

OB 4.10 (a) A candidate failing to secure a minimum of 50% of the IA marks (12/25) in practical, 50% of marks in project work shall not be eligible for the practical/project in the University examination.

OB 4.10 (b) For seminars, the minimum requirement of IA marks shall be 40% of the maximum.

OB 4.11 Such candidates as mentioned in OB 4.10 shall repeat the laboratory work/project work during the subsequent semester(s) and secure at least the minimum marks prescribed.

OB 4.12 For theory subjects, there shall not be any minimum requirements of IA marks.

OB 4.13 Improvement of IA marks shall not be allowed

a. In theory subjects and

b. in Laboratory/Workshop/Seminar where the candidate has already secured the minimum required marks.

OB 4.14 IA marks of those candidates to whom OB 4.11 is applicable, shall be sent separately to the Registrar (Evaluation).

OB 4.15 IA marks shall reach the University before the commencement of examination. After the submission of Internal Assessment marks to the University, any request for change of IA marks shall not be considered under any circumstances.

OB 5 ELIGIBILITY FOR PASSING

OB 5.1 (a) For a pass in a theory subject/drawing, the candidate shall secure minimum of 35% of the maximum marks prescribed in the University examination and 40% of marks in the aggregate inclusive of the IA marks.

OB 5.1 (b) For a pass in a Practical/Project/Viva-voce examination, a candidate shall secure a minimum of 40% of the maximum marks prescribed for the University Examination in the relevant Practical/Project/Viva-voce.

OB 5.1 (c) For a pass in Seminar, a candidate shall secure a minimum of 40% of the maximum marks prescribed.

OB 5.2 The candidates who do not satisfy the condition OB 5.1 shall be deemed to have failed in that subject and may reappear for the University examination in the subsequent examinations. However, the IA marks awarded to the candidate/s at first attempt in the concerned theory subject will be carried forward. In case of Practical/Projects/Seminar revised marks will be taken as per regulations OB 4.10 (a & b) and OB 4.11.

OB 5.3 The candidate who passes a subject of a semester as per OB 5.1 shall not be allowed to appear for the same again, unless he/she opts for rejection of results as per OB 5.4, 5.5, 5.6, 5.7 & 5.8.

OB 5.4 A candidate may at his desire reject his total performance of a semester (including IA marks) or he may reject the result of his performance in University examination of a semester only.

Provided that the rejection is permitted only once during the entire course of study.

OB 5.5 The candidate who desires to reject the performance as per OB 5.4 shall reject performance in all the subjects of the semester, irrespective of whether the candidate has passed or failed in any subject. However, the rejection of performance of 8th semester project results shall not be permitted.

OB 5.6 A candidate, who desires to reject the total performance of the semester including Internal Assessment, has to take readmission for the relevant semester. Application for such readmission shall be sent to the Registrar through the Principal of College within 30 days from the date of the announcement of the results. Late submission of application shall not be accepted for any reasons. Readmission to First semester in such cases shall not be considered as fresh admission i.e., the candidate will continue to have the same University Seat Number, which was allotted earlier.

OB 5.7 The candidate, who desires to reject only the results of University examination of a semester and does not desire readmission, shall be permitted to re-appear for examinations of all the subjects of the semester in the subsequent examinations. However, the IA marks obtained by the candidate in the rejected semester shall be retained. Applications for such rejection shall be sent to the Registrar (Evaluation) through the Principal of the College within 30 days from the date of announcement of the results. Late submission of applications shall not be accepted for any reasons.

If the rejection of the University examination results of the semester happens to be of an odd semester, the candidate shall be allowed to take admission to the immediate next even semester. However, if the rejection of the University result is of even semester, the candidate shall not be allowed to take admission to the next odd semester.

OB 5.8 Such candidates who opt for rejection at final year are eligible for the award of class and distinction at the B.E./ B.Tech., degree level, but are not eligible for the award of ranks.

OB 5.9 A candidate shall be declared to have completed the course of B.E./ B.Tech., degree, provided the candidate has undergone the stipulated course work in all eight semesters as per the regulations.

OB 6 MAXIMUM DURATION FOR COURSE COMPLETION

OB 6.1 A candidate who has not obtained the eligibility for third semester after a period of three academic years from the date of first admission shall discontinue the course. However, the candidate is eligible for readmission for first year B.E./B.Tech. in respective College of the University and he/ she shall be allotted a University Seat Number (USN) without any change in the year of admission in the USN but the serial number of the candidate shall start with six hundred (6XX) series in the same branch.

(Amended and approved in 52nd E.C. Res. No. 2.4)

OB 6.2 The candidate shall complete the course within a period of eight academic years from the date of first admission, failing which he/she has to discontinue the course.

Provided that the candidates admitted under lateral entry scheme shall complete the course within a period of six academic years from the date of first admission, failing which he/she has to discontinue the course.

(Amended and approved in 74th E.C. (12-8-2008) Res. No. 6.1)

OB 7 PROMOTION AND ELIGIBILITY FOR THE EXAMINATIONS

OB 7.1 There shall not be any restriction for promotion from an odd semester to the next even semester, provided the candidate has fulfilled the attendance requirement.

OB 7.2 A candidate shall be eligible for promotion from an even semester to the next odd semester (i.e. to the next academic year) if the candidate has not failed in more than four heads of passing of the immediately preceding two semesters and has passed in all the subjects of all the still lower semester examinations. A theory or practical shall be treated as a head of passing.

Illustrations

a. A candidate seeking eligibility to 3rd semester should not have failed in more than 4 heads of passing of first and second semesters taken together.
b. A candidate seeking eligibility to 5th semester should have passed in all the subjects of 1st and 2nd semesters and should not have failed in more than 4 heads of passing of third and fourth semesters taken together.
c. A candidate seeking eligibility to 7th semester should have passed in all the subjects up to 4th semester and should not have failed in more than 4 heads of passing of 5th and 6th semesters taken together.

OB 8 ELECTIVES

OB 8.1 A candidate shall take one elective in 6th semester from 'Group A', two electives in 7th semester (one each from

groups 'B' and 'C') and two electives in 8th semester (one each from Groups 'D' and 'E'). There shall be a minimum of three electives listed in every group.

OB 8.2 The minimum number of students to be registered for an Elective to be offered shall be not less than ten.

OB 8.3 A candidate shall exercise his option in respect of the electives and register for the same at the beginning of the concerned semester. The candidate may be permitted to opt for change of elective subject within 15 days from the date of commencement of the semester as per the calendar of the University.

OB 9 SEMINAR AND PROJECT

OB 9.1 Seminar topic shall be selected from the emerging technical areas only.

OB 9.2 Project work at 8th semester shall be completed batch wise, each batch consisting of a maximum of four candidates.

OB 9.3 *Viva-voce* examination in project work shall be conducted batch-wise.

OB 10 AWARD OF CLASS AT SEMESTER LEVEL

OB 10.1 For the award of First Class with Distinction in a semester, the candidate shall have secured not less than 70% marks in aggregate in the first attempt and shall have passed in all subjects in one or more attempts.

OB 10.2 For the award of First Class in a semester examination, the candidate shall have securing not less than 60% but less than 70% marks in aggregate in first attempt and shall have passed in all subjects in one or more attempts.

OB 10.3 A candidate, who secures in a semester less than 60% of marks in aggregate in first attempt and passes in all the subjects in one or more attempts, shall be declared to have passed the semester examination in Second Class.

OB 11 AWARD OF CLASS AT DEGREE LEVEL

OB 11.1 The Bachelor Degree in Engineering/Technology shall be awarded to the candidates who have passed all the stipulated examinations from 1st to 8th semesters. However, declaration of the class of the degree shall be based on the performance of the candidate in first attempt from 5th to 8th semester examinations taken together.

OB 11.2 A candidate who has passed in all subjects of 1st to 8th semester securing not less than 70% marks in the first attempt of 5th to 8th semesters taken together shall be declared to be eligible for the award of the B.E. / B.Tech. degree in first class with distinction.

OB 11.3 A candidate who has passed in all subjects of 1st to 8th semester securing not less than 60% but less than 70% of marks in aggregate in the first attempt in 5th to 8th semester examinations taken together shall be declared to be eligible for the award of the B.E./ B.Tech. degree in First Class.

OB 11.4 A candidate who has passed in all subjects of 1st to 8th semester securing less than 60% in aggregate in the first attempt in 5th to 8th semesters shall be declared to be eligible for the award of the B.E. / B.Tech. degree in Second Class.

OB 11.5 The marks secured by the candidate in a semester examination after rejecting the results shall also be taken as first attempt marks and shall be considered for the award of class of the Semester/ Degree but not for the award of rank.

OB 12 AWARD OF PRIZES, MEDALS & RANKS

OB 12.1 For the award of Prizes and Medals, the conditions stipulated by the Donor may be considered subject to the provisions of the statutes framed by the University for such awards.

OB 12.2 For award of ranks in a branch, a minimum of 10 candidates should have appeared in the 8th semester examination. The total number of ranks awarded shall be 10% of total number of candidates appeared in 8th semester or 10 whichever is less in that branch.

OB 12.3 For award of rank in a branch of Engineering / Technology, the aggregate marks secured by the candidate from 5th semester to 8th semester shall be considered. A candidate shall be eligible for a rank at the time of award of degree in each branch of Engineering / Technology, provided the candidate

a. Has passed 1st to 8th semester in all the subjects in first attempt only

b. Has not repeated/rejected any of the lower semesters.

OB 13 TRANSFER OF STUDENTS

OB 13.1 Transfer of students from one college to another college within karnataka state shall be permitted only at the beginning of third, fifth, and seventh semesters, subject to availability of seats within the permitted intake in respective Colleges and subject to the prior approval of the University and the provisions of OB 7.2.

In the case of candidates from Universities other than VTU they should have passed in all the subjects of 1st & 2nd semesters for admission to 3rd semester and all the subjects of 1st to 4th semesters for admission to 5th semester and all the subjects of 1st to 6th semesters for admission to 7th semester.

The candidates seeking admission from Universities other than VTU shall have to

a. apply for establishment of equivalence with prescribed fees as notified by the VTU and

b. Obtain No Objection for admission from the university before commencement of term as notified by VTU.

OB 13.2 Transfer of students within the College from one branch to another branch at 3rd semester shall be permitted with the prior approval of the VTU and subject to the provisions made by the Government of Karnataka and AICTE in this behalf.

OB 13.3 The University may prescribe fee for administrative purpose (for updating of the records), which shall be notified from time to time, for transfer from one college to another (Change of College) or within the College (change of branch).

SCHEME OF TEACHING AND EXAMINATION
B.E. AERONAUTICAL ENGINEERING
III SEMESTER

Sl. No.	Subject Code	Title	Teaching Dept.	Teaching Hours / week		Examination			
				Th.	Pr.	Duration	I.A Marks	Theory/ Practical	Total
1	10MAT31	Engineering Mathematics-III	Maths	04	—	03	25	100	125
2*	10ME32A/ 10ME32B	Material Science and Metallurgy/Mechanical Measurement and Metrology	ME/AE	04	—	03	25	100	125
3	10ME33	Basic Thermodynamics	ME/AE	04	—	03	25	100	125
4	10ME34	Mechanics of Materials	ME/AE	04	—	03	25	100	125
5	10AE35	Manufacturing Processes	ME/AE	04	—	03	25	100	125
6	10ME36A/ 10ME36B	Computer Aided Machine Drawing/ Fluid Mechanics	ME/AE	01	03	03	25	100	125
7*	10MEL37A/ 10MEL37B	Metallography & Material Testing Lab/ Mechanical Measurement and Metrology Lab	ME/AE	—	03	03	25	50	75
8*	10MEL38A/ 10MEL38B	Foundry & Forging Laboratory/ Machine shop	ME/AE	—	03	03	25	50	75
Total				**21**	**09**	**24**	**200**	**700**	**900**

*Note : Student opted for subjects with code A in III semester, shall opt for Subjects with Code B in IV semester

Note : One question has to be set for every unit (6 to 8 hours of teaching).

SCHEME OF TEACHING AND EXAMINATION
(COMMON TO ME/IP/IM/AU/MA/AE)
IV SEMESTER

Sl. No.	Subject Code	Title	Teaching Dept.	Teaching Hours / week		Examination			
				Th.	Pr.	Duration	I.A Marks	Theory/ Practical	Total Marks
1	10MAT41	Engg. Maths – IV	Math	04	—	03	25	100	125
2*	10ME42A/ 10ME42B	Material Science & Metallurgy/Mechanical Measurements & Metrology	ME/IP/IM/AU/ MA/MI/AE	04	—	03	25	100	125
3	10ME43	Applied Thermodynamics	ME/IP/IM/AU/ MA/MI/AE	04	—	03	25	100	125
4	10ME44	Kinematics of Machines	ME/IP/IM/AU/ MA/MI/AE	04	—	03	25	100	125
5	10AE45	Elements of Aeronautics	AE	04	—	03	25	100	125
6	10ME46A/ 10ME46B	Computer Aided Machine drawing/ Fluid Mechanics	ME/IP/IM/AU/ MA/MI/AE	04	—	03	25	100	125
7*	10MEL47A/ 10MEL47B	Metallography & Material Testing Lab/ Mechanical Measurements & Metrology laboratory	ME/IP/IM/AU/ MA/MI/AE	—	03	03	25	50	75
8*	10MEL48A/ 10MEL48B	Foundry & Forging lab / Machine Shop	ME/IP/IM/AU/ MA/MI/AE	—	03	03	25	50	75
		Total		**24**	**06**	**24**	**200**	**700**	**900**

SCHEME OF TEACHING AND EXAMINATION
B.E. AERONAUTICAL ENGINEERING
V SEMESTER

Sl. No.	Subject Code	Title	Teaching Dept.	Teaching Hours / week		Examination			
				Th.	Pr.	Duration	I.A Marks	Theory/ Practical	Total Marks
1	10AL51	Management and Entrepreneurship	@	04	—	03	25	100	125
2	10AE52	Introduction to Composite Materials	AE/ME	04	—	03	25	100	125
3	10AE53	Dynamics of Machines	AE/ME	04	—	03	25	100	125
4	10AE54	Aerodynamics – I	AE	04	—	03	25	100	125
5	10AE55	Aircraft Propulsion	AE	04	—	03	25	100	125
6	10AE56	Aircraft Structures – I	AE	04	—	03	25	100	125
7	10AEL57	Aerodynamics Lab.	AE	—	03	03	25	50	75
8	10AEL58	Energy Conversion Lab	AE/ME	—	03	03	25	50	75
		Total		**24**	**06**	**24**	**200**	**700**	**900**

***Note** : **One question has to be set for every 6 to 8 hours of teaching.**
@ - Indicates that teaching department can be any engineering department / department of management studies

SCHEME OF TEACHING AND EXAMINATION
B.E. AERONAUTICAL ENGINEERING
VI SEMESTER

Sl. No.	Subject Code	Title	Teaching Dept.	Teaching Hours / week		Examination			
				Th.	Pr.	Duration	I.A Marks	Theory/ Practical	Total Marks
1	10AE61	Applied Gas Dynamics	AE/ME	04	—	03	25	100	125
2	10AE62	Aircraft Performance	AE	04	—	03	25	100	125
3	10AE63	Aerodynamics – II	AE	04	—	03	25	100	125
4	10AE64	Finite Element Analysis	AE/ME	04	—	03	25	100	125
5	10AE65	Theory of Vibrations	ME	04	—	03	25	100	125
6	10AE66*	* Elective - I: (Group A)	AE/IEM	04	—	03	25	100	125
7	10AEL67	Structures Lab.	AE	—	03	03	25	50	75
8	10AEL68	Propulsion Laboratory	AE	—	03	03	25	50	75
		Total		**24**	**06**	**24**	**200**	**700**	**900**

Note : One question has to be set for every 6 to 8 hours of teaching.

Subject Code	* Elective I (Group A)
10AE661	Numerical Methods
10AE662	Aircraft Materials
10AE663	Combustion
10AE664	Reliability Engineering
10AE665	Industrial Management
10AE666	Rockets and Missiles

* Students shall register for one subject from Group A Electives

Note : One question has to be set for every unit (6 to 8 hours of teaching).

SCHEME OF TEACHING AND EXAMINATION
B.E. AERONAUTICAL ENGINEERING
VII SEMESTER

Sl. No.	Subject Code	Title	Teaching Dept.	Teaching Hours / week		Examination			
				Th.	Pr.	Duration	I.A Marks	Theory/ Practical	Total Marks
1	10AE71	Control Engineering	AE/ME	04	—	03	25	100	125
2	10AE72	Aircraft Structures - II	AE	04	—	03	25	100	125
3	10AE73	Aircraft Stability and Control	AE	04	—	03	25	100	125
4	10AE74	Gas Turbine / Technology	AE	04	—	03	25	100	125
5	10AE75*	*Electives II – (Group B)	AE	04	—	03	25	100	125
6	10AE76*	*Electives III –(Group C)	AE	04	—	03	25	100	125
7	10AEL77	Design, Modeling and Analysis Laboratory	AE	—	03	03	25	50	75
8	10AEL78	Simulation Laboratory	AE	—	03	03	25	50	75
		Total		**24**	**06**	**24**	**200**	**700**	**900**

Note : One question has to be set for every 6 to 8 hours of teaching.

Subject Code	* Elective II (Group B)
10AE751	Optimisation Techniques
10AE752	Computational Fluid Dynamics
10AE753	Aircraft Maintenance, Repair and Overhaul
10AE754	Statistical Quality Control
10AE755	Theory of plates and shells
10AE756	Nondestructive Testing
10AE757	Mechatronics and Microprocessor
10AE758	Total Quality Management

Subject Code	* Elective III (Group C)
10AE761	Experimental Stress analysis
10AE762	Helicopter Dynamics
10AE763	Space Mechanics and Launch Vehicles
10AE764	Smart Materials
10AE765	Agile Manufacturing
10AE766	Robotics
10AE767	Industrial and Experimental Aerodynamics
10AE768	Micro and Smart Systems Technology

* Students shall register for one subject each from Group B and C Electives

SCHEME OF TEACHING AND EXAMINATION
B.E. AERONAUTICAL ENGINEERING
VIII SEMESTER

Sl. No.	Subject Code	Title	Teaching Dept.	Teaching Hours / week		Examination			
				Th.	Pr.	Duration	I.A Marks	Theory/ Practical	Total Marks
1	10AE81	Flight Vehicle Design	AE	04	—	03	25	100	125
2	10AE82	Avionics	AE	04	—	03	25	100	125
3	10AE83*	*Electives IV- (Group D)	AE	04	—	03	25	100	125
4	10AE84*	*Electives V- (Group E)	AE	04	—	03	25	100	125
5	10AE85	Project Work	AE	—	03	—	100	100	200
6	10AE86	Seminar on Current / Topics	AE	03	—	—	50	—	50
		Total		**19**	**03**	**12**	**250**	**500**	**750**

Note : One question has to be set for every 6 to 8 hours of teaching.

Subject Code	* Elective IV (Group D)
10AE831	Flight Testing
10AE832	Fracture Mechanics
10AE833	Theory of Aeroelasticity
10AE834	Hydraulics and Pneumatics
10AE835	Reliability and Maintenance Engineering
10AE836	Boundary Layer Theory
10AE837	Operation Research
10AE838	Aerospace Quality Assurance

Subject Code	* Elective V (Group E)
10AE841	Aircraft Safety Rules and Regulations
10AE842	Guidance and Navigation
10AE843	Management Information Systems
10AE844	Project Management
10AE845	Product Design and Manufacturing
10AE846	Artificial Intelligence
10AE847	Computer Integrated Manufacturing
10AE848	Aircraft Systems and Instrumentation

* Students shall register for one subject each from Group D and E Electives.

III SEMESTER
ENGINEERING MATHEMATICS-III

Sub Code : 10MAT31 IA Marks : 25
Hrs/ Week : 04 Exam Hours : 03
Total Hours : 52 Exam Marks : 100

PART-A

Unit-I: FOURIER SERIES

Convergence and divergence of infinite series of positive terms, definition and illustrative examples*

Periodic functions, Dirichlet's conditions, Fourier series of periodic functions of period 2π and arbitrary period, half range Fourier series. Complex form of Fourier Series. Practical harmonic analysis. **[7 hours]**

Unit-II: FOURIER TRANSFORMS

Infinite Fourier transform, Fourier Sine and Cosine transforms, properties, Inverse transforms **[6 hours]**

Unit-III: APPLICATIONS OF PDE

Various possible solutions of one dimensional wave and heat equations, two dimensional Laplace? equation by the method of separation of variables, Solution of all these equations with specified boundary conditions. D?lembert? solution of one dimensional wave equation. **[6 hours]**

Unit-IV: CURVE FITTING AND OPTIMIZATION

Curve fitting by the method of least squares- Fitting of curves of the form $y=ax+b$; $y=ax^2+bx+c$; $y=ae^{bx}$; $y=ax^b$ Optimization: Linear programming, mathematical formulation of linear programming problem (LPP), Graphical method and simplex method. **[7 hours]**

PART-B

Unit-V: NUMERICAL METHODS - 1

Numerical Solution of algebraic and transcendental equations: Regula-falsi method, Newton - Raphson method. Iterative methods of solution of a system of equations: Gauss-seidel and Relaxation methods. Largest eigen value and the corresponding eigen vector by Rayleigh's power method. **[6 hours]**

Unit-VI: NUMERICAL METHODS 2

Finite differences: Forward and backward differences, Newton's forward and backward interpolation formulae. Divided differences - Newton's divided difference formula, Lagrange's interpolation formula and inverse interpolation formula.

Numerical integration: Simpson's one-third, three-eighth and Weddle's rules (All formulae/rules without proof) **[7 hours]**

Unit-VII: NUMERICAL METHODS 3

Numerical solutions of PDE finite difference approximation to derivatives, Numerical solution of two dimensional Laplace's equation, one dimensional heat and wave equations **[7 hours]**

Unit-VIII: DIFFERENCE EQUATIONS AND Z-TRANSFORMS

Difference equations: Basic definition; Z-transforms definition, standard Z-transforms, damping rule, shifting rule, initial value and final value theorems. Inverse Z-transform. Application of Z-transforms to solve difference equations. **[6 hours]**

Note: * In the case of illustrative examples, questions are not to be set.

TEXT BOOKS:

1 B.S. Grewal, Higher Engineering Mathematics, Latest edition, Khanna Publishers

2 Erwin Kreyszig, Advanced Engineering Mathematics, Latest edition, Wiley Publications.

REFERENCE BOOK:

1 B.V. Ramana, Higher Engineering Mathematics, Latest edition, Tata Mc. Graw Hill Publications.

2 Peter V. O?eil, Engineering Mathematics, CENGAGE Learning India Pvt Ltd.Publishers

MATERIAL SCIENCE AND METALLURGY

Sub Code	:	10ME32A/10ME42A	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART - A

UNIT - 1

Crystal Structure: BCC, FCC and HCP Structures, coordination number and atomic packing factors, crystal imperfections -point line and surface imperfections. Atomic Diffusion: Phenomenon, Flick's laws of diffusion, factors affecting diffusion. **06 Hours**

UNIT - 2

Mechanical Behaviour: Stress-strain diagram showing ductile and brittle behaviour of materials, linear and non linear elastic behaviour and properties, mechanical properties in plastic range, yield strength offset yield strength, ductility, ultimate tensile strength, toughness. Plastic deformation of single crystal by slip and twinning. **06 Hours**

UNIT - 3

Fracture: Type I, Type II and Type III.

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

Fatigue: Types of fatigue loading with examples, Mechanism of fatigue, fatigue properties, fatigue testing and S-N diagram. **07 Hours**

UNIT - 4

Solidification: Mechanism of solidification, Homogenous and Heterogeneous nucleation, crystal growth, cast metal structures.

Phase Diagram I: Solid solutions Hume Rothary rule substitutional, and interstitial solid solutions, intermediate phases, Gibbs phase rule. **07 Hours**

PART - B

UNIT - 5

Phase Diagram II: Construction of equilibrium diagrams involving complete and partial solubility, lever rule. Iron carbon equilibrium diagram description of phases, solidification of steels and cast irons, invariant reactions. **06 Hours**

UNIT - 6

Heat treating of metals: TTT curves, continuous cooling curves, annealing and its types. normalizing, hardening, tempering, martempering, austempering,

hardenability, surface hardening methods like carburizing, cyaniding, nitriding, flame hardening and induction hardening, age hardening of aluminium-copper alloys.

07 Hours

UNIT - 7

Ferrous and non ferrous materials: Properties, Composition and uses of

- Grey cast iron, malleable iron, SG iron and steel
- Copper alloys-brasses and bronzes.
  Aluminium alloys-Al-Cu,Al-Si,Al-Zn alloys.

06 Hours

UNIT - 8

Composite Materials: Definition, classification, types of matrix materials & reinforcements, fundamentals of production of FRP' sand MMC's advantages and application of composites.

07 Hours

TEXT BOOKS:

1. **Foundations of Materials Science and Engineering,** Smith, 4th Edition McGraw Hill, 2009
2. **Materials Science, Shackleford., & M. K. Muralidhara,** Pearson Publication – 2007.

REFERENCE BOOKS:

1. **An Introduction to Metallurgy; Alan Cottrell,** University Press India Oriental Longman Pvt. Ltd., 1974.
2. **Engineering Materials Science**, W.C.Richards, PHI, 1965
3. **Physical Metallurgy**; Lakhtin, Mir Publications
4. **Materials Science and Engineering,** V.Raghavan , PHI, 2002
5. **Elements of Materials Science and Engineering,** H. VanVlack, Addison- Wesley Edn., 1998
6. **Materials Science and Engineering,**William D. Callister Jr., John Wiley & Sons. Inc, 5th Edition, 2001.
7. **The Science and Engineering of Materials,** Donald R. Askland and Pradeep.P. Phule, Cengage Learning, 4th Ed., 2003.

MECHANICAL MEASUREMENTS AND METROLOGY

Sub Code	:	10ME32B/10ME42B	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART- A

UNIT-1:

Standards of measurement: Definition and Objectives of metrology, Standards of length-International prototype meter, Imperial standard yard, Wave length standard, subdivision of standards, line and end standard, calibration of end bars (Numerical), Slip gauges, Wringing phenomena, Indian Standards (M-81, M-12), Numerical problems on building of slip gauges.

06 Hours

UNIT-2:

System of Limits, Fits, Tolerance and Gauging: Definition of tolerance, Specification in assembly, Principle of interchangeability and selective assembly limits of size, Indian standards, concept of limits of size and tolerances, compound tolerances, accumulation of tolerances, definition of fits, types of fits and their designation (IS 919-1963), geometrical tolerance, positional-tolerances, hole basis system, shaft basis system, classification of gauges, brief concept of design of gauges (Taylor's principles), Wear allowance on gauges, Types of gauges-plain plug gauge, ring gauge, snap gauge, limit gauge and gauge materials.

07 Hours

UNIT-3:

Comparators and Angular measurement: Introduction to comparators, characteristics, classification of comparators, mechanical comparators-Johnson Mikrokator, sigma comparators, dial indicator, optical comparators-principles, Zeiss ultra optimeter, electric and electronic comparators-principles, LVDT, pneumatic comparators, back pressure gauges, solex comparators. Angular measurements, bevel protractor, sine principle and use of sine bars, sine centre, use of angle gauges (numericals on building of angles), clinometers.

07 Hours

UNIT-4:

Interferometer and screw thread, gear measurement: Interferometer, interferometry, autocollimator. Optical flats. Terminology of screw threads, measurement of major diameter, minor diameter, pitch, angle and effective diameter of screw threads by 2-wire and 3-wire methods, best size wire. Tool maker's microscope, gear tooth terminology, use of gear tooth vernier caliper and micrometer.

06 Hours

PART-B

UNIT-5:

Measurements and measurement systems: Definition, significance of measurement, generalized measurement system, definitions and concept of accuracy, precision, calibration, threshold, sensitivity, hysterisis, repeatability, linearity, loading effect, system response-times delay. Errors in measurement, classification of errors. Transducers, transfer efficiency, primary and secondary transducers, electrical, mechanical, electronic transducers, advantages of each type transducers. **07 Hours**

UNIT-6:

Intermediate modifying and terminating devices: Mechanical systems, inherent problems, electrical intermediate modifying devices, input circuitry, ballast circuit, electronic amplifiers and telemetry. Terminating devices, mechanical, cathode ray oscilloscope, oscillographs, X-Y plotters. **06 Hours**

UNIT-7:

Measurement of force, torque and pressure: Principle, analytical balance, platform balance, proving ring. Torque measurement, Prony brake, hydraulic dynamometer. Pressure measurements, principle, use of elastic members, Bridgeman gauge, McLeod gauge, Pirani gauge. **06 Hours**

UNIT-8:

Temperature and strain measurement: Resistance thermometers, thermocouple, law of thermo couple, materials used for construction, pyrometer, optical pyrometer. Strain measurements, strain gauge, preparation and mounting of strain gauges, gauge factor, methods of strain measurement. **07 Hours**

TEXT BOOKS:

1. **Mechanical Measurements,** Beckwith Marangoni and Lienhard, Pearson Education, 6th Ed., 2006.
2. **Engineering Metrology,** R.K. Jain, Khanna Publishers, 1994.

REFERENCE BOOKS:

1. **Engineering Metrology,** I.C. Gupta, Dhanpat Rai Publications, Delhi.
2. **Mechanical Measurements,** R.K. Jain Khanna Publishers, 1994
3. **Industrial Instrumentation,** Alsutko, Jerry. D. Faulk, Cengage Asia Pvt. Ltd. 2002.
4. **Measurement Systems Applications and Design,** Ernest O. Doebelin, 5th Ed., McGraw Hill Book Co.
5. **Metrology & Measurement,** Anand K. Bewoor & Vinay A. Kulkarni, Tata McGraw Hill Pvt. Ltd., New-Delhi

BASIC THERMODYNAMICS

Sub Code	:	10ME33	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART-A

UNIT - 1

Fndamental Concepts & Definitions: Thermodynamics definition and scope, Microscopic and Macroscopic approaches. Some practical applications of engineering thermodynamic Systems, Characteristics of system boundary and control surface, examples. Thermodynamic properties; definition and units, intensive and extensive properties. Thermodynamic state, state point, state diagram, path and process, quasi-static process, cyclic and non-cyclic preesses; Thermodynamic equilibrium; definition, mechanical equilibrium; diathermic wall, thermal equilibrium, chemical equilibrium, Zeroth law of thermodynamics, Temperature; concepts, scales, fixed points and measurements. **06 Hours**

UNIT - 2

Work and Heat: Mechanics, definition of work and its limitations. Thermodynamic definition of work; examples, sign convention. Displacement work; as a part of a system boundary, as a whole of a system boundary, expressions for displacement work in various processes through p-v diagrams. Shaft work; Electrical work. Other types of work. Heat; definition, units and sign convention. **06 Hours**

UNIT - 3

First Law of Thermodynamics: Joules expriments, equivalence of heat and work. Statement of the First law of thermodynamics, extension of the First law to non - cyclic processes, energy, energy as a property, modes of energy, pure substance; definition, two-property rule, Specific heat at constant volume, enthalpy, specific heat constant pressure. Extension of the First law to control volume; steady state-steady flow energy equation, important applications, analysis of unsteady processes such as filming and evacuation of vessels with and without heat transfer. **07 Hours**

UNIT - 4

Second Law of Thermodynamics: Devices converting heat to work; (a) in a thermodynacmic cycle, (b) in a mechanical cycle. Thermal reservoir. Direct heat engine; schematic representation and efficiency. Devices converting work to heat in a theromodynamic cycle; reversed heat engine, schematic representation, coefficients of performace. Keivin - Planck statement of the Secnd law of Thermodynamics; PMM I and PMM II, Clasius statement of Second law of

Thermodynamics,Equivalence of the two statements; Reversible and irrevesible processes; factors that make a process irreversible, reversible heat engines, Carnot cycle, Carnot principles. **07 Hours**

PART-B

UNIT - 5

Entropy: Clasius inequality; Statement, proof, application to a reversible cycle. Entropy; definition, a property, change of entropy, principle of increase in entropy, entropy as a quantitative test for irreversibility, calculation of entropy using Tds relations, entropy as a coordinate. Available and unavailable energy. **06 Hours**

UNIT - 6

Pure Substances: P-T and P-V diagrams, triple point and critical points. Sub-cooled liquid, saturated liquid, mixture of saturated liquid and vapour, saturated vapour and superheated vapour states of pure substance with water as example. Enthalpy of change of phase (Latent heat). Dryness fraction (quality), T-S and H-S diagrams, representation of various processes on these diagrams. Steam tables and its use. Throttling calorimeter, separating and throttling calorimeter. **07 Hours**

UNIT - 7

Thermodynamic relations: Maxwell relation, Causius Clayperon's equation. Ideal gas; equation of state, internal energy and enthalpy as functions of temperature only, universal and partiuclar gas constans, specific heats, perfect and semi-perfect gases. Evaluation of heat, work, change in internal energy. enthalpy and entropy in various quasi-static processes. **07 Hours**

UNIT - 8

Ideal gas mixture : Ideal gas mixture; Dalton's laws of partial pressures, Amagat's law of additive volumes, evaluation of properties, Analysis of various process. Real Gases: Introduction. Van-der Waal's Equation of state, Van-der Waal's constants in terms of critical properties, Law of corresponding states, compressiblity factor; compressibility chart **06 Hours**

Data Handbooks :

1. **Thermodynamic data hand book,** B.T. Nijaguna.
2. **Properties of Refrigerant & Psychometric** (tables & Charts in SI Units), Dr. S.S. Banwait, Dr. S.C. Laroiya, Birla Pub. Pvt. Ltd., Delhi, 2008

TEXT BOOKS:

1. **Basic Engineering Thermodynomics,** A.Venkatesh, University Press, 2008
2. **Basic and Applied Thermodynamics,** P.K.Nag, 2nd Ed., Tata McGraw Hill Pub. 2002

REFERENCE BOOKS:

1. **Thermodynamics,** An Engineering Approach, Yunus A.Cenegal and Michael A.Boles, Tata McGraw Hill publications, 2002
2. **Engineering Thermodynamics,** J.B.Jones and G.A.Hawkins, John Wiley and Sons..
3. **Fundamentals of Classical Thermodynamics,** G.J.Van Wylen and R.E.Sonntag, Wiley Eastern.
4. **An Introduction to Thermodynamics,** Y.V.C.Rao, Wiley Eastern, 1993,
5. **B.K Venkanna, Swati B. Wadavadagi "Basic Thermodynomics,** PHI, New Delhi, 2010

MECHANICS OF MATERIALS

Sub Code	:	10ME34	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART-A

UNIT 1:

Simple Stress and Strain: Introduction, Stress, strain, mechanical properties of materials, Linear elasticity, Hooke's Law and Poisson's ratio, Stress-Strain relation - behaviour in tension for Mild steel, cast iron and non ferrous metals. Extension / Shortening of a bar, bars with cross sections varying in steps, bars with continuously varying cross sections (circular and rectangular), Elongation due to self weight, Principle of super position. **07 Hours**

UNIT 2:

Stress in Composite Section: Volumetric strain, expression for volumetric strain, elastic constants, simple shear stress, shear strain, temperature stresses (including compound bars). **06 Hours**

UNIT 3:

Compound Stresses: Introduction, Plane stress, stresses on inclined sections, principal stresses and maximum shear stresses, Mohr's circle for plane stress. **07 Hours**

UNIT 4:

Energy Methods: Work and strain energy, Strain energy in bar/beams, Castiglinios theorem, Energy methods.

Thick and Thin Cylinder Stresses in thin cylinders, changes in dimensions of cylinder (diameter, length and volume). Thick cylinders Lame's equation (compound cylinders not included). **06 Hours**

PART-B

UNIT 5:

Bending Moment and Shear Force in Beams: Introduction, Types of beams, loads and reactions, shear forces and bending moments, rate of loading, sign conventions, relationship between shear force and bending moments. Shear force and bending moment diagrams for different beams subjected to concentrated loads, uniformly distributed load, (UDL) uniformly varying load (UVL) and couple for different types of beams. **07 Hours**

UNIT 6:

Bending and Shear Stresses in Beams: Introduction, Theory of simple bending, assumptions in simple bending. Bending stress equation, relationship between bending stress, radius of curvature, relationship between bending moment and radius of curvature. Moment carrying capacity of a section. Shearing stresses in beams, shear stress across rectangular, circular, symmetrical I and T sections. (composite / notched beams not included). **07 Hours**

UNIT 7:

Deflection of Beams: Introduction, Differential equation for deflection. Equations for deflection, slope and bending moment. Double integration method for cantilever and simply supported beams for point load, UDL, UVL and Couple. Macaulay's method **06 Hours**

UNIT 8:

Torsion of Circular Shafts and Elastic Stability of Columns:

Introduction. Pure torsion, assumptions, derivation of torsional equations, polar modulus, torsional rigidity / stiffness of shafts. Power transmitted by solid and hollow circular shafts

Columns: Euler's theory for axially loaded elastic long columns. Derivation of Euler's load for various end conditions, limitations of Euler's theory, Rankine's formula. **06 Hours**

TEXT BOOKS:

1. **"Mechanics of Materials"**, by R.C.Hibbeler, Prentice Hall. Pearson Edu., 2005
2. **"Mechanics of materials"**, James.M.Gere, Thomson, Fifth edition 2004.
3. **"Mechanics of materials"**, in SI Units, Ferdinand Beer & Russell Johston, 5th Ed., TATA McGraw Hill- 2003.

REFERENCE BOOKS:

1. **"Strength of Materials"**, S.S. Rattan, Tata McGraw Hill, 2009
2. **"Strength of Materials"**, S.S.Bhavikatti, Vikas publications House -1 Pvt. Ltd., 2nd Ed., 2006.
3. **"Mechanics of Materials"**, K.V. Rao, G.C. Raju, First Edition, 2007
4. **"Engineering Mechanics of Solids"**, Egor.P. Popov, Pearson Edu. India, 2nd, Edison, 1998.
5. **"Strength of Materials"**, W.A. Nash, 5th Ed., Sehaum's Outline Series, Fourth Edition-2007.

MANUFACTURING PROCESSES

Sub Code	:	10AE35	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART- A

Unit 1 **06 Hrs**

Casting Process: Introduction : Concept of Manufacturing process, its importance. Classification of Manufacturing processes. Introduction to Casting process & steps involved. Varieties of components produced by casting process. Advantages & Limitations of casting process.

Patterns: Definition, functions, Materials used for pattern, various pattern allowances and their importance. Classification of patterns.

Binder: Definition, Types of binder used in moulding sand.

Additives: Need, Types of additives used.

Unit 2 **07 Hrs**

Sand Moulding : Types of base sand, requirement of base sand. Types of sand moulds.

Sand moulds: Moulding sand mixture ingredients (base sand, binder & additives) for different sand mixtures. Method used for sand moulding.

Cores: Definition, Need, and Types. Method of making cores, Binders used. Concept of Gating & Risering. Principle involved. And types. Fettling and cleaning of castings. Basic steps involved. Casting defects - causes, features and remedies.

Unit 3 **07 Hrs**

Moulding machines: Jolt type; squeeze type, Jolt & Squeeze type and Sand slinger. **Special moulding Process :Study of important moulding processes**

Green sand, Core sand, Dry sand, Sweep mould, CO_2 mould, Shell mould, Investment mould.

Metal moulds : Gravity die-casting, Pressure die casting, centrifugal casting, Squeeze Casting, Slush casting, Thixocasting and continuous casting processes

Unit4: **06 Hrs**

Welding

Welding process: Definition, Principles, Classification, Application, Advantages & limitations of welding.

Gas Welding: Principle, Oxy – Acetylene welding, Reaction in Gas welding, Flame characteristics, Gas torch construction & working. Forward and backward welding.

Arc Welding: Principle, Metal Arc welding **(MAW)**, Flux Shielded Metal Arc Welding **(FSMAW)**, Inert Gas Welding **(TIG & MIG)**

PART-B

Unit 5: **06 Hrs**

Principles of soldering & brazing: Parameters involved & Mechanism. Different Types of Soldering & Brazing Methods **Inspection Methods** – Methods used for Inspection of casting and welding. Visual, Magnetic particle, Fluorescent particle, Ultrasonic, Radiography, Eddy current, Holography methods of Inspection.

Unit 6: **07 Hrs**

Theory of metal cutting: Single point cutting tool nomenclature, geometry of single point cutting tool. Merchant's circle diagram and analysis, Ernst-Merchant's solution, Shear angle relationship, Problems on Merchant's analysis, Tool wear & tool failure, Tool life, Effects of cutting parameters on tool life, Tool's failure criteria, Taylor's tool life equation, Problems on tool life evaluation.

Unit 7: **07 Hrs**

Cutting tool materials: Desired properties, types of cutting tool materials- HSS carbides, coated carbides, ceramics, cutting fluids, desired properties, types and selection, Heat generation in metal cutting, factors affecting heat generation. Heat distribution in tool and w/p. Measurements of tool tip temperature.

Unit 8: **06 Hrs**

Non-Traditional Machining Process: Principle, need, equipment, operation and applications of LBM, Plasma Arc Machining, Electro chemical machining, Ultrasonic Machining, Abrasive jet machining, Water jet machining

Text Books:

1. Workshop Technology', Hajra Choudhry Vol- I and II, Media Promoters and Publishers Pvt. Ltd., 2004.
2. 'Production Technology', R.K. Jain, Khanna Publications, 2003.

Reference Books:

1. "Manufacturing Technology", Serope Kalpakjain, Steuen.R.Sechmid, Pearson Education Asia, 5th Ed. 2006.
2. "Process and Materials of Manufacturing :, Roy A Lindberg, 4th Ed. Pearson Edu. 2006.
3. 'Manufacturing Science', Amitabha Ghosh and Mallik, Affiliated East-West Press, 2003.
4. 'Fundamentals of Metal Machining and Machine Tools', G. Boothroyd, McGraw Hill, 2000

Scheme of examination:

One Question to be set from each chapter. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

COMPUTER AIDED MACHINE DRAWING

Sub Code	:	10ME36A/10ME46A	IA Marks	:	25
Hrs/ Week	:	04 (1 Hr Theory and 3 hrs practical)	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

Introduction:

Review of graphic interface of the software. Review of basic sketching commands and navigational commands. Starting a new drawing sheet. Sheet sizes. Naming a drawing, Drawing units, grid and snap. **02 Hours**

PART-A

UNIT 1:

Sections of Solids: Sections of Pyramids, Prisms, Cubes, Tetrahedrons, Cones and Cylinders resting only on their bases (No problems on, axis inclinations, spheres and hollow solids). True shape of sections.

Orthographic Views: Conversion of pictorial views into orthographic projections. of **simple machine parts** with or without section. (Bureau of Indian Standards conventions are to be followed for the drawings) Hidden line conventions. Precedence of lines. **08 Hours**

UNIT 2:

Thread Forms: Thread terminology, sectional views of threads. ISO Metric (Internal & External) BSW (Internal & External) square and Acme. Sellers thread, American Standard thread.

Fasteners: Hexagonal headed bolt and nut with washer (assembly), square headed bolt and nut with washer (assembly) simple assembly using stud bolts with nut and lock nut. Flanged nut, slotted nut, taper and split pin for locking, counter sunk head screw, grub screw, Allen screw. **08 Hours**

PART-B

UNIT 3:

Keys & Joints :

Parallel key, Taper key, Feather key, Gibhead key and Woodruff key

Riveted Joints: Single and double riveted lap joints, butt joints with single/ double cover straps (Chain and Zigzag, using snap head rivets). cotter joint (socket and spigot), knuckle joint (pin joint) for two rods. **08 Hours**

UNIT 4:

Couplings:

Split Muff coupling, Protected type flanged coupling, pin (bush) type flexible coupling, Oldham's coupling and universal coupling (Hooks' Joint) **08 Hours**

PART - C

Assembly Drawings

(Part drawings should be given)

1. Plummer block (Pedestal Bearing)
2. Rams Bottom Safety Valve
3. I.C. Engine connecting rod
4. Screw jack (Bottle type)
5. Tailstock of lathe
6. Machine vice
7. Tool Head of a shaper **18 Hours**

Text Books:

1. **'A Primer on Computer Aided Machine Drawing-2007'**, Published by VTU, Belgaum.
2. **'Machine Drawing'**, N.D.Bhat & V.M.Panchal

Reference Books:

1. **'A Text Book of Computer Aided Machine Drawing'**, S. Trymbaka Murthy, CBS Publishers, New Delhi, 2007
2. **'Machine Drawing'**, K.R. Gopala Krishna, Subhash Publication.

3. **'Machine Drawing with Auto CAD'**, Goutam Pohit & Goutham Ghosh, 1st Indian print Pearson Education, 2005
4. **'Auto CAD 2006, for engineers and designers'**, Sham Tickoo. Dream tech 2005
5. **'Machine Drawing'**, N. Siddeshwar, P. Kanniah, V.V.S. Sastri, published by Tata McGraw Hill,2006

NOTE:

Internal assessment: 25 Marks

All the sheets should be drawn in the class using software. Sheet sizes should be A3/A4. All sheets must be submitted at the end of the class by taking printouts.

Scheme of Examination:

Two questions to be set from each Part-A, Part-B and Part-C

Student has to answer one question each from Part-A and Part-B for 20 marks each. And one question from Part-C for 60 marks.

i.e.	**PART-A 1 x 20**	**= 20 Marks**
	PART-B 1 x 20	**= 20 Marks**
	PART-C 1 x 60	**= 60 Marks**
	Total	**= 100 Marks**

FLUID MECHANICS

Sub Code	:	10ME36B/10ME46B	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART – A

UNIT-1

Properties of Fluids: Introduction, Types of fluid, Properties of fluids, viscosity, thermodynamic properties, surface tension, capillarity, vapour pressure and cavitation **06 Hours**

UNIT-2

Fluid Statistics : Fluid pressure at a point, Pascal's law, pressure variation in a static fluid, absolute, gauge, atmospheric and vacuum pressures, simple manometers and differential manometers. Total pressure and center of pressure on submerged plane surfaces; horizontal, vertical and inclined plane surfaces, curved surface submerged in liquid. **07 Hours**

UNIT-3

Buoyancy and Fluid Kinematics:

Buoyancy, center of buoyancy, metacentre and metacentric height, conditions of equilibrium of floating and submerged bodies, determination of Metacentric height experimentally and theoretically.

Kinematics: Types of fluid flow, continuity equation in 2D and 3D (Carversian Co-ordinates only, velocity and acceleration, velocity potential function and stream function. **07 Hours**

UNIT-4

Fluid Dynamics: Introduction equation of motion, Euler's equation of motion, Bernoulli's equation from first principles and also from Euler's equation, limitations of Bernoulli's equation. **06 Hours**

PART-B

UNIT-5

Fluid Flow Measurements : Venturimeter, orificemeter, pitot-tube, vertical orifice, V-Notch and rectangular notches.

Dimensional Analysis : Introduction, derived quantities, dimensions of physical quantities, dimensional homogeneity, Rayleigh's method, Buckingham π theorem, dimensionless numbers, similitude, types of similtudes. **07 Hours**

UNIT-6

Flow through pipes : Minor losses through pipes. Darey's and Chezy's equation for loss of head due to friction in pipes. HGL and TEL. **06 Hours**

UNIT-7

Laminar flow and viscous effects : Reyonold's number, critical Reynold's number, laminar flow through circular pipe-Hagen Poiseille's equation, laminar flow between parallel and stationary plates. **06 Hours**

UNIT-8

Flow past immersed bodies : Drag, Lift, expression for lift and drag, boundary layer concept, displacement, momentum and energy thickness.

Introduction to compressible flow : Velocity of sound in a fluid, Mach nuber, Mach cone, propagation of pressure waves in a compressible fluid. **07 Hours**

Text Books:

1. **Fluid Mechanics,** Oijush.K.Kundu, IRAM COCHEN, ELSEVIER, 3rd Ed. 2005.
2. **Fluid Mechanics**, Dr. Bansal, R.K.Lakshmi Publications, 2004.

Reference Books:

1. **Fluid Mechanics and hydraulics,** Dr.Jagadishlal: Metropolitan Book Co-Ltd., 1997.
2. **Fluid Mechanics (SI Units),** Yunus A. Cengel John M.Oimbala, 2nd Ed., Tata McGraw Hill, 2006.
3. **Fluid Mechanics,** John F.Douglas, Janul and M.Gasiosek and john A.Swaffield, Pearson Education Asia, 5th ed., 2006
4. **Fluid Mechanics and Fluid Power Engineering**, Kumar.D.S, Kataria and Sons., 2004
5. **Fluid Mechanics** -. Merle C. Potter, Elaine P.Scott. Cengage learning

METTALOGRAPHY & MATERIAL TESTING LAB

Sub Code	:	10MEL37A/10MEL47A	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART – A

1. Preparation of specimen for Metallograpic examination of different engineering materials. Identification of microstructures of plain carbon steel, tool steel, gray C.I, SG iron, Brass, Bronze & composites.
2. Heat treatment: Annealing, normalizing, hardening and tempering of steel. Hardness studies of heat-treated samples.
3. To study the wear characteristics of ferrous, non-ferrous and composite materials for different parameters.
4. Non-destructive test experiments like,
   (a). Ultrasonic flaw detection
   (b). Magnetic crack detection
   (c). Dye penetration testing. To study the defects of Cast and Welded specimens

PART – B

1. Tensile, shear and compression tests of metallic and non metallic specimens using Universal Testing Machine
2. Torsion Test
3. Bending Test on metallic and nonmetallic specimens.
4. Izod and Charpy Tests on M.S, C.I Specimen.
5. Brinell, Rockwell and Vickers's Hardness test.
6. Fatigue Test.

Scheme of Examination:

ONE question from part -A:	**20** Marks
ONE question from part -B:	20 **Marks**
Viva -Voice:	**10** Marks
Total :	**50** Marks

MECHANICAL MEASUREMENTS AND METROLOGY LABORATORY

Sub Code	: 10MEL37B/10MEL47B	IA Marks	:	25
Hrs/ Week	: 03	Exam Hours	:	03
Total Hours	: 42	Exam Marks	:	50

PART-A: MECHANICAL MEASUREMENTS

1. Calibration of Pressure Gauge
2. Calibration of Thermocouple
3. Calibration of LVDT
4. Calibration of Load cell
5. Determination of modulus of elasticity of a mild steel specimen using strain gauges.

PART-B: METROLOGY

1. Measurements using Optical Projector / Toolmaker Microscope.
2. Measurement of angle using Sine Center / Sine bar / bevel protractor
3. Measurement of alignment using Autocollimator / Roller set
4. Measurement of cutting tool forces using
   a) Lathe tool Dynamometer
   b) Drill tool Dynamometer.
5. Measurement of Screw thread Parameters using Two wire or Three-wire method.
6. Measurements of Surface roughness, Using Tally Surf/Mechanical Comparator
7. Measurement of gear tooth profile using gear tooth vernier /Gear tooth micrometer
8. Calibration of Micrometer using slip gauges
9. Measurement using Optical Flats

Scheme of Examination:

ONE question from part -A:	**20** Marks
ONE question from part -B:	20 **Marks**
Viva -Voice:	**10** Marks
Total :	**50** Marks

FOUNDRY & FORGING LABORATORY

Sub Code	: 10MEL38A/10MEL48A	IA Marks	:	25
Hrs/ Week	: 03	Exam Hours	:	03
Total Hours	: 42	Exam Marks	:	50

PART – A

1. Testing of Moulding sand and Core sand

Preparation of sand specimens and conduction of the following tests:

1 Compression, Shear and Tensile tests on Universal Sand Testing Machine.
2 Permeability test
3 Core hardness & Mould hardness tests.
4 Sieve Analysis to find Grain Finest number of Base Sand
5 Clay content determination in Base Sand

PART – B

2. Foundry Practice

Use of foundry tools and other equipments.

Preparation of moulds using two moulding boxes using patterns or without patterns. (Split pattern, Match plate pattern and Core boxes).

Preparation of one casting (Aluminum or cast iron-Demonstration only)

PART – C

3. Forging Operations :

- Calculation of length of the raw material required to do the model.
- Preparing minimum three forged models involving upsetting, drawing and bending operations.
- Out of these three models, at least one model is to be prepared by using Power Hammer.

Scheme of Examination:

One question is to be set from Part-A: 10 marks
One question is to be set from either
Part-B or Part-C: 30 marks
Calculation part in case of forging is made compulsory

Calculation (Forging)	+ Foundry Model	= 05 +25 = 30 Marks
Calculation (Forging)	+ Forging Model	= 05 +25 = 30 Marks

Viva-Voce	:	**10** marks.
Total	:	**50** Marks.

MACHINE SHOP

Sub Code	:	10MEL38B/10MEL48B	IA Marks	:	25
Hrs/ Week	:	03	Exam Hours	:	03
Total Hours	:	42	Exam Marks	:	50

PART – A

Preparation of three models on lathe involving Plain turning, Taper turning, Step turning, Thread cutting, Facing, Knurling, Drilling, Boring, Internal Thread cutting and Eccentric turning.

PART – B

Cutting of V Groove/ dovetail / Rectangular groove using a shaper.
Cutting of Gear Teeth using Milling Machine.

Scheme of Examination:

ONE question from part -A:	**30** Marks
ONE question from part -B:	10 **Marks**
Viva -Voice:	**10** Marks
Total :	**50** Marks

IV SEMESTER
ENGINEERING MATHEMATICS-IV

Sub Code	:	10MAT41	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART-A

Unit-I: NUMERICAL METHODS - 1

Numerical solution of ordinary differential equations of first order and first degree; Picard's method, Taylor's series method, modified Euler's method, Runge-kutta method of fourth-order. Milne's and Adams - Bashforth predictor and corrector methods (No derivations of formulae). **[6 hours]**

Unit-II: NUMERICAL METHODS – 2

Numerical solution of simultaneous first order ordinary differential equations: Picard's method, Runge-Kutta method of fourth-order.
Numerical solution of second order ordinary differential equations: Picard's method, Runge-Kutta method and Milne's method. **[6 hours]**

Unit-III: Complex variables – 1

Function of a complex variable, Analytic functions-Cauchy-Riemann equations in cartesian and polar forms. Properties of analytic functions.
Application to flow problems- complex potential, velocity potential, equipotential lines, stream functions, stream lines. **[7 hours]**

Unit-IV: Complex variables – 2

Conformal Transformations: Bilinear Transformations. Discussion of Transformations: $w=z^2$, $w=e^z$, $w=z+(a^2/z)$. Complex line integrals- Cauchy's theorem and Cauchy's integral formula. **[7 hours]**

PART-B

Unit-V: SPECIAL FUNCTIONS

Solution of Laplace equation in cylindrical and spherical systems leading Bessel's and Legendre's differential equations, Series solution of Bessel's differential equation leading to Bessel function of first kind. Orthogonal property of Bessel functions. Series solution of Legendre's differential equation leading to Legendre polynomials, Rodrigue's formula. **[7 hours]**

Unit-VI: PROBABILITY THEORY - 1

Probability of an event, empherical and axiomatic definition, probability associated with set theory, addition law, conditional probability, multiplication law, Baye's theorem. **[6 hours]**

Unit-VII: PROBABILITY THEORY- 2

Random variables (discrete and continuous), probability density function, cumulative density function. Probability distributions – Binomial and Poisson distributions; Exponential and normal distributions. **[7 hours]**

Unit-VIII: SAMPLING THEORY

Sampling, Sampling distributions, standard error, test of hypothesis for means, confidence limits for means, student's t-distribution. Chi -Square distribution as a test of goodness of fit **[6 hours]**

Text Books:

1. B.S. Grewal, Higher Engineering Mathematics, Latest edition, Khanna Publishers
2. Erwin Kreyszig, Advanced Engineering Mathematics, Latest edition, Wiley Publications.

Reference Book:

1. B.V. Ramana, Higher Engineering Mathematics, Latest edition, Tata Mc. Graw Hill Publications.
2. Peter V. O'Neil, Engineering Mathematics, CENGAGE Learning India Pvt Ltd.Publishers

APPLIED THERMODYNAMICS

Sub Code	:	10ME43	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART-A

Unit 1:

Combustion thermodynamics: Theoretical (Stoichiometric) air and excess air for combustion of fuels. Mass balance, actual combustion. Exhaust gas analysis. A./ F ratio, Energy balance for a chemical reaction, enthalpy of formation, enthalpy and internal energy of combustion, Combustion efficiency, adiabatic flow temperature. **07 Hours**

Unit 2:

Gas power cycle: Air Standard cycles: Carnot, Otto, Diesel, Dual and Stirling cycles, P-V and T-S diagrams, description, efficiencies and mean effective pressures, Comparison of Otto, Diesel and dual cycles. **06 Hours**

Unit 3:

I.C. Engine: Testing of two stroke and four stroke SI and CI engines for performance Related numerical problems, heat balance, Motoring Method, Willian's line method, swinging field dynamometer, Morse test. **06 Hours**

Unit 4:

Vapour Power Cycles: Carnot vapour power cycles, drawbacks as a reference cycle, Simple Rankine cycle, description, T- S diagram, analysis for performance , comparison of Carnot and Rankine cycles. Effects of pressure and temperature on Rankine cycle performance. Actual vapour power cycles. Ideal and practical regenerative Rankine cycle, open and closed feed water heaters, Reheat Rankine cycle. **07 Hours**

PART-B

Unit 5:

Reciprocating Compressors: Operation of a single stage reciprocating compressors, work input through P-V diagram and steady state steady flow analysis. Effect of clearance and volumetric efficiency. Adiabatic, isothermal and mechanical efficiencies. Multistage compressor, saving in work, optimum intermediate pressure, inter- cooling, minimum work for compression. **06 Hours**

Unit 6:

Gas turbine and Jet propulsion: Classification of Gas turbines, Analysis of open cycle gas turbine cycle. Advantages and disadvantages of closed cycle. Methods to improve thermal efficiency, Jet propulsion and Rocket propulsion. **07 Hours**

Unit 7

Refrigeration: Vapour compression refrigeration system ; description, analysis, refrigerating effect, capacity , power required, units of refrigeration, COP , Refrigerants and their desirable properties. Air cycle refrigeration; reversed Carnot cycle, reversed Brayton cycle, Vapour absorption refrigeration system, steam jet refrigeration. **06 Hours**

Unit 8

Psychrometry: Atmospheric air and psychrometric properties; Dry bulb temperature, wet bulb temperature, dew point temperature; partial pressures,

specific and relative humidifies and the relation between the two enthalpy and adiabatic saturation temperature. Construction and use of psychrometric chart . Analysis of various processes; heating, cooling , dehumidifying and humidifying. Adiabatic mixing of moist air. Summer and winter air conditioning.

07 Hours

Data Hand Book :

1. **Thermodynomic data hand book,** B.T. Nijaguna.
2. **Properties of Refrigerant & Psychometric** (tables & Charts in SI Units), Dr. S.S. Banwait, Dr. S.C. Laroiya, Birla Pub. Pvt. Ltd., Delhi, 2008

Text Book

1. **Basic and applied Thermodynamics**, P.K. Nag, 2nd Ed., Tata McGraw Hill Pub.Co,2002
2. **Applied Thermodynamics**, Rajput, Laxmi Publication
3. **Applied Thermodynamics**, B.K. Venkahna, Swati B. Wadavadagi, PHI, New Delhi, 2010

Reference Books

1. **Thermodynamics , An engineering approach**, Yunus, A. Cengel and Michael A.Boies, 6th Ed., Tata McGraw Hill pub. Co., 2002,
2. **Fundamental of Classical Thermodynamics,** G.J. Van Wylen and R.E. Sontang Wiley eastern.

KINEMATICS OF MACHINES

Sub Code	:	10ME44	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART - A

UNIT 1:

Introduction: Definitions Link or element, kinematic pairs, Degrees of freedom, Grubler's criterion (without derivation), Kinematic chain, Mechanism, Structure, Mobility of Mechanism, Inversion, Machine.

Kinematic Chains and Inversions: Inversions of Four bar chain; Single slider crank chain and Double slider crank chain. **07 Hours**

UNIT 2:

Mechanisms: Quick return motion mechanisms-Drag link mechanism, Whitworth mechanism and Crank and slotted lever Mechanism.

Straight line motion mechanisms Peaucellier's mechanism and Robert's

mechanism. Intermittent Motion mechanisms -Geneva wheel mechanism and Ratchet and Pawl mechanism. Toggle mechanism, Pantograph, Ackerman steering gear mechanism. **06 Hours**

UNIT 3:

Velocity and Acceleration Analysis of Mechanisms (Graphical Methods) Velocity and acceleration analysis of Four Bar mechanism, slider crank mechanism and Simple Mechanisms by vector polygons: Relative velocity and acceleration of particles .in a common link, relative velocity and accelerations of coincident Particles on separate links- Coriolis component of acceleration. Angular velocity and angular acceleration of links, velocity of rubbing. **07 Hours**

UNIT 4:

Velocity Analysis by Instantaneous Center Method: Definition, Kennedy's Theorem, Determination of linear and angular velocity using instantaneous center method

Klein's Construction: Analysis of velocity and acceleration of single slider crank mechanism. **06 Hours**

PART - B

UNIT 5:

Velocity and Acceleration Analysis of Mechanisms (Analytical Methods): Analysis of four bar chain and slider crank chain using analytical expressions. (Use of complex algebra and vector algebra) **06 Hours**

UNIT 6:

Spur Gears: Gear terminology, law of gearing, Characteristics of involute action, Path of contact. Arc of contact, Contact ratio of spur, helical, bevel and worm gears, Interference in involute gears. Methods of avoiding interference, Back lash. Comparison of involute and cycloidal teeth. Profile Modification. **07 Hours**

UNIT 7:

Gear Trains: Simple gear trains, Compound gear trains for large speed. reduction, Epicyclic gear trains, Algebraic and tabular methods of finding velocity ratio of epicyclic gear trains. Tooth load and torque calculations in epicyclic gear trains. **07 Hours**

UNIT 8:

Cams: Types of cams, Types of followers. Displacement, Velocity and, Acceleration time curves for cam profiles. Disc cam with reciprocating follower having knife-edge, roller and flat-face follower, Disc cam with oscillating roller follower. Follower motions including SHM, Uniform velocity, uniform acceleration and retardation and Cycloidal motion. **06 Hours**

Text Books:

1. **"Theory of Machines"**, Rattan S.S, Tata McGraw-Hill Publishing Company Ltd., New Delhi, and 3rd edition -2009.
2. **"Theory of Machines"**, Sadhu Singh, Pearson Education (Singapore) Pvt. Ltd, Indian Branch New Delhi, 2nd Edi. 2006

Reference Books:

1. **"Theory of Machines & Mechanisms"**, J.J. Uicker, , G.R. Pennock, J.E. Shigley. OXFORD 3rd Ed. 2009.
2. **Mechanism and Machine theory**, Ambekar, PHI, 2007

Graphical Solutions may be obtained either on the Graph Sheets or on the Answer Book itself.

ELEMENTS OF AERONAUTICS

Sub Code	:	10AE45	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1 **06 Hrs**

Historical Developments in Aeronautical Activities:

Early air vehicles: Balloons, Biplanes and Monoplanes, Helicopters; Developments in aerodynamics, aircraft materials, aircraft structures and aircraft propulsion over the years. **06 Hrs**

Aircraft Configurations:

Different types of flight vehicles and their classifications; Components of fixed wing airplane and their functions; Airfoils, wings and other shapes

Unit 3 **08 Hrs**

Principles of Atmospheric Flight:

Physical properties and structure of the atmosphere: The Standard Atmosphere, Temperature, Pressure and Altitude relationships, Mach number, Evolution of theory of lift and drag, Maneuvers, Concepts of stability and control.

Unit 4 **06 Hrs**

Introduction to Space Flight:

Introduction to basic concepts, the upper atmosphere, Differential equations, Lagrange's equation, Orbit equation, Space vehicle trajectories-some basic concepts, Kepler's Laws of planetary motion

PART B

Unit 5 **06 Hrs**

Aircraft Structures and Aircraft Materials:

General types of construction, monocoque, semi-monocoque and geodesic construction; typical wing and fuselage structure. Metallic and non-metallic materials for aircraft application.

Unit 6 **08 Hrs**

Aircraft Power Plants :

Basic ideas about piston, turboprop and jet engines, Use of propeller and jets for thrust production, Comparative merits; Principles of operation of rocket, types of rockets and typical applications, Exploration into space.

Unit 7 **06 Hrs**

Aircraft Systems: Mechanical

Description of different airplane systems and their components: Hydraulics, Pneumatic, Oxygen System, Environmental Control System, and Fuel System.

Unit 8 **06 Hrs**

Aircraft Systems: Electrical

Flight Control System, Aircraft Electrical System, Aircraft Instruments, Navigation System, Communication System.

Text Books:

1. Anderson, J.D., "Introduction to Flight", McGraw-Hill, 1995
2. Lalit Gupta and Dr. O. P. Sharma: Fundamentals of Flight Vol-I to Vol-IV Himalayan Books, 2006

Reference:

1. Kermode, A.C., "Flight without Formulae", McGraw-Hill, 1997.
2. Kroes, Michael J and Rardon, James R "Introduction to Aircraft Basic Science", 7th Edition, Macmillan / McGraw Hill, 1993.
3. Kermode, A.C., "Mechanics of Flight", (Revised by RH Bernard & Dr Philpott), LPE, Pearson Education, 2005.

Scheme of Examination:

One Question is to be set from each unit. Students have to answer any FIVE FULL QUESTIONS out of EIGHT questions, choosing at least TWO questions from Part A and TWO questions from Part B.

V SEMESTER
MANAGEMENT & ENTREPRENEURSHIP

Sub Code	:	10AL51	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART – A
MANAGEMENT

UNIT - 1

MANAGEMENT: Introduction - Meaning - nature and characteristics of Management, Scope and Functional areas of management - Management as a science, art of profession - Management & Administration - Roles of Management, Levels of Management, Development of Management Thought - early management approaches - Modem management approaches.

7 Hours

UNIT - 2

PLANNING: Nature, importance and purpose of planning process Objectives - Types of plans (Meaning Only) - Decision making Importance of planning - steps in planning & planning premises - Hierarchy of plans. **6 Hours**

UNIT - 3

ORGANIZING AND STAFFING: Nature and purpose of organization Principles of organization - Types of organization - Departmentation Committees- Centralization Vs Decentralization of authority. and responsibility - Span of control - MBO and MBE (Meaning Only) Nature and importance of staffing— :Process of Selection & Recruitment (in brief). **6 Hours**

UNIT - 4

DIRECTING & CONTROLLING: Meaning and nature of directing Leadership styles, Motivation Theories, Communication - Meaning and importance - coordination, meaning and importance and Techniques of Co Ordination. Meaning and steps in controlling - Essentials of a sound control system - Methods of establishing control (in brief): **7 Hours**

PART-B
ENTREPRENEURSHIP

UNIT - 5

ENTREPRENEUR: Meaning of Entrepreneur; Evolution of .the Concept; Functions of an Entrepreneur, Types of Entrepreneur, Entrepreneur - an emerging. Class. Concept of Entrepreneurship - Evolution of Entrepreneurship, Development of Entrepreneurship; Stages in entrepreneurial process; Role of

entrepreneurs in Economic Development; Entrepreneurship in India; Entrepreneurship - its Barriers. **6 Hours**

UNIT – 6

SMALL SCALE INDUSTRIES: Definition; Characteristics; Need and rationale; Objectives; Scope; role of SSI in Economic Development. Advantages of SSI Steps to start and SSI - Government policy towards SSI; Different Policies of SSI; Government Support for SSI during 5 year plans. Impact of Liberalization, Privatization, Globalization on SSI Effect of WTO/GA TT Supporting Agencies of Government for SSI, Meaning, Nature of support; Objectives; Functions; Types of Help; Ancillary Industry and Tiny Industry (Definition Only)

7 Hours

UNIT - 7

INSTITUTIONAL SUPPORT: Different Schemes; TECKSOK; KIADB; KSSIDC; KSIMC; DIC Single Window Agency; SISI; NSIC; SIDBI; KSFC.

7 Hours

UNIT - 8

PREPARATION OF PROJECT: Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; Formulation; Guidelines by Planning Commission for Project report; Network Analysis; Errors of Project Report; Project Appraisal. Identification of business opportunities: Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study.

7 Hours

Text Books:

1. **Principles of Management** – P. C.Tripathi, P.N. Reddy – Tata McGraw Hill,
2. **Dynamics of Entrepreneurial Development & Management** Vasant Desai - Himalaya Publishing House
3. **Entrepreneurship Development** – Poornima. M. Charantimath Small Business Enterprises - Pearson Education - 2006 (2 & 4).

Reference Books:

1. **Management Fundamentals** - Concepts, Application, Skill Development - Robers Lusier - Thomson
2. **Entrepreneurship Development** - S.S.Khanka - S.Chand & Co.
3. **Management** - Stephen Robbins - Pearson Education/PHI - 17th Edition, 2003.

INTRODUCTION TO COMPOSITE MATERIALS

Sub Code	: 10AE52	IA Marks	:	25
Hrs/ Week	: 04	Exam Hours	:	03
Total Hours	: 52	Exam Marks	:	100

PART A

Unit 1. **06 Hrs**

Introduction To Composite Materials:

Definition, classification and characteristics of composite materials – fibrous composites, laminated. Matrix materials

Unit 2. **06 Hrs**

Fiber Reinforced Plastic Processing:

Lay up and curing, fabricating process - open and closed mould process - hand lay up techniques structural laminate bag molding, production procedures for bag molding.

Unit 3. **08 Hrs**

Advanced Processing Techniques and Application Of Composites:

Filament winding, pultrusion, pulforming, thermo - forming, injection, injection molding, liquid molding, blow molding, Automobile, Aircrafts, missiles, Space hardware, Electrical and electronics, marine, recreational and Sports equipment, future potential of composites.

Unit 4. **06 Hrs**

Fabrication Of Composite Structures:

Cutting, machining, drilling, mechanical fasteners and adhesive bonding, joining, computer-aided design and manufacturing, tooling, fabrication equipment.

PART B

Unit 5. **06 Hrs**

Macro-Mechanical Behavior of a Lamina:

Stress-strain relation for an orthotropic lamina- Restriction on elastic constants- Strengths of an orthotropic lamina and Failure theories for an orthotropic lamina.

Unit 6. **06 Hrs**

Micro-Mechanical Behavior of a Lamina:

Determination of elastic constants-Rule of mixtures, transformation of coordinates, micro-mechanics based analysis and experimental determination of material constants.

Unit 7. **06 Hrs**

Macro-Mechanical Behavior of a Laminate:

Classical plate theory- Stress and strain variation in a laminate- Resultant forces and moments- A B & D matrices- Strength analysis of a laminate

Unit 8. **08 Hrs**

Metal Matrix Composites:

Reinforcement materials, types, characteristics and selection of base metals. Application ofMMC's.

Text Books:

1. Composites Science and Engineering, K.K Chawla, Springer Verlag, 1998
2. R M Jones, "Mechanics of Composite Materials", McGraw-Hill, New York, 1975

Reference:

1. Meing Schwaitz, "Composite materials hand book", McGraw Hill Book Company. 1984
2. Introduction to Composite materials, Hull and Clyne, Cambridge University Press, 2nd Edition, 1990.
3. Forming Metal handbook, 9th edition, ASM handbook, V15. 1988, P327 338.
4. Mechanics of composites by Artar Kaw, CRC Press. 2002.

DYNAMICS OF MACHINERY

Sub Code	: 10AE53	IA Marks	:	25
Hrs/ Week	: 04	Exam Hours	:	03
Total Hours	: 52	Exam Marks	:	100

PART A

Unit 1. **06 Hrs**

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

Unit 2. **06 Hrs**

Dynamic Force Analysis: D'Alembert's principle, Inertia force, inertia torque,

Dynamic force analysis of four-bar mechanism and slider crank mechanism. Dynamically equivalent systems. Turning moment diagrams and flywheels, Fluctuation of Energy. Determination of size of flywheels.

Unit 3. **08 Hrs**

Friction and Belt Drives: Definitions: Types of friction: laws of friction, Friction in pivot and collar bearings. Belt drives: Flat belt drives, ratio of belt tensions, centrifugal tension, power transmitted.

Unit 4. **06 Hrs**

Balancing of Rotating Masses: Static and dynamic balancing, Balancing of single rotating mass by balancing masses in same plane and in different planes. Balancing of several rotating masses by balancing masses in same plane and in different planes.

PART B

Unit 5. **08 Hrs**

Balancing of Reciprocating Masses: Inertia effect of crank and connecting rod, single cylinder engine, balancing in multi cylinder-inline engine primary & Secondary forces, V-type engine; Radial engine – Direct and reverse crank method.

Unit 6. **06 Hrs**

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

Unit 7. **06 Hrs**

Gyroscope: Vectorial representation of angular motion, Gyroscopic couple. Effect of gyroscopic couple on ship, plane disc, aeroplane, stability of two wheelers and four wheelers.

Unit 8. **06 Hrs**

Analysis of CAMS: Analysis of Tangent cam with roller follower and Circular arc cam operating flat faced and roller followers, Undercutting in Cams.

Text Books:

1. Theory of Machines: Sadhu Singh, Pearson Education, 2nd edition, 2007.
2. Theory of Machines: Rattan S.S. Tata McGraw Hill Publishing Company Ltd., New Delhi, 2nd Edition, 2006.

Reference:

1. Theory of Machines by Thomas Bevan, CBS Publication 1984.
2. Design of Machinery by Robert L. Norton, McGraw Hill, 2001.
3. Mechanisms and Dynamics of Machinery by J. Srinivas, Scitech Publications, Chennai, 2002.
4. Dynamics of machinery by J. B. K. Das & P. L. S. Murthy.

Scheme of examination:

One Question to be set from each unit. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

AERODYNAMICS – I

Sub Code	:	10AE54	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **4 Hrs.**

Review of Basic Fluid Mechanics

Continuity, momentum and energy equation, units and dimensions, inviscid and viscous flows, compressibility, Mach number regimes.

Unit 2. **6 Hrs.**

Description of Fluid Motion

Euler and Lagrangian descriptions, control volume approach to continuity and momentum equations, pathlines, streamlines and streaklines, angular velocity, vorticity, circulation, stream function, velocity potential and relationship between them.

Unit 3. **6 Hrs.**

Airfoil Characteristics

Fundamental aerodynamic variables, airfoil section geometry and wing planform geometry, aerodynamic forces and moments, centre of pressure, pressure coefficient, calculation of airfoil lift and drag from measured surface pressure distributions, typical airfoil aerodynamic characteristics at low speeds.

Unit 4. **10 Hrs**

Two-Dimensional Inviscid Incompressible Flows

Bernoulli's equation, pitot-tube measurement of airspeed, condition on velocity

for incompressible flow, Eulers equations of motion, Governing equations for irrotational, incompressible flow, Laplace equation and boundary conditions. Two-dimensional source, sink and doublet flows, non-lifting flow over a two-dimensional circular cylinder and vortex flow.

PART B

Unit 5. **06 Hrs**

Flow Over Circular Cylinders

Non-lifting flow over a two-dimensional circular cylinder, Lifting flow over a two-dimensionalcircular cylinder, Kutta-Joukowski theorem and generation of lift, D'Alembert's paradox.

Unit 6. **06 Hrs**

Incompressible Flow Over Airfoils

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

Unit 7. **06 Hrs**

Introduction to Viscous Flows

Navier-Stokes equations, boundary layer concept, displacement, momentum thickness and wall skin friction, viscous flow over two-dimensional streamlined and bluff bodies and drag characteristics, aspects of boundary layer separation and airfoil stall.

Unit 8. **08 Hrs**

Introduction to Aerodynamic Testing

Principles of wind tunnel flow simulation, open and closed circuit wind tunnels, and Major features of low speed, transonic and supersonic wind tunnels, smoke and tuft flow visualization techniques, Pressure and Aerodynamic load measurements on a model, total drag determination of two-dimensional bodies using wake survey at low speeds.

Text Books

1. Anderson, Jr. J.D. "Fundamentals of Aerodynamics", Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2007. (Special Indian Edition).
2. Houghton E.L and Carpenter P.W. "Aerodynamics for Engineering Students, CBS Publications and Distributors, 1993. (4th Edition).

References :

1. Pope A. and Harper, J J.,"Low Speed Wind Tunnel testing", John Wiley Inc. New York, 1966

2. Anderson, Jr. J.D. "Introduction to Flight", Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2007. (Special Indian Edition).
3. Schlichting, H. "Boundary Layer Theory" Mc Graw Hill, New York, 2004
4. Duncan WJ, Thom AS and Young AD., "Mechanics of Fluids", Second Edition, Edward Arnold Printers Ltd, London, 1981
5. Pope A. and Goin, KL. "High Speed Wind Tunnel Testing", John Wiley & Sons Inc. New York, 1965

Scheme of examination:

One Question to be set from each unit. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

AIRCRAFT PROPULSION

Sub Code	:	10AE55	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **06 Hrs**

Introduction

Introduction: Review of thermodynamic principles, Principles of aircraft propulsion, Types of power plants, Basics of heat transfer; conduction, convection, radiation, diffusion mass transfer basic concepts and governing equations.

Unit 2. **07 Hrs**

Fundamentals of Gas Turbine Engines

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

Unit 3. **07 Hrs**

Subsonic and Supersonic Inlets for Jet Engines

Internal flow and Stall in subsonic inlets – Boundary layer separation – Major features of external flow near a subsonic inlet – Relation between minimum area ratio and eternal deceleration ratio – Diffuser performance – Supersonic inlets – Starting problem on supersonic inlets – Shock swallowing by area variation – External declaration – Models of inlet operation.

Unit 4. **06 Hrs**

Combustion Chambers and Nozzles

Classification of combustion chambers – Important factors affecting combustion chamber design – Combustion process – Combustion chamber performance – Effect of operating variables on performance – Flame tube cooling – Flame stabilization – Use of flame holders – .Theory of flow in isentropic nozzles – Convergent nozzles and nozzle choking – Nozzle throat conditions – Nozzle efficiency – Losses in nozzles – Over expanded and under – expanded nozzles – Ejector and variable area nozzles – Interaction of nozzle flow with adjacent surfaces – Thrust reversal.

PART B

Unit 5. **07 Hrs**

Compressors

Principle of operation of centrifugal compressor – Work done and pressure rise – Velocity diagrams – Diffuser vane design considerations – Concept of prewhirl – Rotation stall – Elementary theory of axial flow compressor – Velocity triangles – degree of reaction – Three dimensional – Air angle distributions for free vortex and constant reaction designs – Compressor blade design – Centrifugal and Axial compressor performance characteristics.

Unit 6. **07 Hrs**

Intoduction to Turbines:

Types of turbines-Operating Priciple-Design consideration – Velocity triangles – degree of reaction -performance parameters – Basics of blade design principles

Unit 7. **06 Hrs**

Ramjet Propulsion:

Operating principle – Sub critical, critical and supercritical operation – Combustion in ramjet engine – Ramjet performance – Sample ramjet design calculations – Introduction to scramjet – Preliminary concepts in supersonic combustion – Integral ram- rocket

Unit 8. **06 Hrs**

Fundamentals of Rocket Propulsion

Types and Classification of rockets Operating principle – Specific impulse of a rocket – Rocket nozzle classification – Rocket performance considerations

Text Books

1. V. Ganesan, " Gas Turbine", Tata McGraw Hill Pub. Co. Ltd., 1996
2. Hill, P.G. & Peterson, C.R. "Mechanics & Thermodynamics of Propulsion" Addison – Wesley Longman INC, 1999.

References

1. Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H. "Gas Turbine Theory", Longman,
2. 1989.
3. Oates, G.C., "Aero thermodynamics of Aircraft Engine Components", AIAA Education Series, New York, 1985.
4. "Rolls Royce Jet Engine" – Third Edition – 1983.
5. Mathur, M.L. and Sharma, R.P., "Gas Turbine, Jet and Rocket Propulsion", Standard Publishers & Distributors, Delhi, 1999.
6. Sutton, G.P., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 5th Edn., 1993.
7. Heat & mass transfer by Domkundwar

Scheme of examination:

One Question to be set from each unit. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

AIRCRAFT STRUCTURES – I

Sub Code	:	10AE56	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **06 Hrs**

Loads On Aircraft

Structural nomenclature – Types of loads – load factor – Aerodynamics loads – Symmetric manoeuvre loads – Velocity diagram – Function of structural components.

Unit 2. **06 Hrs**

Materials for Aircraft Structures

Metallic and non-metallic materials, Use of Aluminium alloy, titanium, stainless steel and composite materials. Desirable properties for aircraft application

Unit 3. **06 Hrs**

Mechanical Properties of Material

Stress – Strain - Tensile properties – Compression properties – Shear properties – Bearing properties – Creep and Stress properties – Fracture properties –Fatigue properties.

Unit 4 **08 Hrs**

Statically Determinate And Interdeterminate Structures

Analysis of plane truss – Method of joints – 3 D Truss - Plane frames, Composite beam - Clapeyron's Three Moment Equation - Moment Distribution Method.

.

PART B

Unit 5. **06 Hrs**

Energy Methods Strain

Energy due to axial, bending and Torsional loads - Castigliano's theorem - Maxwell's Reciprocal theorem, Unit load method - application to beams, trusses, frames, rings, etc.

Unit 6. **06 Hrs**

Columns

Columns with various end conditions – Euler's Column curve – Rankine's formula - Column with initial curvature - Eccentric loading – South well plot – Beam column.

Unit 7. **08 Hrs**

Theory of Elasticity

Concept of stress and strain, derivation of Equilibrium equations, strain-displacement relation, compatibility conditions and boundary conditions. Plane stress and Plane strain problems in 2D elasticity and Airy's Stress function

Unit 8. **06 Hrs**

Failure Theory

Maximum Stress theory – Maximum Strain Theory – Maximum Shear Stress Theory – Distortion Theory – Maximum Strain energy theory – Application to aircraft Structural problems.

Text Book

1. Mechanics of Materials, Dr.BC Punmia, Ashoak Kumar Jain, Arun Kumar Jain, Lakshmi Publication
2. Megson, T.M.G., "Aircraft Structures for Engineering Students", Edward Arnold, 1995.
3. Timoshenko and Goodier," Theory of Elasticity' Mc Graw Hill Co.

Reference

1. Donaldson, B.K., "Analysis of Aircraft Structures – An Introduction", McGraw-Hill, 1993.
2. Timoshenko, S., "Strength of Materials", Vol. I and II, Princeton D. Von Nostrand Co, 1990

Scheme of Examination:

One Question to be set from each unit. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least TWO questions from Part A and TWO questions from Part B.

AERODYNAMICS LABORATORY

Sub Code	:	10AEL57	IA Marks	:	25
Hrs/ Week	:	03	Exam Hours	:	03
Total Hours	:	42	Exam Marks	:	50

LIST OF EXPERIMENTS

1. Calibration of a subsonic wind tunnel
2. Smoke flow visualization studies on a two-dimensional circular cylinder at low speeds.
3. Smoke flow visualization studies on a two dimensional airfoil at different angles of incidence at low speeds
4. Tuft flow visualization on a wing model at different angles of incidence at low speeds: identify zones of attached and separated flows.
5. Surface pressure distributions on a two-dimensional circular cylinder at low speeds and calculation of pressure drag.
6. Surface pressure distributions on a two-dimensional symmetric airfoil at zero incidences at low speeds.
7. Surface pressure distributions on a two-dimensional cambered airfoil at different angles of incidence and calculation of lift and pressure drag.
8. Calculation of total drag of a two-dimensional circular cylinder at low speeds using pitot-static probe wake survey.
9. Calculation of total drag of a two-dimensional cambered airfoil at low speeds at incidence using pitot-static probe wake survey.
10. Measurement of a typical boundary layer velocity profile on the tunnel wall (at low speeds) using a pitot probe and calculation of boundary layer displacement and momentum thickness.

ENERGY CONVERSION LABORATORY

Sub Code	: 10AEL58	IA Marks	:	25
Hrs/ Week	: 03	Exam Hours	:	03
Total Hours	: 42	Exam Marks	:	50

PART – A
(Individual Experiments)

21 Hrs

1. Determination of Flash point and Fire point of lubricating oil using Abel Pensky and Pensky Martins Apparatus.
2. Determination of Calorific value of solid, liquid and gaseous fuels
3. Determination of Viscosity of lubricating oil using Redwood, Saybolt Viscometer and Torsion viscometers.
4. Valve Timing/port opening diagram of an I.C. engine (4 stroke/ 2stroke).
5. Use of planimeter.

PART – B
(Group Experiments)

21 Hrs

1. Performance Tests on I.C. Engines, Calculations of IP, BP, Thermal efficiencies, SFC, FP, heat balance sheet for
   (a) Four stroke Diesel Engine
   (b) Four stroke Petrol Engine
   (c) Multi-cylinder Diesel/Petrol Engine, (Morse test)
   (d) Two stroke Petrol Engine
   (e) Variable Compression Ratio I.C. Engine

VI SEMESTER
APPLIED GAS DYNAMICS

Sub Code	: 10AE61	IA Marks	:	25
Hrs/ Week	: 04	Exam Hours	:	03
Total Hours	: 52	Exam Marks	:	100

PART A

Unit 1. **07 Hrs**

Basics of Compressible Flow

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

Unit 2. **07 Hrs**

Normal, Oblique Shocks and Expansion Waves

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

Unit 3. **06Hrs**

Fanno Flow

Flow with friction in constant area duct. Fanno lines. Fanno equation. Definition of friction constant, Friction loss. Effect of wall friction on flow properties. Friction parameter. Local flow properties in terms of local Mach number.

Unit 4. **06 Hrs**

Rayleigh Flow

Flow with heating or cooling in ducts. Governing equations. Heating relations for a perfect gas. Slope of Rayleigh line. Entropy considerations. Maximum heat transfer.

PART B

Unit 5. **07 Hrs**

Differential Equations of Motion for Steady Compressible Flows Basic potential equations for compressible flow. Linearisation of potential equation-small perturbation theory. Methods for solution of nonlinear potential equation -Introduction. Boundary conditions. Pressure coefficient expression.

Unit 6. **06 Hrs**

Similarity Rules

Two-dimensional linearized flow. Prandtl - Glauert rule and Gotherts rule. Von-Karman rule for transonic flow. Application to wings of finite span. Aerodynamic characteristics for actual and transformed bodies.

Unit 7. **06 Hrs**

Flow of Real Fluids.

Shock Wave – Boundary layer interaction. Experimental characteristics of airfoils in compressible flow. Nature of pressure distribution.

Unit 8. **07 Hrs**

Measurements in Compressible Flow

Types of Wind tunnel. Optical methods of flow visualization-shadow technique, Mach zender interferometer, Schileren technique. Wind tunnel Instrumentation and measurements-Pressure, Temperature, Flow rate, Hot-wire anemometer, Velocity measurements.

Text Books:

1. Radhakrishnan, E., "Gas Dynamics", Prentice Hall of India.1995 edition.
2. Yahya, S.M., "Fundamentals of Compressible flow", Wiley Eastern, 2003.

Reference Books:

1. John D Anderson, "Modern Compressible Flow", Mc Graw Hill 1999.
2. Ascher.H.Saphiro, "Dynamics and Thermodynamics of Compressible fluid flow", Ronald Press,1953.
3. H.W. Liepmann and A.Roshko, "Elements of Gas Dynamics"

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

AIRCRAFT PERFORMANCE

Sub Code	:	10AE62	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **06 Hrs**

Introduction:

The evolution of the airplane and the performance- a short history; The standard atmosphere; The Drag polar- source of aerodynamic force-lift, drag and moments; aerodynamic coefficients-Variation of lift, drag and moment coefficient with

angle of attack and Mach number Components of drag; Aerodynamic center; Equilibrium conditions; Variation of thrust, power and SFC with velocity and altitudes for air breathing engines..

Unit 2. **07 Hrs**

The Equations of Motion Steady Unaccelerated Flight:

Introduction, 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, Power available and maximum velocity, Altitude effects on power available and power required; thrust available and thrust required.

Unit 3. **07 Hrs**

Steady Performance – Level Flight, Climb & Glide:

Equation of motion for steady level flight, Performance of airplane in level flight. Maximum speed in level flight. Climb Performance: Equation of motion for Rate of climb- graphical and analytical approach -Absolute ceiling, Service ceiling, Time to climb – graphical and 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.

Unit 4. **06 Hrs**

Fundamental Airplane Performance Parameters:

The fundamental Parameters: Thrust – to – weight ratio, Wing loading, Drag polar, and lift-to – drag ratio. Minimum velocity: Stall and High lift devices, Nature of stall – flow separation, High lift deices, Aerodynamic relations associated with lift-to-drag ratio.

PART B

Unit 5. **07 Hrs**

Range And Endurance:

Propeller driven Airplane: Physical consideration, Quantitative formulation, Breguet equation for Range and Endurance, Conditions for maximum range and endurance.

Jet Airplane: Physical consideration, Quantitative formulation, Equation for Range and Endurance, Conditions for maximum range and endurance, Effect of head wind tail wind

Unit 6. **06 Hrs**

Aircraft Performance In Accelerated Flight

Take-off Performance: Calculation of Ground roll, Calculation of distance while airborne to clear obstacle, Balanced field length

Unit 7. **06 Hrs**

Landing Performance and Accelerated Climb:

Calculation of approach distance, Calculation of flare distance, Calculation of ground roll, ground effects. Acceleration in climb.

Unit 8. **07 Hrs**

Manouver Performance:

Turning performance: Level turn, load factor, Constraints on load factor, Minimum turn radius, Maximum turn rate. Pull-up and Pull-down maneuvers: (Turning rate, turn radius). Limiting case for large load factor. The V-n diagram. Limitations of pull up and push over.

Text Books:

1. John D. Anderson, Jr. "Aircraft Performance and Design", McGraw-Hill International Editions, Aerospace Science/ Technology Editions, 1999
2. John D. Anderson, Jr., "Introduction to flight" McGraw-Hill International Editions, Aerospace Science/ Technology Editions, 2000

References

1. Perkins, C.D., and Hage, R.E., "Airplane Performance stability and Control", John Wiley Son Inc, New York, 1988.
2. Barnes W. McCormick, ' Aerodynamics, Aeronautics, and Flight Mechanics', John Wiley & Sons, Inc. 1995.

Scheme of Examination: Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B

AERODYNAMICS – II

Sub Code	:	10AE63	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **06 Hrs.**

Introduction To Two-Dimensional Panel Methods

Non-lifting flows over arbitrary bodies, source panel method, lifting flows over arbitrary bodies, vortex panel method, some examples

Unit 2. **08 Hrs.**

Incompressible Flows Over Finite Wings

Downwash, Induced drag, vortex filament, the Biot-Savart Law, Prandtl's lifting line theory and its limitations, Elliptic lift distribution.

Unit 3. **06 Hrs.**

Subsonic linearized flow over airfoils

Full velocity potential equation, linearized velocity potential equation and boundary condition, Prandtl-Glauret compressibility correction.

Unit 4. **06 Hrs.**

Effects Of Compressibility

Basics of speed of sound, Mach waves, Normal shock waves, Oblique shock waves, Expansion fan, Prandtl – Meyer expansion, Critical Mach number; Drag-divergence Mach number, Sound Barrier, Transonic area rule,.

PART B

Unit 5. **06 Hrs.**

Applications Of Finite Wing Theory

Simplified horse-shoe vortex model, formation flight, influence of downwash on tail plane, ground effects.

Unit 6. **06 Hrs.**

Bodies Of Revolution

Introduction to slender body theory, cylindrical coordinates, boundary conditions, pressure coefficient, Subsonic flow past a axially symmetric body at zero incidence and solution for a slender cone.

Unit 7. **06 Hrs.**

Swept Wings And High-Lift Systems

Introduction to sweep effects, swept wings, pressure coefficient, typical aerodynamic characteristics, Subsonic and Supersonic leading edges. Introduction to high-lift systems, flaps, leading-edge slats and typical high - lift characteristics.

Unit 8. **08 Hrs.**

Viscous Flows

Derivation of Navier-Stokes equation for two-dimensional flows, boundary approximations, laminar boundary equations and boundary conditions, Blasius solution, qualitative features of boundary layer flow under pressure gradients, Integral method, aspects of transition to turbulence, turbulent boundary layer properties over a flat plate at low speeds.

Text Books:

1. Anderson, Jr. J.D. "Fundamentals of Aerodynamics", Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2007. (Special Indian Edition).
2. H.W. Liepmann and A.Roshko, "Elements of Gas Dynamics"
3. Schlichting, H, "Boundary layer theory", McGraw Hill, New York 2004

Reference:

1. Bertin, John J., "Aerodynamics for Engineers". Pearson Education Inc., 2002.
2. White, F.M., " Fluid Mechanics", Mc Graw Hill Inc. New York, 1986
3. Houghton E.L and Carpenter P.W. "Aerodynamics for Engineering Students", CBS Publications and Distributors,8 1993. (4th Edition).
4. Anderson, Jr. J.D. "Introduction to Flight", Tata McGraw-Hill Publishing Co. Ltd., New Delhi, 2007. (Special Indian Edition).

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

FINITE ELEMENT ANALYSIS

Sub Code	:	10AE64	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **08 Hrs.**

Introduction: Basic Concepts, Background Review:

Stresses and Equilibrium, Plane stress, Plane strain, Potential energy and Equilibrium. Rayleigh - Ritz Method, Galerkin's Method, Simple applications in structural Analysis. Construction or discrete models - sub domains and nodes - simple elements for the FEM - Simplex, complex and multiples elements Polynomial selection -illustrative examples

Unit 2 **06 Hrs**

Fundamentals of Finite Element Method:

Elements and shape functions and natural coordinates, Use of local and natural coordinates, compatibility and convergence requirements of shape functions, Construction of shape functions for bar element and beam element

Unit 3 **06 Hrs**

Analysis of Discrete Elements:

Bar elements, uniform bar elements, uniform section, mechanical and thermal

loading, varying section, truss analysis, Frame element, Beam element, problems for various loadings and boundary conditions.

Unit 4 **06 Hrs**

Analysis of Two dimensional Elements:

Shape functions of Triangular, Rectangular and Quadrilateral elements, different types of higher order elements, constant and linear strain triangular elements, stiffness matrix

PART B

Unit 5 **06 Hrs**

Analysis of Three dimensional elements:

Four-Noded Tetrahedral Element (TET 4), Eight-Noded Hexahedral Element (HEXA 8), Tetrahedral elements, Hexahedral elements: Serendipity family, Hexahedral elements: Lagrange family.

Unit 6 **06 Hrs**

Theory of Isoparametric Elements:

Isoparametric, sub parametric and super-parametric elements, characteristics of Isoparametric quadrilateral elements, structure of computer program for FEM analysis, description of different modules, pre and post processing.

Unit 7 **06 Hrs**

Axisymmetric solids subjected to axisymmetric loading:

Axisymmetric formulation, finite element modeling of triangular and quadrilateral element

Unit 8 **08 Hrs**

Field Problems:

Heat transfer problems, Steady state fin problems, 1D heat conduction governing equation, Derivation of element matrices for two dimensional problems, Dynamic consideration- Formulation-Hamilton's principle, Element mass matrices.

Text Books:

1. Chandrupatla T. R., "Finite Elements in engineering"- 2nd Edition, PHI, 2007.
2. C.S. Krishnamurthy - "Finite Element analysis - Theory and Programming", Tata McGraw Hill Co. Ltd, New Delhi
3. Bhavikatti, Finite element Analysis, New Age International

Reference Books:

1. Rajasekharan. S - "Finite element analysis in engineering design", Wheeler Publishers
2. Bathe. KJ - "Finite Element Procedures", PHI Pvt. Ltd., New Delhi

4. Zienkiewicz. O.C. - "The Finite Element Method", Tata McGraw Hill Co. Ltd, New Delhi
5. Rao S. S. "Finite Elements Method in Engineering"- 4th Edition, Elsevier, 2006

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

THEORY OF VIBRATIONS

Sub Code	:	10AE65	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1 **06 Hrs**
Introduction
Types of vibrations, S.H.M, principle of super position applied to Simple Harmonic Motions. Beats, Fourier theorem and simple problems.

Unit 2 **07 Hrs**
Undamped Free Vibrations
Single degree of freedom systems. Undamped free vibration,natural frequency of free vibration, Spring and Mass elements, effect of mass of spring, Compound Pendulum.

Unit 3 **07 Hrs**
Damped Free Vibrations
Single degree of freedom systems, different types of damping, concept of critical damping and its importance, study of response of viscous damped systems for cases of under damping, critical and over damping, Logarithmic decrement.

Unit 4 **06 Hrs**
Forced Vibration
Single degree of freedom systems, steady state solution with viscous damping due to harmonic force. Solution by Complex algebra, reciprocating and rotating unbalance, vibration isolation, transmissibility ratio. due to harmonic exitation and support motion.

PART B

Unit 5 **06 Hrs**
Vibration Measuring Instruments & Whirling Of Shafts
Vibration of elastic bodies – Vibration of strings – Longitudinal, lateral and torsional Vibrations

Unit 6. **08 Hrs**
Systems With Two Degrees Of Freedom
Introduction, principle modes and Normal modes of vibration, co-ordinate coupling, generalized and principal co-ordinates, Free vibration in terms of initial conditions. Geared systems. Forced Oscillations-Harmonic excitation. Applications:

a) Vehicle suspension.
b) Dynamic vibration absorber.
c) Dynamics of reciprocating Engines.

Unit 7 **06 Hrs**
Continuous Systems
Introduction, vibration of string, longitudinal vibration of rods, Torsional vibration of rods, Euler's equation for beams.

Unit 8 **06 Hrs**
Numerical Methods For Multi-Degree Freedom Systems
Introduction, Influence coefficients, Maxwell reciprocal theorem, Dunkerley's equation. Orthogonality of principal modes, Method of matrix iteration-Method of determination of all the natural frequencies using sweeping matrix and Orthogonality principle. Holzer's method, Stodola method.

Text Books:
1. Theory of Vibration with Applications: W.T. Thomson and Marie Dillon Dahleh, Pearson Education 5th edition, 2007.
2. Mechanical Vibrations: V.P. Singh, Dhanpat Rai & Company Pvt. Ltd., 3rd edition, 2006

Reference Books:
1. Mechanical Vibrations: S.S. Rao, Pearson Education Inc, 4th Edition, 2003.
2. Mechanical Vibrations: S. Graham Kelly, Schaum's Outline Series, Tata McGraw Hill, Special Indian edition, 2007.
3. Theory & Practice of Mechanical vibrations: J.S. Rao & K. Gupta, New Age International Publications, New Delhi, 2001.
4. Elements of Vibrations Analysis: Leonanrd Meirovitch, Tata McGraw Hill, Special Indian edition, 2007.

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B

ELECTIVE - I (Group A)
NUMERICAL METHODS

Sub Code	:	10AE661	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1 **06Hrs**

Numerical Computation

Motivation and Objectives/ Number Representation/ Machine Precision/ Round-off Error/ Truncation Error/ Random Number Generation.

Unit 2 **06 Hrs**

Linear Algebraic Systems

Motivation and Objectives/ Gauss-Jordan Elimination/Gaussian Elimination/ LU Decomposition/ III- Conditioned Systems/ Iterative Methods.

Unit 3 **06 Hrs**

Interpolation and Approximation

Lagrangian Polynomials - Divided differences Interpolating with a cubic spline - Newton's forward and backward difference formulas.

Unit 4 **08 Hrs**

Eigen Values and Eigen vectors

Motivation and Objectives/ The characteristics Polynominal/ Power Methods / Jacobi's Method/ Householder Transformation/ QR Method/ Danilevsky's Method/ Polynominal Roots.

PART B

Unit 5 **08 Hrs**

Numerical Differentiation and Integration

Derivative from difference tables - Divided differences and finite differences - Numerical integration by trapezoidal and Simpson's 1/3 and 3/8 rules - Two and Three point Gaussian quadrature formulas - Double integrals using trapezoidal and Simpson's rules.

Unit 6 **06 Hrs**

Curve Fitting

Motivation and objectives/ Interpolation/ Newton's Difference Formula/ Cubic Splines/ Least Square/ Two-Dimensional Interpolation.

Unit 7 **06 Hrs**

Root Finding

Motivation and Objectives/ Bracketing methods/ Contraction Mapping Method/ Se cant Method/ Muller's Method/ Newton's Method/ Polynomial Roots/ Nonlinear Systems of Equations.

Unit 8 **06 Hrs**

Optimization

Motivation and Objectives/ Local and Global Minima/ Line Searches/ Steepest Descent Method/ Conjugate-Gradient Method/ Quasi-Newton Methods/ Penalty Functions/ Simulated Annealing.

Text Book:

1. Applied Numerical methods for Engineers Using Mat Lab and C-Robert Schilling and Sandra Harris, Thomson Learning, 2002.
2. Applied Numerical Analysis – Gerald and Wheatley, Pearson Education, 2002.

Reference Books:

1 Numerical Recipes in C – William Press et. Al., 2e, Cambridge University Press.

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B

AIRCRAFT MATERIALS

Sub Code	:	10AE662	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit – 1 **06 Hrs**

Introduction To Aircraft Materials:

General properties of materials, Definition of terms, Requirements of aircraft materials, Testing of aircraft materials, Inspection methods, Application and trends in usage in aircraft structures and engines, Introduction to smart materials and nanomaterials; Selection of materials for use in aircraft.

Unit – 2 **08 Hrs**

Aircraft Metal Alloys And Superalloys:

Aluminum alloys, Magnesium alloys, Titanium alloys, Plain carbon and Low carbon Steels, Corrosion and Heat resistant steels, Maraging steels, Copper alloys, Producibility and Surface treatments aspects for each of the above; General introduction to superalloys, Nickel based superalloys, Cobalt based superalloys, and Iron based superalloys, manufacturing processes associated with superalloys, Heat treatment and surface treatment of superalloys.

Unit – 3 **06 Hrs**

Composite Materials:

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, titanium and nickel based composites for engines.

Unit – 4 **06 Hrs**

Polymers, Polymeric Materials & Plastics and Ceramics & Glass:

Knowledge and identification of physical characteristics of commonly used polymeric material: plastics and its categories, properties and applications; commonly used ceramic, glass and transparent plastics, properties and applications, adhesives and sealants and their applications in aircraft.

PART B

Unit – 5 **06 Hrs**

Ablative and Super Conducting Materials:

Ablation process, ablative materials and applications in aerospace; Phenomenon of super conduction, super conducting materials and applications in aerospace.

Unit – 6 **07 Hrs**

Aircraft Wood, Rubber, Fabrics & Dope And Paint:

Classification and properties of wood, Seasoning of wood, Aircraft woods, their properties and applications, Joining processes for wood, Plywood; Characteristics and definition of terminologies pertaining to aircraft fabrics and their applications, Purpose of doping and commonly used dopes; Purpose of painting, Types of aircraft paints, Aircraft painting process.

Unit – 7 **06 Hrs**

Corrosion and Its Prevention:

Knowledge of the various methods used for removal of corrosion from common aircraft metals and methods employed to prevent corrosion.

Unit – 8 **07 Hrs**

High Energy Materials:

Materials for rockets and missiles. Types of propellants and its general and desirable properties, insulating materials for cryogenic engines. Types of solid propellants: Mechanical characterization of solid propellants using uni-axial, strip-biaxial and tubular tests.

Text Books:

1. Handbook of Aircraft materials Interline publishers, C G Krishnadas Nair, , Bangalore, 1993.
2. Aicraft Material and Processes, Titterton G F, , English Book Store, New Delhi, 1998

Reference:

1. Advanced Aerospace Material, H Buhl, Spring Berlin 1992
2. Aerospace material Vol. 1,2,3 ARDB, Balram Gupta, S Chand & Co 1996
3. Materials for Missiles and Space, Parker E R, John Wiley.
4. The Materials of Aircraft Construction, Hill E T, Pitman London.

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B

COMBUSTION

Sub Code	:	10AE663	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit – 1 **06 Hrs**

Review of Basic Concepts:

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

Unit – 2 **06 Hrs**

Chemical Equilibrium And Kinetics:

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

Unit – 3 **08 Hrs**

Premixed Flames:

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

Unit – 4 **06 Hrs**

Diffusion Flames:

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

PART B

Unit – 5 **06 Hrs**

Combustion in Piston Engines:

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

Unit – 6 **07 Hrs**

Combustion in Gas-Turbine Engines:

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

Unit – 7 **07 Hrs**

Combustion in Rocket Engines:

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

Unit – 8 **06 Hrs**

Emissions:

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

Text Books:

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

Reference Books:

1. Industrial Combustion by Charles E. Baukal.
2. Heat Transfer in Industrial Combustion by CE Baukal Jr
3. Combustion, Fossil Power Systems by G. Singer. 4th Ed. 1966 Ed Pub.

4. Fuels and Combustion, Sharma, S.P., and Chandra Mohan , Tata Me. Graw Hill Publishing Co.,Ltd., New Delhi, 1987.
5. Gas Turbine, Jet and Rocket Propulsion, Mathur, M.L., and Sharma, R.P., ,' Standard Publishers and Distributors, Delhi, 1988

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B

RELIABILITY ENGINEERING

Sub Code	:	10AE664	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1 **07 Hrs**

Introduction

Reliability concepts and definitions, probability distribution functions and their application in reliability Evaluation,Reliability Evaluation in Engineering systems using Markov Models

Unit 2 **07 Hrs**

Failure analysis

Causes of failure, concept of hazard failure models, Bath Tub curve, MTTF, MTBF

Unit 3 **06 Hrs**

Reliability Modeling

System reliability for various configurations and combinational aspects, Weibull analysis On reliability

Unit 4 **06 Hrs**

Reliability Studies:

Reliability improvement, redundancy, reliability-cost trade-off

PART B

Unit 5 **06 Hrs**

Maintainability and Availability concepts

System Safety analysis

Unit 6 **07 Hrs**

Maintenance concepts

Types of Maintenance, Modern trends in Maintenance Philosophy like BITE, **IRAN,** HUM, TPM etc.

Unit 7 **06 Hrs**

Failure Investigation Process and Methodologies like FTA, FMEA

Unit 8 **07 Hrs**

Reliability and Quality Improvement techniques like, Bench Marking, JIT, Quality Circles, Quality Audit, TQM, Kaizan etc.

Text Book:

1. Introduction to Reliability Engineering, E.E. Lewis, John Wiley.

Reference Books:

1. Probability and statistics with Reliability, Queuing and Computer, K.S. Trivedi,
2. Science Applications, PHI.
3. Reliability Engineering, E Balagurswamy, Tata McGraw Hill Publications.

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

INDUSTRIAL MANAGEMENT

Sub Code	:	10AE665	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART - A

Unit – 1 **06 Hrs**

Introduction: Historical perspective, contribution of Taylor, Henry Fayol, Gilbert, Charles Babbage, Henry Gantt to the evolution of management science in the Indian context. Ownership of Industries Proprietorship, partnership, joint stock companies, public and private undertakings, co-operative organizations

Unit – 2 **08 Hrs**

Quality Philosophy: The Meaning of Quality and Quality Improvement; Brief History of Quality Methodology; Statistical Methods for Quality Control and

Improvement; Total Quality Management (quality philosophy, links between quality and productivity, quality costs legal aspects of quality implementing quality improvement). Definitions and aims of standardizations, techniques for standardization (Statistical Principles, Codification system, variety control and value Engineering).

Unit – 3 **06 Hrs**

Statistical Process Control: Chance and assignable causes, Statistical Basis of the Control Charts -basic principles, choices of control limits, significance of control limits, control limits, analysis of pattern on Variable attribute control charts (no numericals)

Unit – 4 **06 Hrs**

Work Study, Incentives, Health And Safety: Work study-Motion study and Method time study, principles of motion economy, charts and diagrams, Job evaluation systems, Multi skilling, Wage payment and plans, Incentive schemes, Training and Development, Safety Regulations and safe practices.

PART - B

Unit – 5 **06 Hrs**

Motivation And Behavior: Hawthorns studies and its findings Maslows theory X and Y theory, Immaturity theory motivation hygiene theory, Pretence of needs and satisfaction of needs, goal oriented behavior, integration of organizational goals and needs of employee.

Unit – 6 **06 Hrs**

Management And Behavioral Approach: Contribution of Elton Mayo and Skinner to behavior sciences. Skills of a manager at various levels in an organization and inter-related systems, understanding past behavior, predicting future behavior, directing, changing and controlling behavior.

Unit – 7 **07 Hrs**

Process Management: Definition of process management. Major process decisions-process choice, vertical integration, resource flexibility, customer involvement, capital intensity, relationships between decisions, service operation, economics of scoop and gaining focus. Designing process-process rearranging and process improvement

Unit – 8 **07 Hrs**

Management Of Technology: Meaning and role of technology-primary areas of technology management, management of technology and its role in improving

business performance. Creating and applying technology-R and D stages and technology fusion. Technology strategy. Implementation guidelines.

Text Books:

1. **Principles of Management**, Koontz O Donnel,"Mc.Graw Hill Intl.Book Co.
2. **Statistical Quality Control:** E.L. Grant and R.S. Leavenworth, 7th edition, McGraw- Hill publisher

Reference Books:

1. **Essentials of management,** Koontz Weirich,TATA McGraw Hill Intl. Book Co., 7th Edition.
2. **Management of Organizational Behaviour,** Hersey Paul and Kenneth H," PHI.
3. **Operations management-strategy and analysis,**Lee J.Krajewski and Larry P. Ritzman, Fifth Edition Addison-Wiley.
4. **Organizational Behaviour,** Stephen P Robbins, 9th Edition, Pearson Education Publications, ISBN-81-7808-561-5 2002

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

ROCKETS AND MISSILES

Sub Code	:	10AE666	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART-A

Unit-1 **06 Hrs**

Rockets Classification and Definitions, Rocket propulsion, nuclear rocket engine, electric rocket propulsion, other rocket propulsion concepts. Application of rocket propulsion. Total impulse, exhaust velocity, energy and efficiency, acceleration in multiple of earth gravity or thrust to vehicle weight ratio.

Unit-2 **06 Hrs**

Nozzle Theory and Flight Performance, Ideal rocket thrust and thrust coefficient, characteristics velocity and specific impulse. Principal losses in real nozzles. Nozzle alignment, Gravity free, drag free space flight, forces acting on a vehicle in atmospheric space flight.

Unit-3 **06 Hrs**

Rocket Propellant ; Propellant - Desirable Physical Properties. Liquid Oxidizers, Liquid mono propellants. Solid Propellant Classification. Propellant characteristics. Aging and useful life. Typical ingredients of composite solid propellants. Hybrid Rocket Propellant –Introduction, Application, Grain Configuration.

Unit-4 **08 Hrs**

Selection of Rocket Propulsion System. Idealized process for selecting propulsion system. Advantages and disadvantages of solid and liquid propellant rockets. Criteria for selection.

PART-B

Unit-5 **08 Hrs**

Missile Aerodynamics. Theory of bodies of revolution. Lift and moment of slender bodies of revolution. Pressure distribution and loading of slender bodies of revolution. Planar W-B Interference. Generalized nature of Aerodynamic forces and stability derivatives.

Unit-6 **06 Hrs**

Missile Aerodynamic Control; Types of Controls-Conventions. Change in Missile Attitude due to Impulsive Pitch Control. Altitude effects. Equations of motion for missile pitch control. All moving control for Cruciform Controls.

Unit-7 **06 Hrs**

Thrust Vector Control: Thrust Vector Control Mechanism-advantages and disadvantages. TVC with multiple thrust chamber or nozzle. Testing, Integration with Vehicle.

Unit-8 **06 Hrs**

Rocket Testing Different types of tests, Test facility and safe guards. Instrumentation and data management Flight testing & post accident procedure.

Text Books:

1. George P Sutton and Oscar Biblarz, 'Rocket Propulsion Element', John Wiley and Sons Inc 2001
2. Jack N Neilson, 'Missile Aerodynamics', McGraw hill Book Company, Inc 1960

Reference Books:

1. S S Chin, 'Missile Configuration Design

Scheme of Examination:
Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

STRUCTURES LABORATORY

Sub Code	:	10AEL67	IA Marks	:	25
Hrs/ Week	:	03	Exam Hours	:	03
Total Hours	:	42	Exam Marks	:	50

List of Experiments

1. Deflection of a Simply Supported Beam.
2. Verification of Maxwell's Reciprocal Theorem..
3. Determination of Young's Modulus using strain gages.
4. Poisson Ratio Determination
5. Buckling load of slender Eccentric Columns and Construction of Southwell Plot
6. Shear Failure of Bolted and Riveted Joints
7. Bending Modulus of sandwich Beam
8. Verification of Superposition Theorem
9. Determination of fundamental frequency of a cantilever beam and harmonics.
10. Frequency spectrum analysis for a cantilever beam.

PROPULSION LABORATORY

Sub Code	:	10AEL68	IA Marks	:	25
Hrs/ Week	:	03	Exam Hours	:	03
Total Hours	:	42	Exam Marks	:	50

List Of Experiments

1. Study of an aircraft piston engine. (Includes study of assembly of sub systems, various components, their functions and operating principles)
2. Study of an aircraft jet engine (Includes study of assembly of sub systems, various components, their functions and operating principles)
3. Study of forced convective heat transfer over a flat plate.
4. Cascade testing of a model of axial compressor blade row.
5. Study of performance of a propeller.
6. Determination of heat of combustion of aviation fuel.
7. Study of free jet
8. Measurement of burning velocity of a premixed flame.
9. Fuel-injection characteristics
10. Measurement of nozzle flow.

VII SEMESTER
CONTROL ENGINEERING

Sub Code	:	10AE71	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART - A

UNIT - 1

Introduction: Concept of automatic controls, Open loop and closed loop systems, Concepts of feedback, requirements of an ideal control system, Types of controllers- Proportional, Integral Proportional Integral, Proportional Integral Differential controllers. **07 Hrs**

UNIT- 2

Mathematical Models: Transfer function models, models of mechanical systems, models of electrical circuits, DC and AC motors in control systems, models of thermal systems, models of hydraulic systems, pneumatic system, Analogous systems: Force voltage, Force current. **06 Hrs**

UNIT - 3

Block Diagrams and Signal Flow Graphs: Transfer Functions definition, function, block representation of systems elements, reduction of block diagrams, Signal flow graphs: Mason's gain formula. **07 Hrs**

UNIT- 4

Transient and Steady State Response Analysis: Introduction, first order and second order system response to step, ramp and impulse inputs, concepts of time constant and its importance in speed of response. System stability: Routh's-Hurwitz Criterion. **06 Hrs**

PART -B

UNIT - 5

Frequency Response Analysis: Polar plots, Nyquist stability criterion, Stability analysis, Relative stability concepts, Gain margin and phase margin, M&N circles. **06 Hrs**

UNIT - 6

Frequency Response Analysis Using Bode Plots: Bode attenuation diagrams, Stability analysis using Bode plots, Simplified Bode Diagrams. **07 Hrs**

UNIT - 7

Root Locus Plots: Definition of root loci, General rules for constructing root loci, Analysis using root locus plots. **06 Hrs**

UNIT 8

System Compensation and State Variable Characteristics of Linear Systems: Series and feedback compensation, Introduction to state concepts, state equation of linear continuous data system. Matrix representation of state equations, controllability and observability, Kalman and Gilberts test. **07 Hrs**

Text Books :

1. **Modern Control Engineering,** Katsuhiko Ogatta, Pearson Education,2004.
2. **Control Systems Principles and Design,** M.Gopal, 3rd Ed., TMH,2000.

Reference Books :

1. **Modern Control Systems**, Richard.C.Dorf and Robert.H.Bishop, Addison Wesley,1999
2. **System dynamics & control**, Eronini-Umez, Thomson Asia pte Ltd. singapore, 2002.
3. **Feedback Control System**, Schaum's series. 2001.

AIRCRAFT STRUCTURES - II

Sub Code	:	10AE72	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **06 Hrs**

Introduction to Aircraft Structural Design:

Structural layout of the Airplane and components, Structural design V-n diagram,loads acting on major components such as wing, fuselage, tails, landing gear etc.,Concept of allowable stress and margin of safety.

Unit 2. **06 Hrs**

Unsymmetrical Bending:

Bending stresses in beams of unsymmetrical sections – Bending of symmetric sections with skew loads

Unit 3. **06 Hrs**

Shear Flow in Open Sections:

Thin walled beams, Concept of shear flow, shear centre, Elastic axis. With one axis of symmetry, with wall effective and ineffective in bending, unsymmetrical beam sections.

Unit 4. **08 Hrs**

Shear Flow in Closed Sections:

Bredt – Batho formula, Single and multi – cell structures, Approximate methods, Shear flow in single & multi-cell structures under torsion. Shear flow in single and multi-cell under bending with walls effective and ineffective.

PART B

Unit 5. **06 Hrs**

Buckling of Plates:

Rectangular sheets under compression, Local buckling stress of thin walled sections, Crippling stresses by Needham's and Gerard's methods, Thin walled column strength. Sheet – stiffener panels. Effective width, inter rivet and sheet wrinkling failures.

Unit 6. **08 Hrs**

Stress Analysis in Wing And Fuselage:

Procedure – Shear and bending moment distribution for semi cantilever and other types of wings and fuselage, thin webbed beam. With parallel and non parallel flanges, Shear resistant web beams, Tension field web beams (Wagner's).

Unit 7. **06 Hrs**

Design of Aircraft Structure:

Design criteria – Safety Factor – Design life criteria – Analysis method – Life Assessment procedures – Design Principle – Future Airworthiness Requirements– Two bay crack criteria – Widespread Fatigue damage.

Unit 8. **06 Hrs**

Joints and Fittings And Introduction to Post Buckling:

General theory for the design of fittings, Estimation of fitting design loads, design of riveted, bolted and welding joints, post buckling of structures, concept of effective width.

Text Books:

1. Megson, T.M.G., "Aircraft Structures for Engineering Students", Edward Arnold,1995.

2. Peery, D.J., and Azar, J.J., "Aircraft Structures", 2nd edition, McGraw–Hill, N.Y., 1993.

Reference:

1. Bruhn. E.H. "Analysis and Design of Flight vehicles Structures", Tri – state off set company, USA, 1985.
2. Rivello, R.M., "Theory and Analysis of Flight Structures", McGraw-Hill, 1993.
3. D Williams & Edward Arnold, An Introduction to the Theory of Aircraft Structures.

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

AIRCRAFT STABILITY AND CONTROL

Sub Code	:	10AE73	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **06 Hrs**

Static Longitudinal Stability:

Historical perspective, Aerodynamic Nomenclature, Equilibrium conditions, Definition of static stability, Definition of longitudinal static stability, stability criteria, Contribution of airframe components: Wing contribution, Tail contribution, Fuselage contribution, Power effects- Propeller airplane and Jet airplane

Unit 2. **07 Hrs**

Static Longitudinal Stability and Control-Stick Fixed

Introduction, Trim condition. Static margin. stick fixed neutral points. Longitudinal control, Elevator power, Elevator angle versus equilibrium lift coefficient, Elevator required for landing, Restriction on forward C.G. range,

Unit 3. **07 Hrs**

Static Longitudinal Stability and Control-Stick Free

Introduction, Hinge moment parameters, Control surface floating characteristics

and aerodynamic balance, Estimation of hinge moment parameters, The trim tabs, Stick-free Neutral point, Stick force gradient in unaccelerated flight, Restriction on aft C.G.

Unit 4. **06 Hrs**

Static Directional Stability and Control

Introduction, Definition of directional stability, Static directional stability rudder fixed, Contribution of airframe components, Directional control. Rudder power, Stick-free directional stability, Requirements for directional control, Rudder lock, Dorsal fin. One engine inoperative condition.. Weather cocking effect.

PART B

Unit 5. **06 Hrs**

Static Lateral Stability And Control

Introduction, definition of Roll stability. Estimation of dihedral effect., Effect of wing sweep, flaps, and power, Lateral control, Estimation of lateral control power, Aileron control forces, Balancing the aileron. Coupling between rolling and yawing moments. Adverse yaw effects. Aileron reversal.

Unit 6. **07 Hrs**

Dynamic Longitudinal Stability

Definition of Dynamic longitudinal stability: types of modes of motion: long or phugoid motion, short period motion. Airplane Equations of longitudinal motion, Derivation of rigid body equations of motion, Orientation and position of the airplane, gravitational and thrust forces, Small disturbance theory.

Unit 7. **07 Hrs**

Estimation of Dynamic Derivatives:

Aerodynamic force and moment representation, Derivatives due to change in forward speed, Derivatives due to the pitching velocity, Derivatives due to the time rate of change of angle of attack, Derivatives due to rolling rate, Derivatives due to yawing rate

Unit 8. **06 Hrs**

Dynamic Lateral and Directional Stability

Routh's criteria. Factors affecting period and damping of oscillations. Effect of wind shear. Flying qualities in pitch. Cooper-Harper Scale. Response to aileron step-function, side-slip excursion. Dutch roll and Spiral instability. Auto- rotation and spin. Stability derivatives for lateral and directional dynamics. Roll-Pitch-Yaw Inertial coupling.

Text Books:

1. Nelson, R.C. "Flight Stability and Automatic Control", McGraw-Hill Book Co., 2007.
2. Perkins, C.D., and Hage, R.E., "Airplane Performance stability and Control", John Wiley Son Inc, New York, 1988.

References

1. Bernard Etkin, " Dynamics of Flight Stability and Control", John Wiley & Sons, Second Edition, 1982.
2. Bandu N. Pamadi, ' Performance, Stability, Dynamics and Control of Airplanes', AIAA 2nd Edition Series, 2004.
3. Barnes W. McCormick, ' Aerodynamics, Aeronautics, and Flight Mechanics', John Wiley & Sons, Inc. 1995.

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B

GAS TURBINE TECHNOLOGY

Sub Code	:	10AE74	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART-A

Unit 1. **06 Hrs**

Types, Variation & Applications

Types of engines showing arrangement of parts. Operating parameters. Energy distribution of turbojet, turboprop and turbofan engines. Comparison of thrust and specific fuel consumption. Thrust, pressure and velocity diagrams.

Unit 2. **07 Hrs**

Engine Parts

Compressor assembly, types of burners: advantages and disadvantages. Influence of design factors on burner performance. Effect of operating variables on burner performance. Performance requirements of combustion chambers. Construction of nozzles. Impulse turbine and reaction turbine. Exhaust system, sound suppression. Thrust reversal: types, design & systems. Methods of thrust augmentation, afterburner system.

Unit 3. **06 Hrs**

Materials and Manufacturing

Criteria for selection of materials. Heat ranges of metals, high temperature strength. surface finishing. Powder metallurgy. Use of composites and Ceramics. Superalloys for Turbines.

Unit 4. **07 Hrs**

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.

PART – B

Unit 5. **06 Hrs**

Engine Performance

Design & off-design Performance. Surge margin requirements, surge margin stack up. Transient performance. Qualitative characteristics quantities. Transient working lines. Starting process & Wind milling of Engines. Thrust engine start envelope. Starting torque and speed requirements Calculations for design and off-design performance from given test data – (case study for a single shaft Jet Engine). Engine performance monitoring.

Unit 6. **07 Hrs**

Component Level Testing

Compressor: Compressor MAP. Surge margin, Inlet distortions. Testing and Performance Evaluation. **Combustor:** Combustor MAP, Pressure loss, combustion light up test. Testing and Performance Evaluation. **Turbines:** Turbine MAP. Turbine Testing and Performance Evaluation. **Inlet duct & nozzles:** Ram pressure recovery of inlet duct. Propelling nozzles, after burner, maximum mass flow conditions. Testing and Performance Evaluation.

Unit 7. **07 Hrs**

Engine Testing

Proof of Concepts: Design Evaluation tests. Structural Integrity. Environmental Ingestion Capability. Preliminary Flight Rating Test, Qualification Test, Acceptance Test. Reliability figure of merit. Durability and Life Assessment Tests, Reliability Tests. Engine testing with simulated inlet distortions and, surge test. Estimating engine-operating limits. Methods of displacing equilibrium lines.

Types of engine testings: Normally Aspirated Testing, Open Air Test Bed ,Ram Air Testing, Altitude Testing, Altitude test facility, Flying Test Bed, Ground Testing of Engine Installed in Aircraft, Flight testing. Jet thrust measurements in

flight. Test procedure: Test Schedule Preparation, Test Log Sheets, Test Documents. Type approval.

Unit 8. **06 Hrs**

Test Cells

Factors for design of engine test beds. Test bed calibration. Steps in test bed cross calibration.Measurements and Instrumentation. Data Acquisition system, Measurement of Shaft speed, Torque, Thrust, Pressure, Temperature, Vibration, Stress, Temperature of turbine blading etc. Engine performance trends: Mass and CUSUM plots. Accuracy and Uncertainty in Measurements. Uncertainty analysis. Performance Reduction Methodology.

Text Books:

1. Irwin E. Treager, 'Gas Turbine Engine Technology' , GLENCOE Aviation Technology Series, 7th Edition, Tata McGraw Hill Publishing Co.Ltd. Print 2003.
2. P.P Walsh and P. Peletcher, 'Gas Turbine Performance' Blackwell Science, 1998, ISBN 0632047843.
3. Michael J. Kores , and Thomas W. Wild,' Aircraft Power Plant', GLENCOE Aviation Technology Series, 7th Edition, Tata McGraw Hill Publishing Co.Ltd. 2002.

Reference Books:

1. Advance Aero-Engine Testing, AGARD-59 Publication
2. MIL –5007 E , 'Military Specifications: Engine , Aircraft, Turbo Jet & Turbofan ; General Specification for Advance Aero Engine testing', 15th Oct 1973.
3. J P Holman,' Experimental methods for Engineers', Tata McGraw –Hill Publishing Co. Ltd . ,2007.
4. A S Rangawala-Turbomachinery dynamics-Design and operations, McGraw –Hill Publishing Co. Ltd . ,2007.

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B

ELECTIVE - II (Group B)
OPTIMISATION TECHNIQUES

Sub Code	:	10AE751	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **06 Hrs**

Introduction

Non-linear programming. Mathematical fundamentals. Numerical evaluation of gradient.

Unit 2. **06 Hrs**

Unconstrained Optimisation

One dimensional, single variable optimization. Maximum of a function. Unimodal-Fibonacci method. Polynomial based methods.

Unit 3. **07 Hrs**

Unconstrained Minimisation

Multivariable functions. Necessary and sufficient conditions for optimality. Convexity. Steepest Descent Method -Convergence Characteristics. Conjugate Gradient Method. Linear programming -Simplex Method.

Unit 4. **07 Hrs**

Constrained Minimisation

Non-linear programming. Gradient based methods. Rosens's gradient, Zoutendijk's method, Generalised reduced gradient, Sequential quadratic programming. Sufficient condition for optimality.

PART B

Unit 5. **06 Hrs**

Direct Search Methods

Direct search methods for nonlinear optimization. Cyclic coordinate search. Hooke and Jeeves Pattern search method. Generic algorithm.

Unit 6. **06 Hrs**

Discrete And Dynamic Programming

Integer and discrete programming. Branch and bound algorithm for mixed integers. General definition of dynamic programming problem. Problem modeling and computer implementation. Shortest path problem.

Unit 7. **07 Hrs**

Optimisation Application

Transportation problem. Transportation simplex method. Network problems. Maximum flow in net works. General definition of dynamic programming. Problem modeling and computer implementation.

Unit 8. **07 Hrs**

Finite Element Based Optimisation

Parameter optimization using gradient methods -Derivative calculation. Shape optimisation. Topology optimisation of continuum structures.

Text Books:

1. Ashok D Belegundu and Tirupathi R . Chandrupatla, 'Optimisation Concepts and Applications in Engineering', Pearson Education, In C.,1991.

Reference Books:

1. Fletcher, R., 'Practical Methods of Optimisation', Wiley, New York ,2nd Edition, 1987.
2. Dennis J.E. and Schnabel, R. B., 'Numerical Methods for Unconstrained Optimisation and Nonlinear Equations', Prentice Hall, Engle Wood Cliffs, New Jersey, 1983.
3. S.S. Rao, ' Optimisation -Theory and Application', Wiley Eastern Ltd., 5th Edition.1990.

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B

COMPUTATIONAL FLUID DYNAMICS

Sub Code	:	10AE752	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **06 Hrs**

Introduction

Insight into power and philosophy of CFD. CFD ideas to understand. CFD application. Need for parallel computers for CFD algorithms. Models of flows. Substantial derivative, Divergence of velocity.

Unit 2. **07 Hrs**

Governing Equations

Continuity, Momentum and Energy equations; derivation in various forms. Integral versus Differential form of equations. Comments on governing equations. Physical boundary conditions. Forms of the governing equations particularly suited for CFD work: Shock fitting and Shock capturing methods. Generic form of equations.

Unit 3. **06 Hrs**

Mathematical Behavior of Partial Differential Equations:

Classification of partial differential equations. Cramer rule and Eigen value method. Hyperbolic, parabolic and elliptic forms of equations. Impact on physical and computational fluid dynamics; case studies: steady inviscid supersonic flow; unsteady invisid flow; steady boundary layer flow; and unsteady thermal conduction.

Unit 4. **07 Hrs**

Discretization

Essence of discretization. Taylor series approach for the construction of finite-difference quotients. Higher order difference quotients. Up-wind differencing. Midpoint leap frog method. Reflection boundary condition. Difference equations. Explicit and Implicit approach: definition and contrasts. Errors and analysis of stability. Error propagation. Stability properties of Explicit and Implicit methods.

PART B

Unit 5. **07 Hrs**

Grid Generation

Body –fitted coordinate system. Need for grid generation. Essential properties of grids. Types of grids (O-type, C-type and H- type). Various grid generation techniques - Algebraic, and Numerical grid generation. Elliptic grid generation. Structured, Un-structured grids, Adaptive grids, Grid collapse. Multi-Grid methods .Grid accuracies.

Unit 6. **06 Hrs**

Appropriate Transformation

General transformation of equations. Metrics and Jacobians. Generic form of the governing flow equations with strong conservative form in the transformed space. Transformation of continuity equation from physical plane into computational plane; application of Grids stretching .

Unit 7. **06 Hrs**

Finite Volume Techniques

Finite Volume Discretization - Cell Centered Formulation. High resolution finite volume upwind Scheme. Runge - Kutta Time Stepping . Multi - Time –Step Integration scheme. Cell Vertex Formulation. Numerical dispersion.

Unit 8. **07 Hrs**

CFD Application to Some Problems

Time and space marching. LAX-WENDROFF Technique . Relaxation technique. Point iterative mehod. Successive over-relaxation/under relaxation. Aspects of numerical dissipation and dispersion; artificial viscosity. The Alternating-Direction- (ADI) Implicit Technique. Approximate factorization scheme. Upwind schemes; Flux vector splitting.

Text Books:

1. John D Anderson Jr. Computational Fluid Dynamics, 'The Basics with Applications', McGraw Hill International Edn; 1995 .
2. Tapan K. Sengupta, 'Fundamentals of Computational Fluid Dynamics', Universities Press (India) Private Limited; 2005.

References:

1. F. Wendt (Editor), "Computational Fluid Dynamics - An Introduction", Springer – Verlag, Berlin; 1992.
2. Charles Hirsch, "Numerical Computation of Internal and External Flows", Vols. I and II. John Wiley & Sons, New York; 1988.
3. Jiyuan Tu, Guan Heng Yeoh, and Chaoqun Liu, ' Computational Fluid Dynamics- A Practical Approach', Elsevier Inc; 2008.

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

AIRCRAFT MAINTENANCE, REPAIR AND OVERHAUL

Sub Code	:	10AE753	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **07 Hrs**

Welding In Aircraft Structural Components

Equipments used in welding shop and their maintenance – Ensuring quality welds – Welding jigs and fixtures – Soldering and brazing.

Unit 2. **06 Hrs**

Sheet Metal Repair And Maintenance

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

Unit 3. **07 Hrs**

Plastics and Composites in Aircraft

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

Unit 4. **06 Hrs**

Inspection And Repair Of Composite Components:

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

PART B

Unit 5. **07 Hrs**

Aircraft Jacking, Assembly And Rigging

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

Unit 6. **07 Hrs**

Review of Hydraulic and Pneumatic System

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

Unit 7. **06 Hrs**

Inspection And Maintenance Of Auxilary Systems:

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

Unit 8. **06 Hrs**

Safety Practices

Hazardous materials storage and handling, Aircraft furnishing practices – Equipments. Troubshooting - Theory and practices.

Text Book

1. KROES, WATKINS, DELP, "Aircraft Maintenance and Repair", McGraw-Hill, New York,1992.

References

1. LARRY REITHMEIR, "Aircraft Repair Manual", Palamar Books, Marquette, 1992
2. BRIMM D.J. BOGGES H.E., "Aircraft Maintenance", Pitman Publishing corp. New York, 1940.

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

STATISTICAL QUALITY CONTROL

Sub Code	:	10AE754	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART - A

UNIT - 1

Introduction: The Meaning of Quality and Quality Improvement; Brief History of Quality Methodology; Statistical Methods for Quality Control and Improvement; Total Quality Management (quality philosophy, links between quality and productivity, quality costs, legal aspects of quality implementing, quality improvement). **06 Hours**

UNIT - 2

Modeling Process Quality: Mean, Median, Mode, Standard deviation, Calculating area, The Deming funnel experiment, Normal distribution tables, Finding the Z score, Central limit theorem. **06 Hours**

UNIT - 3

Methods And Philosophy Of Statistical Process Control: Chance and assignable causes, Statistical Basis of the Control Charts (basic principles, choices of control limits, significance of control limits, sample size and sampling frequency, rational subgroups, analysis of pattern on control charts, warning limits, Average Run Length-ARL) **06 Hours**

UNIT - 4

Control Charts For Variables: Control Charts for X-Bar and R- Charts, Type I and Type II errors, the probability of Type II error. Simple Numerical Problems **08 Hours**

PART - B

UNIT - 5

Process Capability: The foundation of process capability, Natural Tolerance limits, c_p – process capability index, c_{pk}, p_p – process performance index, summary of process measures. Numerical problems **06 Hours**

UNIT 6: Control Charts For Attributes: Binomial distribution, Poisson distribution (from the point of view of Quality control) Control Chart for Fraction Nonconforming, Control Chart for number Nonconforming, Control Charts for Nonconformities or Defects, Control Chart for Number of non conformities per unit. Numerical problems **07 Hours**

UNIT - 7

Lot-By-Lot Acceptance Sampling For Attributes: The acceptance sampling problem, single sampling plan for attributes, Double, Multiple, and Sequential sampling, AOQL, LTPD, OC curves, Military Standard 105E, the Dodge-Romig sampling plans. Numerical problems **07 Hours**

UNIT - 8

Cumulative-Sum (Cusum) & Exponentially Weighted Moving Average (Ewma) Control Charts: CUSUM Control Chart (basic principles of the chart for monitoring the process mean); EWMA control chart (EWMA control chart for monitoring process mean), design of an EWMA control chart. **06 Hours**

Text Books:

1. **Statistical Quality Control,** E.L. Grant and R.S. Leavenworth, 7th edition, McGraw- Hill publisher.
2. **Statistical Quality Control,** RC Gupta, Khanna Publishers, New Delhi, 2005

Reference Books:

1. **Statistical Process Control and Quality Improvement,** Gerald M. Smith, Pearson Prentice Hall. ISBN 0 – 13-049036-9.
2. **Statistical Quality Control for Manufacturing Managers,** W S Messina, Wiley & Sons, Inc. New York, 1987
3. **Statistical Quality Control,** Montgomery, Douglas, 5th Edition, John Wiley & Sons, Inc. 2005, Hoboken, NJ (ISBN 0-471-65631-3).
4. **Principles of Quality Control,** Jerry Banks, Wiley & Sons, Inc. New York.

THEORY OF PLATES AND SHELLS

Sub Code	:	10AE755	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **06 Hrs**

Introduction

Plate and Shell Structures in Aerospace Vehicles. Flexural rigidity of plates. Flexural rigidity of shells. Introduction to bending and buckling of plates and shells. Reinforced plates. Eccentrically compressed shells.

Unit 2. **07 Hrs**

Bending of Thin Plates -Stresses Pure bending of plates. Isotropic and orthotropic flat plates. Flexural rigidity of plate. Bending of plates by distributed lateral load. Combined bending and tension or compression. Bending and twisting moments. Shear stress.

Unit 3. **06 Hrs**

Bending Of Thin Plates - Strain Energy

Slopes of deflection of surface. Different edge conditions: - built in edge, simply supported edge and, free edge. Combined bending and tension or compression of plates. Strain energy by: – bending of plates, bending by lateral loads, combined bending and tension or compression of plates.

Unit 4. **07 Hrs**

Buckling Of Thin Plates

Method of calculation of critical loads. Buckling of simply supported rectangular plates uniformly compressed in one direction. Buckling of uniformly compressed rectangular plates simply supported along two opposite sides perpendicular to the direction of compression and having various edge conditions along the other two sides. Critical values of compressive stress.

PART B

Unit 5. **07 Hrs**

Buckling of Reinforced Plates

Stability of plates reinforced by ribs. Simply supported rectangular plates with longitudinal ribs. General equation for critical compressive stress. Critical compressive stress for a plate stiffened by one rib. Study of the experimental value of buckling of plates.

Unit 6. **07 Hrs**

Bending of Thin Shells

Deformation of an element of a shell. Expression for components of normal stresses. Flexural rigidity of shell. Case of deformation with presence of shearing stresses.

Unit 7. **06 Hrs**

Strain Energy Of Deformation Of Shells: Strain energy of deformation of shell:-bending and stretching of middle surface. Symmetrical deformation of a circular cylindrical shell. Differential equation for bending of strip.

Unit 8. **06 Hrs**

Buckling of Shells

Symmetrical buckling of cylindrical shell under the action of uniform axial compression :-differential equation , critical stress. Symmetrical buckling of cylindrical shell under the action of uniform axial pressure. Study of the experimental values of cylindrical shells in axial compression. Bent or eccentrically compressed shells.

Text Books:

1. Timoshenko, S.P. and Gere, J.M., "Theory of Elastic Stability", McGraw-Hill Book Co. 1986.
2. Timoshenko, S.P. Winowsky. S., and Kreger, "Theory of Plates and Shells", McGraw-Hill Book Co. 1990

References:

1. Flugge, W. "Stresses in Shells", Springer – Verlag, 1985.

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

NON DESTRUCTIVE TESTING

Sub Code	:	**10AE756**	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1 **07 Hrs**

Introduction

An Overview. Factors influencing the Reliability of NDE. Defects in materials. Defects in composites. NDT methods used for evaluation of materials and composites.

Unit 2 **07 Hrs**

Radiographic Inspection **X –**

Ray radiography: Principles of X – ray radiography, equipment. Production of X -rays, absorption, scattering, X-ray film processing; industrial radiographic practice, micro-radiography

Gamma ray radiography: Radioactivity, gamma ray sources, film radiography, application, examples. General radiographic procedures. Reading and Interpretation of Radiographs. Defects in welding.

Unit 3 **06 Hrs**

Ultrasonics

Principle of wave propagation. Ultrasonic equipment. Variables affecting an ultrasound test. Basic methods and general considerations. Testing of products. Ultrasonic testing of composites.

Unit 4. **06 Hrs**

Ultrasonic Inspection

Ultrasonic application for thickness measurement. Types of scanning, types of indication. Welding inspection, tube inspection, test standards, determination of elastic constants.

PART -B

Unit 5. **06 Hrs**

Liquid Penetrant Test

Basic concept. Test equipment. Test Parameters & Procedure. Safety precautions.

Unit 6. **07 Hrs**

Magnetic Particle Test

Methods of generating magnetic field. Demagnetization of materials. Magnetic particle test: Principles , Test Equipment and Procedure. Interpretation and evaluation.

Unit 7. **06 Hrs**

Eddy Current Test

Principles of eddy current. Factors affecting eddy currents. Test system and test arrangement. Standardization and calibration. Application and effectiveness.

Unit 8. **07 Hrs**

Some Other Methods

Thermal Inspection: **Principles, equipment, inspection methods, applications.**

Optical Holography: Principles, applications, holographic recording interferometer techniques of inspection

Acoustic Emission Inspection: Principle, comparison with other NDT methods, applicability, acoustic emission waves and propagation. Instrumentation principles.

Text Book:

1. J Prasad and C G Krishnadas Nair, ' Non-Destructive Test and Evaluation of Materials', Tata McGraw-Hill Publishing Co. Ltd., 2008.

Reference Books:

1. Metals Hand Book, Vol-17, 9th Edition, Non destructive evaluation & quality control, American society of metals. 2001
2. Baldev Raj, T. Jayakumar, M. Thavasimuthu, 'Nondestructive Testing', Narosa Publishing House, 1997.

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

MECHATRONICS AND MICROPROCESSOR

Sub Code	:	10AE757	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART - A

UNIT - 1

Introduction to Mechatronic Systems: Measurement and control systems Their elements and functions, Microprocessor based controllers. **06 Hours**

UNIT - 2

Review of Transducers and Sensors: Definition and classification of transducers. Definition and classification of sensors. Principle of working and applications of light sensors, proximity sensors and Hall effect sensors. **07 Hours**

UNIT 3

Electrical Actuation Systems: Electrical systems, Mechanical switches, solid-state switches, solenoids, DC & AC motors, Stepper motors and their merits and demerits. **06 Hours**

UNIT - 4

Signal Conditioning: Introduction to signal conditioning. The operational amplifier, Protection, Filtering, Wheatstone bridge, Digital signals Multiplexers, Data acquisition, Introduction to Digital system. Processing Pulse-modulation. **07 Hours**

PART - B

UNIT - 5

Introduction to Microprocessors: Evolution of Microprocessor, Organization of Microprocessors (Preliminary concepts), basic concepts of programming of microprocessors.

Review of concepts - Boolean algebra, Logic Gates and Gate Networks, Binary & Decimal number systems, memory representation of positive and negative integers, maximum and minimum integers. Conversion of real, numbers, floating point notation, representation of floating point numbers, accuracy and range in floating point representation, overflow and underflow, addition of floating point numbers, character representation. **07 Hours**

UNIT - 6

Logic Function: Data word representation. Basic elements of control systems 8085A processor architecture terminology such as CPU, memory and address,

ALU, assembler data registers, Fetch cycle, write cycle, state, bus, interrupts. Micro Controllers. Difference between microprocessor and micro controllers. Requirements for control and their implementation in microcontrollers. Classification of micro controllers. **07 Hours**

UNIT - 7

Organization & Programming of Microprocessors: Introduction to organization of INTEL 808S-Data and Address buses, Instruction set of 8085, programming the 8085, assembly language programming. **06 Hours**

UNIT - 8

Central Processing Unit of Microprocessors: Introduction, timing and control unit basic concepts, Instruction and data flow, system timing, examples of INTEL 8085 and INTEL 4004 register organization. **06 Hours**

Text Books:

1. **Mechatronics,** W.Bolton, Longman, 2Ed, Pearson Publications, 2007.
2. **Microprocessor Architecture, Programming And Applications With 8085/8085A,** R.S. Ganokar, Wiley Eastern.

Reference Books:

1. **Mechatronics and Microprocessors,** K.P.Ramchandran, G.K.Vijayraghavan, M.S.Balasundran, Wiley, 1st Ed, 2009
2. **Mechatronics - Principles, Concepts and applications** – Nitaigour and Premchand Mahilik - Tata McGraw Hill- 2003.
3. **Mechatronics Principles & applications,** Godfrey C. Onwubolu, Elsevier..
4. **Introduction Mechatronics & Measurement systems,** David.G. Aliciatore & Michael. B. Bihistaned, Tata McGraw Hill, 2000.

TOTAL QUALITY MANAGEMENT

Sub Code	:	10AE758	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART - A

UNIT - 1

Principles and Practice: Definition, basic approach, gurus of TQM, TQM Framework, awareness, defining quality, historical review, obstacles, benefits of TQM. **06 Hours**

UNIT - 2

Leadership: Definition, characteristics of quality leaders, leadership concept, characteristics of effective people, ethics, the Deming philosophy, role of TQM leaders, implementation, core values, concepts and framework, strategic planning communication, decision making, **06 Hours**

UNIT - 3

Customer Satisfaction and Customer Involvement:

Customer Satisfaction : customer and customer perception of quality, feedback, using customer complaints, service quality, translating needs into requirements, customer retention, Case studies.

Employee Involvement – Motivation, employee surveys, empowerment, teams, suggestion system, recognition and reward, gain sharing, performance appraisal, unions and employee involvement, case studies. **07 Hours**

UNIT - 4

Continuous Process Improvement: process, the Juran trilogy, improvement strategies, types of problems, the PDSA Cycle, problem-solving methods, Kaizen, reengineering, six sigma, case studies.

Tools and Techniques: Benching marking, information technology, quality management systems, environmental management system, quality function deployment, quality by design, failure mode and effect analysis, product liability, total productive maintenance. **07 Hours**

PART - B

UNIT - 5

Quality Management Tools : Why Why, forced filed analysis, nominal group technique, affinity diagram, interrelationship digraph, tree diagram, matrix diagram, prioritization matrices, process decision program chart, activity network diagram. **07 hours**

UNIT - 6

Statistical Process Control : Pareto diagram, process flow diagram, cause-and-effect diagram, check sheets, histograms, statistical fundamentals, Control charts, state of control, out of control process, control charts for variables, control charts for attributes, scatter diagrams, case studies. **06 Hours**

UNIT - 7

Building and Sustaining Performance Excellence in Organizations : Making the commitment to total quality, organizational culture and total quality, change management, sustaining the quality organization, self-assessment processes, implementing ISO 9000, Bald ridge, and sis sigma, a view toward the future. **07 Hours**

UNIT - 8

Design for Six Sigma: Tools for concept development, tools for design development, tools for design optimization, tools for design verification, problems. **06 Hours**

Text Books:

1. **Total Quality Management:** Dale H. Bester field, Publisher - Pearson Education India, ISBN: 8129702606, Edition 03/e Paperback (Special Indian Edition)
2. **Total Quality Management for Engineers:** M. Zairi, ISBN: 1855730243, Publisher: Wood head Publishing

Reference Books:

1. **A New American TQM, four revolutions in management,** Shoji Shiba, Alan Graham, David Walden, Productivity press, Oregon, 1990
2. **100 Methods for Total Quality Management:** Gopal K. Kanji and Mike Asher, ISBN: 0803977476, Publisher: Sage Publications, Inc.; Edition - 1
3. **Organisational Excellence through TQM, H.** Lai, New age pub, 2008

ELECTIVE III (GROUP C)
EXPERIMENTAL STRESS ANALYSIS

Sub Code	:	10AE761	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART - A

UNIT-1

Electrical Resistance Strain Gages: Strain sensitivity in metallic alloys, Gage construction, Adhesives and mounting techniques, Gage sensitivity and gage factor, Performance Characteristics, Environmental effects, Strain Gage circuits. Potentiometer, Wheatstone's bridges, Constant current circuits. **06 Hours**

UNIT-2

Strain Analysis Methods: Two element, three element rectangular and delta rosettes, Correction for transverse strain effects, Stress gage, Plane shear gage, Stress intensity factor gage. **06 Hours**

UNIT-3

Photo-elasticity: Nature of light, Wave theory of light - optical interference , Stress optic law – effect of stressed model in plane and circular polariscopes, Isoclinics & Isochromatics, Fringe order determination Fringe multiplication techniques, Calibration photoelastic model materials **08 Hours**

UNIT-4

Two Dimensional Photo-elasticity: Separation methods: Shear difference method, Analytical separation methods, Model to prototype scaling, Properties of 2D photo-elastic model materials, Materials for 2D photo-elasticity **06 Hours**

PART -B

UNIT-5

Three Dimensional Photo elasticity: Stress freezing method, Scattered light photo-elasticity, Scattered light as an interior analyzer and polarizer, Scattered light polariscope and stress data Analyses. **06 Hours**

UNIT-6

Photoelastic (Birefringent) Coatings : Birefringence coating stresses, Effects of coating thickness: Reinforcing effects, Poisson's, Stress separation techniques: Oblique incidence, Strip coatings. **08 Hours**

UNIT-7

Brittle Coatings: Coatings stresses, Crack patterns, Refrigeration techniques, Load relaxation techniques, Crack detection methods, Types of brittle coatings, Calibration of coating. Advantages and brittle coating applications. **06 Hours**

UNIT-8

Moire Methods: Moire fringes produced by mechanical interference .Geometrical approach, Displacement field approach to Moire fringe analysis ,0ut of plane displacement measurements, Out of plane slope measurements .Applications and advantages **06 Hours**

Text Books:

1. **"Experimental Stress Analysis",** Dally and Riley, McGraw Hill.
2. **"Experimental Stress Analysis".** Sadhu Singh, Khanna publisher.
3. **Experimental stress Analysis,** Srinath L.S tata McGraw Hill.

References Books :

1. **"Photoelasticity Vol I and Vol II,** M.M.Frocht, John Wiley & sons.
2. **"Strain Gauge Primer",** Perry and Lissner,
3. **"Photo Elastic Stress Analysis",** Kuske, Albrecht & Robertson John Wiley & Sons.
4. **"Motion Measurement and Stress Analysis",** Dave and Adams,

HELICOPTER DYNAMICS

Sub Code	:	10AE762	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART- A

Unit 1. **06 Hrs**

Introduction to Helicopter

Definitions. Genealogical tree of aircraft. Comparison between fixed wing aircraft and helicopter. Some helicopter configurations, major parts, and their functions. Civil and Military applications of helicopters. High speed rotorcraft.

Unit 2. **07 Hrs**

Hover And Vertical Flight

Momentum theory and its application. Hovering flight and ground effects. Forces acting during hovering flight. Disc loading and power loading. Thrust and power coefficients. Figure of merit for hover thrust efficiency. Rotor solidity and blade loading coefficient. Forces acting during vertical flight. Cockpit control for vertical flight. Vertical climb and descend - variation in induced velocities. Torque balance and directional control, turning flights.

Unit 3. **07 Hrs**

Forward Flight

Forces acting on helicopter in forward flight. Method of achieving translatory flight. Controlling cyclic pitch: Swash-plate system. Blade flapping, feathering. Schematics showing flapping, lead/lag and feathering motion of rotor blade. Drag hinges. Lateral tilt - with and without conning. Lateral and longitudinal asymmetry of lift in forward flight. Types of rotors - teetering design, articulated design,, the hinge less design and bearing less design. Cockpit control of rotor system (collective and cyclic pitch).

Unit 4. **06 Hrs**

Basic Helicopter Performance

Hovering and axial climb and descent performance. Forward flight performance - total power required, effect of gross weight, effect of density altitude, lift – drag ratios, speed for minimum power, speed for maximum range. Factors affecting the maximum attainable forward speed. Autorotation- autorotation in forward flight, autorotation index. Ground effects in hover, transition and near ground, at low speed and high speed flights.

PART B

Unit 5. **06 Hrs**

Rotor Airfoil Aerodynamics And Dynamic Stall Rotor airfoil requirements - Reynolds number and Mach number influence. Airfoil shape criteria. Dynamic stall in rotor environment, flow topology. Effect of sweep angle on dynamic stall. Effect of aerofoil shape on dynamic stall.

Unit 6. **07 Hrs**

Helicopter Stabilty And Control

Introductory concepts of stability, control and trim- hover trim and forward flight trim. Static stability of helicopters: longitudinal, lateral – directional and, directional. Dynamic stability aspects. Flight controls and stability augmentation, Main rotor control and tail rotor control.

Unit 7. **07 Hrs**

Standards , Specifications And Testing Aspects

Scope of requirements. General and operational requirements. Military derivatives of civil rotorcraft. Structural strength and design for operations on specified surfaces. Rotorcraft vibration classification. Flight and Ground Handling Qualities – General requirements and definitions. Control characteristics, breakout forces. Levels of handling qualities. Flight Testing - General handling fight test requirements and, the basis of limitations.

Unit 8. **06 Hrs**

Conceptual Design Of Helicopters

Design requirements. Design of main rotor - rotor dia, tip speed, rotor solidity, blade twist and aerofoil selection. Fuselage design - fuselage drag, vertical drag and down loads, side forces. Empennage design.

Text Books:

1. John Fay, 'The Helicopter, History, Piloting & How it Flies', Sterling Book House 2007
2. Gordon Leisshman J, 'Principles of Helicopter Aerodynamics', Cambridge University Press, 2002

Reference Books:

1. Bramwell,'Helicopter Dynamics'.
2. Def Stan 00970, Vol. 2 Rotorcraft
3. Saunders, G H, 'Dynamics of Helicopter Flight', John Wiley & Sons, Inc, NY, 1975

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

SPACE MECHANICS AND LAUNCH VEHICALS

Sub Code	:	10AE763	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **07 Hrs**

Intoduction to Space Mechanics

Space vehicles/ platforms. Inertial and Earth fixed coordinate reference frames. Representation of vector (position, velocity and acceleration) in fixed and moving reference frames, Coordinate transformations, Euler transformations.

Unit 2. **06 Hrs**

Central Force Motion

Two body problem and one body problem. Kepler's laws of motion.

Unit 3. **07 Hrs**

Orbital Mechanics

Establishment of orbits, single impulse and two impulse orbital transfers, ballistic trajectory, orbital perturbations – general and special perturbation methods, Sun synchronous and Geo-synchronous orbits.

Unit 4. **06 Hrs**

Satellite Dynamics

Geosynchronous and geostationary satellites life time - satellite perturbations - Hohmann orbits - calculation of orbit parameters - Determination of satellite rectangular coordinates from orbital elements

PART B

Unit 5. **06 Hrs**

Introduction to Launch Vehicles

Introduction to launch vehicles.. Introduction to Solid, Liquid and Cryogenic rocket engines. Performance parameters. Comparison of liquid propellant, solid Propellant and hybrid rockets.

Unit 6. **07 Hrs**

Principles of Operation and Types of Rocket Engines

One dimensional and two dimensional rocket motions in free space and homogeneous gravitational fields. Description of vertical, inclined and gravity turn trajectories. Simple approximations to burnout velocity

Unit 7. **06 Hrs**

Rocket Performance and Staging

Launch vehicle trajectories, two body problem and orbital elements. Staging of rockets

Unit 8. **07 Hrs**

Spacecraft

Preliminary concepts of space, spacecraft. Introduction to manned and unmanned space missions. Spacecraft power generation. Life support system for manned space missions.

Materials for spacecraft: Selections of materials for spacecraft - special requirements of materials to perform under adverse conditions - ablative materials. . Life time estimation for a satellite.

Text Books:

1. M. H. Kaplan: Modern Spacecraft Dynamics and Control, John Wiley and Sons, 1976.
2. W. T. Thomson: Introduction to Space Dynamics, Dover Publications, 1986
3. G P Sutton, Rocket Propulsion Elements John Wiley and Sons, 1993

Reference Books:

1. H.S. Siefert (Ed.), "Space Mechanics", John Wiley & Sons, 1969.

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

SMART MATERIALS

Sub Code : 10AE764		IA Marks	: 25
Hrs/ Week : 04		Exam Hours	: 03
Total Hours : 52		Exam Marks	: 100

PART - A

UNIT - 1

Introduction: Characteristics of composites and ceramics materials, Dynamics and controls, concepts, Electro-magnetic materials and shape memory alloys-processing and characteristics **06 Hours**

UNIT - 2

Sensing And Actuation: Principals of electromagnetic, acoustics, chemical and mechanical sensing and actuation, Types of sensors and their applications, their compatibility writer conventional and advanced materials, signal processing, principals and characterization. **07 Hours**

UNIT - 3

Control Design: Design of shape memory alloys, Types of MR fluids, Characteristics and application, principals of MR fluid value designs, Magnetic circuit design, MR Dampers, Design issues. **06 Hours**

UNIT - 4

Optics And Electromagnetic: Principals of optical fiber technology, characteristics of active and adaptive optical system and components, design and manufacturing principles. **07 Hours**

PART - B

UNIT - 5

Structures: Principles of drag and turbulence control through smart skins, applications in environment such as aerospace and transportation vehicles, manufacturing, repair and maintainability aspects. **07 Hours**

UNIT - 6

Controls: Principles of structural acoustic control, distributed, amalog and digital feed back controls, Dimensional implications for structural control. **06 Hours**

UNIT - 7

Principles Of Vibration And Modal Analysis: PZT Actuators, MEMS, Magnetic shape Memory Alloys, Characteristics and Applications. **07 Hours**

UNIT - 8

Information Processing: Neural Network, Data Processing, Data Visualisation and Reliability – Principals and Application domains. **06 Hours**

Text Books:

1. **Analysis and Design',** A. V. Srinivasan, 'Smart Structures –Cambridge University Press, New York, 2001, (ISBN : 0521650267)
2. **'Smart Materials and Structures',** M V Gandhi and B S Thompson Chapmen & Hall, London, 1992 (ISBN : 0412370107)

Reference Books:

1. **'Smart Materials and Structures',** Banks HT, RC Smith, Y Wang, Massow S A, Paris 1996
2. **G P Gibss' Adaptive Structres',** Clark R L, W R Saunolers, Jhon Wiles and Sons, New York, 1998
3. **An introduction for scientists and Engineers',** Esic Udd, Optic Sensors : Jhon Wiley & Sons, New York, 1991 (ISBN : 0471830070)

AGILE MANUFACTURING

Sub Code	:	10AE765	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART - A

UNIT - 1

Agile Manufacturing: Definition, business need, conceptual frame work, characteristics, generic features. **06 Hours**

UNIT - 2

Developing Agile Manufacturing: Enterprise, Strategies, integration of organization, workforce and technology, reference models, examples. **07 Hours**

UNIT - 3

Integration Of Product /Process Development: Principles, Robust design approach, Approaches to enhance ability in manufacturing, Role of QFD, Managing people in Agile orgnisation, Approaches. **06 Hours**

UNIT - 4

Application Of It/Is Concepts In Agile Manufacturing: Strategies, Management of complexities and information. flow, approaches, applications of multimedia to improve agility in manufacturing, system concepts. **07 Hours**

PART - B

UNIT - 5

Agile Supply Chain Management: Principles, IT/IS concepts in supply chain management, enterprise integration and management in agile manufacturing, concepts, Agility, Adaptability and learners – comparison of concepts. **07 Hours**

UNIT - 6

Computer Control Of Agile Manufacturing: CAPP for Agile Manufacturing, Aggregate capacity planning and production line design / redesign in Agile manufacturing, Cellular manufacturing, concepts, examples. **07 Hours**

UNIT - 7

Corporate Knowledge Management In Agile Manufacturing: Strategies, strategic options in Agile manufacturing, Role of standards. **06 Hours**

UNIT - 8

Design Of Skill & Knowledge: Enhancing technology for Machine tool system, Resumption of design requirement geometry, definition, methods, decision support for selection of cutting parameters, design enhancements, parametric approach only. **06 Hours**

Text Books:

1. **'Agile Manufacturing-** Forging Mew Frontiers', **Poul T Kidd,** Amagow Co. UK, ISBN-0-201-63163-6, 1994
2. **"Agile Manufacturing",** A Gunasekharan, the 21st Century Competitive strategy, ISBN -13 978-0-08-04 3567-1, Elsevier Press, India

Reference Books:

1. **O Levine Transitions to Agile Manufacturing,** Joseph C

Moutigomery and Lawrurence – Staying Flexible for competitive advantage, ASQC quality press, Milwaukee. Wisconsiw, USA 1996
2. **Agile Development for Mass Customization,** David M Andeson and B Joseph Pine, Irwin Professional Publishing, Chicogo USa 1997

ROBOTICS

Sub Code	:	10AE766	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART - A

UNIT - 1

Introduction and Mathematical Representation of Robots: History of Robots, Types of Robots, Notation, Position and Orientation of a Rigid Body, Some Properties of Rotation Matrices, Successive Rotations, Euler Angles For fixed frames X- Y -Z and moving frame ZYZ. Transformation between coordinate system, Homogeneous coordinates, Properties of A/BT, Types of Joints: Rotary, Prismatic joint, Cylindrical joint, Spherical joint, Representation of Links using Denvit - Hartenberg Parameters: Link parameters for intermediate, first and last links, Link transformation matrices, Transformation matrices of 3R manipulator, PUMA560 manipulator, SCARA manipulator **07 Hours**

UNIT - 2

Kinematics of Serial Manipulators: Direct kinematics of 2R, 3R, RRP, RPR manipulator, puma560 manipulator, SCARA manipulator, Stanford arm, Inverse kinematics of 2R, 3R manipulator, puma560 manipulator. **06 Hours**

UNIT - 3

Velocity and Static's of Manipulators: Differential relationships, Jacobian, Differential motions of a frame (translation and rotation), Linear and angular velocity of a rigid body, Linear and angular velocities of links in serial manipulators, 2R, 3R manipulators, Jacobian of serial manipulator, Velocity ellipse of 2R manipulator, Singularities of 2R manipulators, Statics of serial manipulators, Static force and torque analysis of 3R manipulator, Singularity in force domain. **07 Hours**

UNIT - 4

Dynamics of Manipulators: Kinetic energy, Potential energy, Equation of motion using Lagrangian, Equation of motions of one and two degree freedom spring mass damper systems using Lagrangian formulation, Inertia of a link,

Recursive formulation of Dynamics using Newton Euler equation, Equation of motion of 2R manipulator using Lagrangian Newton-Euler formulation. **06 Hours**

PART-B

UNIT - 5

Trajectory Planning: Joint space schemes, cubic trajectory, Joint space schemes with via points, Cubic trajectory with a via point, Third order polynomial trajectory planning, Linear segments with parabolic blends, Cartesian space schemes, Cartesian straight line and circular motion planning **07 Hours**

UNIT - 6

Control: Feedback control of a single link manipulator- first order, second order system, PID control, PID control of multi link manipulator, Force control of manipulator, force control of single mass, Partitioning a task for force and position control- lever, peg in hole Hybrid force and position controller. **08 Hours**

UNIT - 7

Actuators: Types, Characteristics of actuating system: weight, power-to-weight ratio, operating pressure, stiffness vs. compliance, Use of reduction gears, comparision of hydraulic, electric, pneumatic actuators, Hydraulic actuators, proportional feedback control, Electric motors: DC motors, Reversible AC motors, Brushles DC motors, Stepper motors- structure and principle of operation, stepper motor speed-torque characteristics **06 Hours**

UNIT - 8

Sensors: Sensor characteristics, Position sensors- potentiometers, Encoders, LVDT, Resolvers, Displacement sensor, Velocity sensor-encoders, tachometers, Acceleration sensors, Force and Pressure sensors piezoelectric, force sensing resistor, Torque sensors, Touch and tactile sensor, Proximity sensors-magnetic, optical, ultrasonic, inductive, capacitive, eddy-current proximity sensors. **05 Hours**

Text Books:

1. **Fundamental Concepts and Analysis,** Ghosal A., Robotics, Oxford,2006
2. **Introduction to Robotics Analysis, Systems, Applications**, Niku, S. B., Pearso Education, 2008

Reference Books:

1. **Introduction to Robotics: Mechanica and Control,** Craig, J. J., 2nd :J?:dition, Addison-Welsey, 1989.
2. **Fundamentals of Robotics, Analysis and Control**, Schilling R. J., PHI, 2006

INDUSTRIAL AND EXPERIMENTAL AERODYNAMICS

Sub Code	:	10AE767	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **06 Hrs**

Wind Energy Collectors

Horizontal axis and vertical axis machines. Power coefficient. Betz coefficient by momentum theory.

Unit 2. **07 Hrs**

Vehicle Aerodynamics

Power requirements and drag coefficients of automobiles. Effects of cut back angle. Aerodynamics of Trains and Hovercraft.

Unit 3. **06 Hrs**

Building Aerodynamics

Pressure distribution on low rise buildings, wind forces on buildings. Environmental winds in city blocks, Special problems of tall buildings, building codes, building ventilation and architectural aerodynamics.

Unit 4. **07 Hrs**

Flow Induced Vibrations

Effects of Reynolds number on wake formation of bluff shapes, Vortex induced vibrations, Galloping and stall flutter.

PART B

Unit 5. **07 Hrs**

Model Measurements

Balances :- design, installation and, calibration. Internal balances. Mounting of models, rigidity. Measurement of interference. Lift and drag measurements through various techniques. Testing procedures. Testing:- 3-D wings, controls, complete model, power effects, aero elasticity, dynamic stability. Testing with ground plane, testing wind mill generator. Testing for local loads. Testing of rotor. Testing engines, Jettison tests. Data reduction. Data correction.

Unit 6. **06 Hrs**

Wind Tunnel Boundary Corrections and Scale Effects

Effects of lateral boundaries. Method of images. Wall corrections. Effects of Buoyancy, Solid Blocking, Wake Blocking. General downwash correction. Lift interference correction. Corrections for reflection plane models. Scale effects on aerodynamic characteristics and stability derivatives.

Unit 7. **07 Hrs**

Near sonic And Transonic Testing

Near sonic tunnel design. Calibration of test section. Model support system. Tare and interference evaluation. Near transonic testing.

Unit 8. **06 Hrs**

Supersonic Wind Tunnel Testing

Types of supersonic tunnels: - continuous, intermittent (indraft ,and blowdown). Pressure-vacuum tunnels. Supersonic tunnel design features. Calibration of test section. Optical systems- Schlieren set-up. Starting loads.Hypersonic wind tunnels - General introduction.

Text Books:

1. Jewel B. Barlow, William H RAE, Jr. and Alan Pope, ' Low speed Wind Tunnel Testing', John Wiley & Sons; 1999.
2. M.Sovran (Ed), "Aerodynamics and drag mechanisms of bluff bodies and road Vehicles", Plenum press, New york, 1978.
3. P.Sachs, "Winds forces in engineering", Pergamon Press, 1978.

REFERENCE BOOKS:

1 R.D.Blevins, " Flow induced vibrations",Van Nostrand,1990.

2 N.G.Calvent, "Wind Power Principles", Charles Griffin & Co.,London,1979

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

MICRO AND SMART SYSTEMS TECHNOLOGY

Sub Code	:	10AE768	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART - A

UNIT - 1

Introduction To Micro And Smart Systems:

a) What are smart-material systems? Evolution of smart materials, structures and systems. Components of a smart system. Application areas. Commercial products.

b) What are microsystems? Feynman's vision. Micromachined transducers. Evolution of micro-manufacturing. Multi-disciplinary aspects. Applications areas. Commercial products. **05 Hours**

UNIT - 2

Micro And Smart Devices And Systems: Principles And Materials:

a) Definitions and salient features of sensors, actuators, and systems.
b) Sensors: silicon capacitive accelerometer, piezo-resistive pressure sensor, blood analyzer, conductometric gas sensor, fiber-optic gyroscope and surface-acoustic-wave based wireless strain sensor.
c) Actuators: silicon micro-mirror arrays, piezo-electric based inkjet print-head, electrostatic comb-drive and micromotor, magnetic micro relay, shape-memory-alloy based actuator, electro-thermal actuator
d) Systems: micro gas turbine, portable clinical analyzer, active noise control in a helicopter cabin **08 Hours**

UNIT - 3

Micro-Manufacturing And Material Processing:

a) Silicon wafer processing, lithography, thin-film deposition, etching (wet and dry), wafer-bonding, and metallization.
b) Silicon micromachining: surface, bulk, moulding, bonding based process flows.
c) Thick-film processing:
d) Smart material processing:
e) Processing of other materials: ceramics, polymers and metals
f) Emerging trends **07 Hours**

UNIT - 4

Modeling:

a) Scaling issues.
b) Elastic deformation and stress analysis of beams and plates. Residual stresses and stress gradients. Thermal loading. Heat transfer issues. Basic fluids issues.
c) Electrostatics. Coupled electromechanics. Electromagnetic actuation. Capillary electro-phoresis. Piezoresistive modeling. Piezoelectric modeling. Magnetostrictive actuators. **06 Hours**

PART - B

UNIT - 5

Computer-Aided Simulation And Design:

Background to the finite element method. Coupled-domain simulations using Matlab. Commercial software. **08 Hours**

UNIT - 6

Electronics, Circuits And Control:

Carrier concentrations, semiconductor diodes, transistors, MOSFET amplifiers, operational amplifiers. Basic Op-Amp circuits. Charge-measuring circuits. Examples from microsystems. Transfer function, state-space modeling, stability,

PID controllers, and model order reduction. Examples from smart systems and micromachined accelerometer or a thermal cycler. **08 Hours**

UNIT - 7

Integration And Packaging Of Microelectro Mechanical Systems:

Integration of microelectronics and micro devices at wafer and chip levels. Microelectronic packaging: wire and ball bonding, flip-chip. Low-temperature-cofired-ceramic (LTCC) multi-chip-module technology. Microsystem packaging examples. **06 Hours**

UNIT - 8

Case Studies:

BEL pressure sensor, thermal cycler for DNA amplification, and active vibration control of a beam. **04 Hours**

PART - C

UNIT - 9

Mini-projects and class-demonstrations (not for Examination)

09 Hours

a) CAD lab (coupled field simulation of electrostatic-elastic actuation with fluid effect)
b) BEL pressure sensor
c) Thermal-cycler for PCR
d) Active control of a cantilever beam

Text Books And A Cd-supplement:

1. A course-pack with matter taken from the following books including some newly written material. (This is until the textbook is ready. Chapter-wise resource material is indicated below.)
2. **MEMS & Microsystems: Design and Manufacture,** Tai-Ran Tsu, Tata Mc-Graw-Hill.

Reference books:

1. Animations of working principles, process flows and processing techniques, A CD-supplement with Matlab codes, photographs and movie clips of processing machinery and working devices.
2. **Laboratory hardware kits for** (i) BEL pressure sensor, (ii) thermal-cycler and (iii) active control of a cantilever beam.
3. **Microsystems Design,** S. D. Senturia, 2001, Kluwer Academic Publishers, Boston, USA. ISBN 0-7923-7246-8.
4. **Analysis and Design Principles of MEMS Devices,** Minhang Bao, Elsevier, Amsterdam, The Netherlands, ISBN 0-444-51616-6.
5. **Design and Development Methodologies,** Smart Material Systems and MEMS: V. Varadan, K. J. Vinoy, S. Gopalakrishnan, Wiley.
6. **MEMS-** Nitaigour Premchand Mahalik, TMH 2007

DESIGN, MODELING AND ANALYSIS LABORATORY

Sub Code	:	10AEL77	IA Marks	:	25
Hrs/ Week	:	03	Exam Hours	:	03
Total Hours	:	42	Exam Marks	:	50

List of Experiments

Part-A **21 Hrs**

1. Modeling of Symmetric Aerofoil Geometry, And Generation of Body Fitting Mesh.
2. Modeling of Cambered Aerofoil Geometry, And Generation of Body Fitting Mesh.
3. Modeling of 2-D Incompressible and Inviscid Flow over an Aerofoil. Computations and Analysis for Velocity Vectors and Pressures Distributions.
4. Modeling of 2-D Incompressible and Viscous Flow over an Aerofoil. Computations and Analysis for Velocity Vectors and Pressures Distributions.
5. Geometric Modeling and Mesh Generation of 2-D Convergent-Divergent Nozzle and Analyses of Flow for Adiabatic Conditions.

Part-B **21 Hrs**

6. Structural Modeling of Sandwich Beam of Rectangular Cross-Section and Analyses for Stresses.
7. Structural Modeling of a Three Dimensional Wing.
8. Structural Modeling and Stress Analysis of a Fuselage Bulk Head.
9. Structural Modeling and Stress Analysis of a Simply Supported Rectangular Plate Uniformly Compressed In one Direction.
10. Structural Modeling and Stress Analysis of a Simply Supported Rectangular Plate Uniformly Compressed In one Direction with a Cut-Out in Center.

Scheme of Examination

ONE question From Part-A	20 Marks
ONE question From Part-B	20 Marks
VIVA Voce	10 Marks
Total	**50 Marks**

SIMULATION LABORATORY

Sub Code	:	10AEL78	IA Marks	:	25
Hrs/ Week	:	03	Exam Hours	:	03
Total Hours	:	42	Exam Marks	:	50

List of Experiments

Part-A **21 Hrs**

1. Falling sphere with viscous drag – Investigate velocity versus time plot; & simulate the fall.
2. Frequency response for a spring-mass system; simulation of the oscillations.
3. Simulation of simple servo-mechanism feedback system in time domain.
4. Simulation of simple servo-mechanism feedback system in 's' domain.
5. Simulate with transfer functions the experiments (3) and (4) above.

PART B **21 Hrs**

6. Digital simulation of Analog Computations.
7. Simulate a bomb drop from an aircraft on a moving tank for pure – pursuit motion.
8. Simulate an Air Speed Indicator to read air speeds for the pressures read from a Pitot-static tube, with compressibility corrections.
9. Simulate a runaway.
10. Simulate a point take-off from a runaway.

Scheme of Examination

ONE question From Part-A	20 Marks
ONE question From Part-B	20 Marks
VIVA Voce	10 Marks
Total	**50 Marks**

VIII SEMESTER
FLIGHT VEHICLE DESIGN

Sub Code	:	10AE81	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART-A

Unit 1. **06 Hrs**

Conceptual Aircraft Design

Operational specifications-mission requirements. Government standards and regulations (MIL Specs, JAR-23 and JAR-25). Design process, flow chart, survey of various types of airplanes, over-view of design process. Airplane configuration description. Take-off weight-Preliminary Estimate-Spread sheet approach.

Unit 2. **06 Hrs**

Preliminary Aerodynamic Design

Selection of wing loading. Initial Airplane layout. Three view drawings. Arrangement of surfaces, mass, moment and inertia properties & balance diagram. Wing loading effect on take-off, landing, climb, acceleration, range, combat, flight ceiling, glide rate. Spread sheets.

Unit 3. **07 Hrs**

Design Of Structural Components:Wing, Fuselage And Tail

Mainplane: Airfoil cross-section shape, taper ratio selection, sweep angle selection, wing drag estimation. Spread sheet for wing design. Fuselage: Volume consideration, quantitative shapes, air inlets, wing attachments. Aerodynamic considerations and drag estimation. Spread sheets. Tail arrangements: Horizontal and vertical tail sizing. Tail planform shapes. Airfoil selection type. Tail placement. Spread sheets for tail design.

Unit 4. **07 Hrs**

Power for Flight

Propulsion selection, thrust to weight ratio, number of engines, engine rating, turbo-jet engine sizing. Installed thrust corrections, spread sheets. Propeller propulsive systems. Propeller design for cruise, static thrust. Turboprop propulsion. Piston and turbo-prop sizing. Propeller spread sheets.

PART-B

Unit 5. **07 Hrs**

Performance Estimation

Take-off phases, minimum take-off specification, climb gradients. Balanced field length. Landing approach. Free roll and braking. Spread sheet for take-off and landing distance. Enhance lift considerations - passive lift enhancement, trailing edge flap configuration, lift and drag determination. Active lift enhancement, Drag polar. Power to climb and maneuver.

Unit 6. **07 Hrs**

Static Stability

Longitudinal stability, static margin and stabilization. Control surface sizing. Effect of static margin on performance. Lateral and directional static stability-contribution of airframe components. Aileron sizing, rudder area sizing. Longitudinal maneuverability.

Unit 7. **06 Hrs**

Design Aspects of Sub-Systems

Air-conditioning and pressurisation, ice protection systems. Electric power system. Hydraulic systems, fuel system. Landing gear.

Unit 8. **06 Hrs**

Design Aspects: Avionics, Controls and Weapon Systems.

Communication system, Navigation system, Radar, Flight control system, Weapon systems, and weapon system interface.

Text Books:

1. Tomas C Corke., "Design of Aircraft," Person Education, LPE, 2003.
2. John P Fielding, Introduction to Aircraft Design Cambridge University Press, 1999

Reference:

1. Darrol Stinton D.," The Design of the Aeroplane", Black Well Science, 2nd Edition, 2001
2. Daniel P. Raymer, "Aircraft Design: A Conceptual approach", AIAA Education Services, 1992.

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

AVIONICS

Sub Code	:	10AE82	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **07 Hrs**

Power Distribution System

Bus Bar, split bus bar system, special purpose cables. Electrical diagram and identification scheme. Circuit controlling devices. Power utilisation-typical application to avionics. Need for Avionics in civil and military aircraft.

Unit 2. **06 Hrs**

Inertial Navigation System

Gyroscopic versus Inertial platform. Structure of stable platform. Inertial Navigation units. Inertial alignment. Inertial interface system. Importance of Compass swing.

Unit 3. **07 Hrs**

Electronic Flight Control System

Fly-by-wire system: - basic concept and features. Pitch and Roll rate: - command and response. Control Laws. Frequency response of a typical FBW actuator. Cooper Harper scale. Redundancy and failure survival. Common mode of failures and effects analysis.

Unit 4. **06 Hrs**

Electronic Flight Instrument Systems

Display -units, presentation, failure, and annunciation. Display of air data.

PART-B

Unit 5. **07 Hrs**

Introduction to Avionics Sub Systems and Electronic Circuits

Typical avionics subsystems. Amplifier, oscillator, aircraft communication system, transmitter, receiver, antenna.

Unit 6. **06 Hrs**

Principles of Digital Systems

Digital Computers – Microprocessors – Memories

Unit 7. **06 Hrs**

Flight Deck and Cockpits

Control and display technologies CRT, LED, LCD, EL and plasma panel - Touch screen - Direct voice input (DVI) - Civil cockpit and military cockpit : MFDS, HUD, MFK, HOTAS

Unit 8. **07 Hrs**

Avionics Systems Integration

Avionics equipment fit. Electrical data bus system. Communication Systems, Navigation systems, Flight control systems, Radar , Electronic Warfare, and fire control system. Avionics system architecture–Data buses MIL–STD 1553 B.

Text Books

1. R P G Collinson,' Introduction to Avionics Systems,' Kulwar Academic Publishers', 2003
2. E H J Pallett,' Aircraft Electrical System,'. Pitman Publishers, 1976.

References

1 Middleton, D.H., Ed., 'Avionics Systems', Longman Scientific and Technical Longman Group UK Ltd., England, 1989.

2 Spitzer, C.R., 'Digital Avionic Systems', Prentice Hall, Englewood Cliffs, N.J., USA., 1987.

3. R.B. Underdown & Tony Palmer, 'Navigation~, Black Well Publishing 2001

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

ELECTIVE IV (GROUP D)
FLIGHT TESTING

Sub Code	:	10AE831	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **06 Hrs**

Introduction

Purpose and scope of flight testing, basic definition, types of flight tests, sequence of flight testing, planning the test program, governing 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.

Unit 2. **07 Hrs**

Flight Test Instrumentation

Planning flight test instrumentation, sensing and transducing techniques. Measurement of linear and angular displacements, velocities and accelerations, vibration, force, temperature - onboard and ground based data acquisition system. Radio telemetry.

Unit 3. **07 Hrs**

Performance Flight Testing - Range, Endurance And Climb

Airspeed – in flight calibration. Level flight performance for propeller driven aircraft and for Jet aircraft - Techniques and data reduction. Range and endurance estimation of propeller and jet aircraft. Climb performance methods.

Unit 4. **06 Hrs**

Performance Flight Testing -Take-Off, Landing, Turning Flight

Turning performance limitations. Drag estimation. Take-off and landing - methods, procedures and data reduction.

PART B

Unit 5. **07 Hrs**

Stability And Control - Longitudal And Manoeuvring

Flight test Methods :-Static longitudinal stability ; Dynamic longitudinal stability. Data reduction. Maneuvering stability methods & data reduction.

Unit 6. **07 Hrs**

Stability And Control - Lateral & Directional

Flight Test methods: - Lateral and directional static stability; Lateral and directional dynamic stability. Regulations and data reduction.

Unit 7. **06 Hrs**

Flying Qualities

MIL and FAR regulations. Cooper-Harper scale. Pilot Rating . Flight test procedures.

Unit 8. **06 Hrs**

Hazardous Flight Testing Stall

and spin- regulations, test and recovery techniques. Dive testing for flutter, vibration and buffeting.

Text Books:

1. Ralph D Kimberlin, 'Flight Testing of Fixed Wing Aircraft' ,AIAA educational Series,2003.

Reference Books:

1. ADARD, Flight Test Manual Vol. I to IV

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

FRACTURE MECHANICS

Sub Code	:	10AE832	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART - A

UNIT - 1

Fracture Mechanics Principles: Introduction, Mechanisms of Fracture, a crack in structure, the Griffith's criterion, modern design – strengths, stiffness and toughness. Stress intensity approach **06 Hours**

UNIT - 2

Stress Analysis For Members With Cracks: Linear elastic fracture mechanics, Crack tip stress and deformations, Relation between stress intensity factor and fracture toughness, Stress intensity based solutions. Crack tip plastic zone estimation, Plane stress and plane strain concepts. The Dugdale approach, the thickness effect. **07 Hours**

UNIT - 3

Elastic – Plastic Fracture Mechanics: Introduction, Elasto–plastic factor criteria, crack resistance curve, J-integral, Crack opening displacement, crack tip opening displacement. Importance of R-curve in fracture mechanics, experimental determination of J-integral, COD and CTOD. **07 Hours**

UNIT - 4

Dynamic And Crack Arrest: Introduction, the dynamic stress intensity and elastic energy release rate, crack branching, the principles of crack arrest, the dynamic fracture toughness. **06 Hours**

PART - B

UNIT - 5

Fatigue And Fatigue Crack Growth Rate: Fatigue loading, various stages of crack propagation, the load spectrum, approximation of the stress spectrum, the crack growth integration, fatigue crack growth laws. **07 Hours**

UNIT - 6

Fracture Resistance Of Materials: Fracture criteria, fatigue cracking criteria, effect of alloying and second phase particles, effect of processing and anisotropy, effect of temperature, closure. **06 Hours**

UNIT - 7

Computational Fracture Mechanics: Overview of numerical methods, traditional methods in computational fracture mechanics – stress and displacement marching, elemental crack advance, virtual crack extension, the energy domain integral, finite element implementation. Limitations of numerical fracture analysis. **07 Hours**

UNIT - 8

Fracture Toughness Testing Of Metals: Specimen size requirements, various test procedures, effects of temperature, loading rate and plate thickness on fracture toughness. Fracture testing in shear modes, fatigue testing, NDT methods. **06 Hours**

Text Books:

1. **Introduction to Fracture Mechanics**, Karen Hellan McGraw Hill Pub.2000
2. **Fracture of Engineering Brittle Materials,** Jayatilake, Applied Science, London. 2001.

Reference Books:

1. **Fracture Mechanics – Fundamentals and Application,** T.L. Anderson, CRC press 1998
2. **Elementary Engineering Fracture Mechanics**, David Broek, Artinus Nijhoff, London 1999.
3. **Fracture and Fatigue Control in Structures**, Rolfe and Barsom, Printice Hall 2000.
4. **Fundamentals of Fracture Mechanics**, Knott, Bureworth 2000.

THEORY OF AEROELASTICITY

Sub Code	: 10AE833	IA Marks	: 25
Hrs/ Week	: 04	Exam Hours	: 03
Total Hours	: 52	Exam Marks	: 100

PART A

Unit 1. **06 Hrs**

Introduction

Aeroelasticity - definition and problems. Influence of aeroelastic phenomenon on design :- flutter, buffeting, dynamic loads problems, load distribution, divergence, control effectiveness & reversal. Critical flutter speeds versus wing sweep back. Effect of speed on control effectiveness.

Unit 2. **07 Hrs**

Deformation of Airplane Structures Under Static Loads

Deformation due to several forces. Influence coefficients. Properties of influence coefficients. Deformation under distributed forces. Influence functions. Properties of influence functions. Simplified elastic airplane. Deformation of airplane wing. Force and torque applied to wing. Integration by weighting matrices. Bending, torsional and shear stiffness curves.

Unit 3. **06 Hrs**

Static Aeroelastic Phenomena

Load distribution and divergence-wing torsional divergence (two-dimensional case, & finite wing case). Swept wing divergence. Prevention of Aeroelastic instabilities.

Unit 4. **07 Hrs**

Control Effectiveness and Reversal

Aileron effectiveness and reversal -2 dimensional case, and finite wing case. Strip theory. Aileron effectiveness in terms of wing -tip helix angle. Critical aileron reversal speed. Rate of change of local pitching moment coefficient with aileron angle.

PART B

Unit 5. **06 Hrs**

Deformation Of Airplane Structures Under Dynamic Loads

Differential and Integral forms of equations of motions of vibrations. Natural modes and frequencies of complex airplane structures - introduction. Dynamic response phenomenon -equations of disturbed motion of an elastic airplane.

Unit 6. **07 Hrs**

Dynamic Problems of Aeroelasticity

Flutter. Single-degree-of- freedom system. Determination of critical flutter speed. Aeroelastic modes. Wing bending and torsion flutter. Coupling of bending and torsion oscillations and destabilizing effects of geometric incidences. Stall flutter, Supersonic panel flutter, Buffeting and, Aileron buzz. Flutter prevention and control.

Unit 7. **07 Hrs**

Test Model Similarities

Dimensional concepts. Vibration model similarity laws. . Dimensionless form of equation of motion. Mode shapes and natural frequencies in dimensionless forms. Model scale factors.Flutter model similarity law. Scale factors. Structural simulation:-shape, mass and, stiffness.

Unit 8. **06 Hrs**

Testing Techniques

Measurement of structural flexibility. Measurements of natural frequencies and mode shapes. Polar plot of the damped response. Identification and measurement of normal modes. Steady state aeroelastic model testing. Dynamic aeroelastic model testing. Flight flutter testing.

Text Books:

1. Dowell, E. H., Crawley, E. F., Curtiss Jr., H. C., Peters, D. A., Scanlan, R. H., and Sisto, F., A Modern Course in Aeroelasticity, Kluwer Academic Publishers, 3rd Edition, 1995. (TL574.A37.M62)
2. Bisplinghoff, R., Ashley, H., and Halfman, R. L., Aeroelasticity, Dover, 1955. (TL570.B622)

Reference Books:

1. Fung, Y. C., An Introduction to the Theory of Aeroelasticity, 1955 (Dover, 1969).
2. Megson THG,' Aircraft structures for Engineering students', Edward Arnold.
3. Bisplinghoff, R. and Ashley, H., Principles of Aeroelasticity, Dover, 1962. (TL570.B623)

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

HYDRAULICS AND PNEUMATICS

Sub Code	:	10AE834	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART - A

UNIT -1

Introduction to Hydraulic Power: Definition of hydraulic system, advantages, limitations, applications, Pascal's law, structure of hydraulic control system, problems on Pascal's law.

The source of Hydraulic Power: Pumps Classification pumps, Pumping theory of positive displacement pumps, construction and working of Gear pumps, Vane pumps, Piston pumps, fixed and variable displacement pumps, Pump performance characteristics, pump Selection factors, problems on pumps. **07 Hours**

UNIT -2

Hydraulic Actuators and Motors: Classification cylinder and hydraulic motors, Linear Hydraulic Actuators [cylinders], single and double acting cylinder, Mechanics of Hydraulic Cylinder Loading, mounting arrangements, cushioning, special types of cylinders, problems on cylinders, construction and working of rotary actuators such as gear, vane, piston motors, Hydraulic Motor Theoretical Torque, Power and Flow Rate, Hydraulic Motor Performance, problems, symbolic representation of hydraulic actuators (cylinders and motors).

06 Hours

UNIT - 3

Control Components in Hydraulic Systems: Classification of control valves, Directional Control Valves- Symbolic representation, constructional features of poppet, sliding spool, rotary type valves solenoid and pilot operated DCV, shuttle valve, check valves, Pressure control valves - types, direct operated types and pilot operated types. Flow Control Valves - compensated and non-compensated FCV, needle valve, temperature compensated, pressure compensated, pressure and temperature compensated FCV, symbolic representation. **07 Hours**

UNIT - 4

Hydraulic Circuit Design And Analysis: Control of Single and Double Acting Hydraulic Cylinder, Regenerative circuit, Pump Unloading Circuit, Double Pump Hydraulic System, Counter balance Valve Application, Hydraulic Cylinder Sequencing Circuits, Automatic cylinder reciprocating system, Locked Cylinder using Pilot check Valve, Cylinder synchronizing circuit using different methods, factors affecting synchronization, Hydraulic circuit for force multiplication, Speed Control of Hydraulic Cylinder, Speed Control of Hydraulic Motors, Safety circuit, Accumulators, types, construction and applications with circuits.

06 Hours

PART – B

UNIT - 5

Maintenance of Hydraulic System: Hydraulic Oils - Desirable properties, general type of Fluids, Sealing Devices, Reservoir System, Filters and Strainers, wear of Moving Parts due to solid -particle Contamination, temperature control (heat exchangers), Pressure switches, trouble shooting. **06 Hours**

UNIT - 6

Introduction to Pneumatic Control: Definition of pneumatic system, advantages, limitations, applications, Choice of working medium. Characteristic of compressed air. Structure of Pneumatic control System, fluid conditioners and FRL unit.

Pneumatic Actuators: Linear cylinder - Types, Conventional type of cylinder-working, End position cushioning, seals, mounting arrangements- Applications. Rod - Less cylinders types, working, advantages, Rotary cylinders- types construction and application, symbols. **07 Hours**

UNIT-7

Pneumatic Control Valves: DCV such as poppet, spool, suspended seat type slide valve, pressure control valves, flow control valves, types and construction, use of memory valve, Quick exhaust valve, time delay valve, shuttle valve, twin pressure valve, symbols. 3Hrs Simple Pneumatic Control: Direct and indirect actuation pneumatic cylinders, speed control of cylinders - supply air throttling and Exhaust air throttling and Exhaust air throttling.

Signal Processing Elements: Use of Logic gates - OR and AND gates in pneumatic applications. Practical Examples involving the use of logic gates, Pressure dependant controls- types - construction - practical applications, Time dependent controls principle. Construction, practical applications. **07 Hours**

UNIT-8

Multi- Cylinder Application: Coordinated and sequential motion control, Motion and control diagrams. Signal elimination methods, Cascading method-principle, Practical application examples (up to two cylinders) using cascading method (using reversing valves).

Electro- Pneumatic Control: Principles - signal input and out put, pilot assisted solenoid control of directional control valves, Use of relay and contactors. Control circuitry for simple signal cylinder application.

Compressed Air: Production of compressed air- Compressors Preparation of compressed air-Driers, Filters, Regulators, Lubricators, Distribution of compressed air Piping layout. **06 Hours**

Text Books:

1. **"Fluid Power with Applications",** Anthony Esposito, Sixth edition, Pearson Education, Inc, 2000.
2. **'Pneumatics and Hydraulics',** Andrew Parr, Jaico Publishing Co

Reference Books:

1. **'Oil Hydraulic systems', Principles and Maintenance** S. R. Majurr, Tata McGraw Hill Publishing Company Ltd. - 2001
2. **'Industrial Hydraulics', Pippenger, Hicks"** McGraw Hill, New York
3. **'Hydraulic & Pneumatic Power for Production',** Harry L. Stewart
4. **'Pneumatic Systems',** S. R. Majumdar, Tata McGraw Hill Publish 1995
5. **Power Hydraulics'** Michael J Pinches & John G Ashby, Prentice Hall

RELIABILITY AND MAINTENANCE ENGINEERING

Sub Code	:	10AE835	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **06 Hrs**

Introduction

Definition. Performance, cost and reliability. Quality, reliability and safety. Probability and sampling. Probability concept. Discrete random variables. Binomial distribution. Multiple sampling methods. Continuous random variables.

Unit 2. **07 Hrs**

Quality & Its Measures

Quality & reliability. Taguchi methodology. Quality measure. The six Sigma Methodology.

Unit 3. **06 Hrs**

Data & Distributions

Non parametric methods. Histograms. Probability Plotting. Point and interval estimates. Normal and Lognormal Parameters.

Unit 4. **07 Hrs**

Reliability & Rates of Failure

Reliability characterisation. Bath tub curve. MTBF concept. Constant failure rate model.

Time dependent failure rates. Component failures and failure modes.

PART-B

Unit 5. **06 Hrs**

Reliability Testing

Reliability enhancement procedures. Reliability growth testing, Environmental stress testing. Nonparametric methods. Ungrouped data. Accelerated life testing.

Unit 6. **07 Hrs**

Redundancy

Introduction: Active and standby redundancy. Constant failure rate models. Redundancy limitations. Multiply redundant system. Case studies.

Unit 7. **07 Hrs**

Maintained Systems

Types of maintenance. Preventive maintenance, Idealised maintenance, Imperfect maintenance.Redundant components. Corrective maintenance. Maintainability. Repair: revealed failures. Testing & repair: unrevealed failures. Prediction of maintenance schedules. Modern trends in maintenance Philosophy like BITE, IRAN, HUM, TPM etc.

Unit 8. **06 Hrs**

System Safety Analysis

Product and equipment hazards. Human errors. Methods of analysis. Failure Modes and Effects Analysis. Fault tree construction. Direct evaluation of fault tree.

Text Book:

1 E.E. Lewis, 'Introduction to Reliability Engineering', John Wiley., 1994

Reference Books:

1 K.S. Trivedi, 'Probability and statistics with Reliability', Queuing and Computer Science Applications, PHI.

2 E Balagurswamy, 'Reliability Engineering,' Tata McGraw Hill Publications.

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

BOUNDARY LAYER THEORY

Sub Code	:	10AE836	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **06 Hrs**

Preliminary Concepts

Some examples of viscous flow phenomena: - aerofoil, cylinder, circular pipe. Boundary conditions for viscous flow problems. The kinematics properties of viscous flow.

Unit 2. **07 Hrs**

Fundamental Equations of Viscous Flow

Conservation of mass, momentum and energy equations. Mathematical characterisation of basic equations. Dimensionless parameters in viscous flow.

Unit 3. **06 Hrs**

Solutions of Viscous Flow Equations

Classification of solutions. Couette flow, stability of Couette flow. Poiseuille steady flow through duct. Unsteady duct flow between plates with bottom injection and top suction. Plane stagnation flow- differential equation free of parameters.

Unit 4. **07 Hrs**

Introduction to Laminar Boundary Layer

Laminar boundary layer equations. Flat plate Integral analysis. Displacement thickness, Momentum and Energy thicknesses for two dimensional flows; Shape factor. Some insight into boundary layer approximations. Discussion of Navier Stokes equations. Concept of thermal boundary layer.

PART B

Unit 5. **06 Hrs**

Laminar Boundary Layer Equations

Dimensionless variables. Laminar boundary layer equations. Similarity solutions for steady two-dimensional flow. Blasius solution for flat- plate flow, wall shear stress. Flat plate heat transfer for constant wall temperature. Some examples of Falkner-Skan potential flows. Reynolds analogy as a function of pressure gradient.

Unit 6. **06 Hrs**

Transition to Turbulence

Stability of laminar flows - concept of small disturbance stability. Temporal instability and Spatial instability. Stability of Blasius and Falkner-Skan profiles. Effect of wall temperature. Transition to turbulence. Affecting parameters.

Unit 7. **07 Hrs**

Incompressible Turbulent Mean Flow

Physical and mathematical description of turbulence. Fluctuations and time averging. Turbulent flow in pipes and channels. Free turbulence: - jets, wakes and mixing layers.

Unit 8. **07 Hrs**

Instrumentation and Measurements:

Hot wire and Hot film anemometer for turbulence measurements. Schlieren methods for flow visualization. Pressure probes, Interferometer and Smoke method.

Text Books:

1. H. Schlichting, 'Boundary Layer Theory', McGraw- Hill, New York, 1979.
2. Frank White,' Viscous Fluid flow' - McGraw Hill, 1991.
3. J.P.Hollman and W.J. Gajda, Jr. 'Experimental methods for Engineers', 5th Edition McGraw- Hill , 1989

Reference Books:

2. Ronald L., Panton, 'Incompressible fluid flow', John Wiley & Sons, 1984.
3. Boundary Layer by T.R.Oke

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

OPERATION RESEARCH

Sub Code	:	10AE837	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART- A

UNIT -1

Introduction: Evolution of OR, definition of OR, scope of OR, application areas of OR, steps (phases) in OR study, characteristics and limitations of OR, models used in OR, linear programming (LP) problem-formulation and solution by graphical method. **04 Hours**

UNIT -2

Solution Of Linear Programming Problems: The simplex method-canonical and standard form of an LP problem, slack, surplus and artificial variables, big M method and concept of duality, dual simplex method. **08 Hours**

UNIT -3

Transportation Problem: Formulation of transportation problem, types, initial basic feasible solution using different methods, optimal solution by MODI method, degeneracy in transportation problems, application of transportation problem concept for maximization cases. Assignment Problem-formulation, types, application to maximization cases and travelling salesman problem. **08 Hours**

UNIT -4

Integer Programming: Pure and mixed integer programming problems, solution of Integer programming problems-Gomory's all integer cutting plane method and mixed integer method, branch and bound method, Zero-One programming. **06 Hours**

PART- B

UNIT -5

Pert-CPM Techniques: Introduction, network construction - rules, Fulkerson's rule for numbering the events, AON and AOA diagrams; Critical path method to find the expected completion time of a project, floats; PERT for finding expected duration of an activity and project, determining the probability of completing a project, predicting the completion time of project; crashing of simple projects. **08 Hours**

UNIT -6

Queuing Theory: Queuing systems and their characteristics, Pure-birth and Pure-death models (only equations), empirical queuing models – M/M/1 and M/M/C models and their steady state performance analysis. **06 Hours**

UNIT -7

Game Theory: Formulation of games, types, solution of games with saddle point, graphical method of solving mixed strategy games, dominance rule for solving mixed strategy games. **06 Hours**

UNIT -8

Sequencing: Basic assumptions, sequencing 'n' jobs on single machine using priority rules, sequencing using Johnson's rule-'n' jobs on 2 machines, 'n' jobs on 3 machines, 'n' jobs on 'm' machines. Sequencing 2 jobs on 'm' machines using graphical method. **06 Hours**

Text Books

1. **Operations Research,** P K Gupta and D S Hira, Chand Publications, New Delhi - 2007
2. **Operations Research,** Taha H A, Pearson Education

Refernce Books

1. **Operations Research,** A P Verma, S K Kataria &Sons, 2008
2. **Operations Research,** Paneerselvan, PHI
3. **Operations Research,** A M Natarajan, P Balasubramani, Pearson Education, 2005
4. **Introduction to Operations Research,** Hillier and Liberman,8th Ed., McGraw Hill
5. **Operations Research** S.D. Sharma, Ledarnath Ramanath & Co, 2002

AEROSPACE QUALITY ASSURANCE

Sub Code	:	10AE838	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **06 Hrs**

Quality Concepts

Concepts and definition, design specifications, manufacture in conformance with design applications, role of quality assurance during usage of aircraft.

Unit 2. **07 Hrs**

Quality Assurance during Overhaul

Quality assurance during overall / repair of aircraft and its aggregates, concession and deviations . Production permits.

Unit 3. **06 Hrs**

Quality Control

Units of measure, measuring actual performance. Continuous process regulation. Strategic quality management. Role of quality director. Quality culture.

Unit 4. **07 Hrs**

Probability Concepts

Concept of variation. Quantitative methods of summarizing data. Normal curve, Exponential Probability distribution. Weibull probability distribution. Poisson distribution. Binomial distribution. Scope for data analysis. Sample size. Regression analysis.

PART B

Unit 5. **06 Hrs**

Designing For Quality

Early warning concepts and design assurance. Designing for basic function requirements. Design for Time- Oriented performance. Designing for safety. Designing for maintainability.

Unit 6. **07 Hrs**

Manufacture & Reliability Prediction

Initial planning for qualities. Failure patterns. Predicting reliability during design. Exponential formula. Setting specification limits. Process quality audits. Self inspection.

Unit 7. **07 Hrs**

Inspection, Test & Measurements

Sampling risk. Analysis of some rule to thumb. Sampling plot. Evaluation of parameters affecting field performance. Acceptance sampling plan. Feed back . Field data.

Unit 8. **06 Hrs**

Quality Assurance

Zero defect analogy, FMECA, Fault Tree Analysis, bench marking, quality circles, quality audit. Quality standards ISO 9000, TQM, CMM, Six Sigma. Quality organizational set up in production / repair / operational set up.

Text Books:

1. J M Juran, Frank M Gryna, 'Quality Planning and Analysis,' TMH Publications, 2005

Reference Books:

1. M Fox, 'Quality Assurance Management', McGraw Hill Publications
2. Oalela, 'ISO 9000 A, Manual for TQM', Parga man Publishers.
3. S C Keshu and K K Ganapathi, 'Aircraft production technology and Management, ' Interline Publishers,1993

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

ELECTIVE V (GROUP E)
AIRCRAFT SAFETY RULES AND REGULATIONS

Sub Code	:	10AE841	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **06 Hrs**

C.A.R. Series 'A' – Procedure for Civil Air Worthiness Requirements and Responsibility Operators Vis-À-Vis Air Worthiness Directorate

Responsibilities of operators / owners- Procedure of CAR issue, amendments etc., Objectives and targets of airworthiness directorate; Airworthiness regulations and safety oversight of engineering activities of operators.

Unit 2. **06 Hrs**

C.A.R. Series 'B' – Issue Approval of Cockpit Check List, Mel, Cdl:

Deficiency list (MEL & CDL); Preparation and use of cockpit checklist and emergency list.

Unit 3. **07 Hrs**

C.A.R. Series 'C' – Defect Recording, Monitoring, Investigation and Reporting

Defect recording, reporting, investigation, rectification and analysis; Flight report; Reporting and rectification of defects observed on aircraft; Analytical study of in-flight readings & recordings; Maintenance control by reliability Method.

Unit 4. **07 Hrs**

C.A.R. Series 'D' – And Aircraft Maintenance Programmes

Reliability Programmes (Engines); Aircraft maintenance programme & their approval; On condition maintenance of reciprocating engines; TBO – Revision programme; Maintenance of fuel and oil uplift and consumption records – Light aircraft engines; Fixing routine maintenance periods and component TBOs – Initial & revisions.

PART B

Unit 5. **06 Hrs**

C.A.R. Series 'E' – Approval of Organizations

Approval of organizations in categories A, B, C, D, E, F, & G - Requirements of infrastructure at stations other than parent base.

Unit 6. **07 Hrs**

C.A.R. Series 'F' – Air Worthiness And Continued Air Worthiness:

Procedure relating to registration of aircraft; Procedure for issue / revalidation of Type Certificate of aircraft and its engines / propeller; Issue / revalidation of Certificate of Airworthiness; Requirements for renewal of Certificate of Airworthiness.

Unit 7. **06 Hrs**

C.A.R. Series 'L'&'M'

Issue of AME Licence, its classification and experience requirements, Mandatory Modifications / Inspections.

Unit 8. **07 Hrs**

C.A.R. Series 'T'&'X'

Flight testing of (Series) aircraft for issue of C of A; Flight testing of aircraft for which C of A had been previously issued. Registration Markings of aircraft; Weight and balance control of an aircraft; Provision of first aid kits & Physician's kit in an aircraft; Use furnishing materials in an aircraft; Concessions; Aircraft log books; Document to be carried on board on Indian registered aircraft; Procedure for issue of tax permit; Procedure for issue of type approval of aircraft components and equipment including instruments.

Text Books:

1. "Civil Aviation Requirements with latest Amendment (Section 2 Airworthiness)" – Published by DGCA, The English Book Store, 17-1, Connaught Circus, New Delhi 2000.

References:

1. "Aircraft Manual (India) Volume" – Latest Edition, The English Book Store, 17-1, Connaught Circus, New Delhi.

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

GUIDANCE AND NAVIGATION

Sub Code	:	10AE842	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **06 Hrs**

Introduction

Concepts of navigation, guidance and control. Introduction to basic principles. Air data information.

Unit 2. **07 Hrs**

Radar Systems

Principle of working of radar. MTI and Pulse Doppler radar. Moving target detector. Limitation of MTI performance. MTI from a moving platform (AMTI)

Unit 3. **06 Hrs**

Tracking With Radar

Mono pulse tracking. Conical scan and sequential lobbing. Automatic tracking with surveillance radar (ADT)

Unit 4. **07 Hrs**

Other Guidance Systems

Gyros and stabilised platforms.Inertial guidance and Laser based guidance. Components of Inertial Navigation System. Imaging Infrared guidance. Satellite navigation. GPS.

PART B

Unit 5. **06 Hrs**

Transfer Functions

Input-output Transfer function. Basic altitude reference. Concepts of Open loop and Close Loop.

Unit 6. **07 Hrs**

Missile Control System

Guided missile concept. Roll stabilisation. Control of aerodynamic missile. Missile parameters for dynamic analysis. Missile autopilot schematics. Acceleration command and root locus.

Unit 7. **06 Hrs**

Missile Guidance

Proportional navigation guidance; command guidance. Comparison of guidance system performance. Bank to turn missile guidance

Unit 8. **07 Hrs**

Integrated Flight/Fire Control System

Director fire control system. Tracking control laws. Longitudinal flight control system. Lateral flight control system. Rate of change of Euler angle , Auto Pilot

Text Books:

1. Merrilh I. Skolnik,' Introduction to Radar Systems', 3rd edition, Tata Mc Graw Hill , 2001.
2. John H Blakelock,' Automatic control of Aircraft & Missiles', Wile – Inter Science Publication, 2nd edition, May 1990.
3. N.S. Nagaraj, Elements of Electronic Navigation, TMH publication, 2nd Edition 2006.

Reference Books:

1. R.B. Underdown & Tony Palmer, 'Navigation', Black Well Publishing; 2001.

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.

MANAGEMENT INFORMATION SYSTEMS

Sub Code	:	10AE843	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART - A

UNIT - 1

The Information Age: An Overview: The purpose, data, information, and information systems and their types, ethical and societal issues, information systems in business functions, web empowered enterprises. **05 Hours**

UNIT - 2

Strategic Uses of Information Systems: Strategies and Strategic moves, Achieving a competitive advantage, creating and maintaining strategic information systems, Business Functions and Supply Chains – effectiveness and efficiency, accounting, finance, engineering, supply chain management, Human resource management, Enterprise resource planning. **05 Hours**

UNIT - 3

Information Technology: Business Hardware – components, classification of computers, output devices, storage media, and purchasing,, Business Software – programming languages and software development tools, language translation, compilers and interpreters, system software, open source software, software licensing, ethical issues, **08 Hours**

UNIT - 4

Business Networks and Telecommunication: Telecommunication in Business and Daily Use, Bandwidths and Media, networks, protocols, internet networking services, Telecommuting – pros and cons, Future of Networking Technologies. **08 Hours**

PART - B

UNIT - 5

Web Enabled Commerce: Web enabled enterprises – web business and technologies, web enabled business, Challenges of Global Information Systems – Multinational organizations, international commerce, ethical issues. **07 hours**

UNIT - 6

Decision Support and Business intelligence: Decision support and expert systems – decision support and decision making process, structured and unstructured problems, decision support systems, expert systems, geographical systems, Business Intelligence and Knowledge Management – Date Mining and online analysis, knowledge management, **06 Hours**

UNIT - 7

Planning, Acquisition, and Control: Systems Planning and Development – Planning Information systems, systems development life cycle, agile methods, systems integration, ethical issues – IS professionals certification. **07 Hours**

UNIT - 8

Choices in Systems Acquisition: Options and Priorities, outsourcing, licensing applications, software as a service, user application development, ethical issues-computer use policies for employees. **06 Hours**

Text Book

1. **Management Information Systems**, Effy Oz, Cengage Learning, INDIA EDITION, 2009.
2. **Management Information Systems**, James A O'Brien, Irwin, 9th Ed., McGraw Hill.

Reference Books:

1. **Management Information Systems,** Laudon & Laudon, PHI 1998 Ed. ISBN 81-203-1282-1
2. **Management Information systems,** S.Sadagopan, Prentice Hall of India, 1998 Ed. ISBN 81-203-1180-9
3. **Information systems for Modern management** G.R.Murdick PHI 2002.

PROJECT MANAGEMENT

Sub Code	:	10AE844	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART - A

UNIT 1

Introduction: Definition of project, characteristics of projects, understand projects, types of projects, scalability of project tools, project roles, **04 Hours**

UNIT 2

Project Selection And Prioritization – Strategic planning process, Strategic analysis, strategic objectives, portfolio alignment – identifying potential projects, methods of selecting projects, financial mode / scoring models to select projects, prioritizing projects, securing and negotiating projects. **05 Hours**

UNIT 3

Planning Projects: Introduction, developing the project management plan, understanding stake holders, communication planning, project meeting management, communication needs of global and virtual project teams, communication technologies, Constructing Work Breakdown Structures – scope planning, scope definition, work breakdown structures (WBS), Using Microsoft project for work breakdown structures. **08 Hours**

UNIT 4

Scheduling Projects: purpose of a project schedule, historical development, how project schedules are limited and created, develop project schedules, uncertainty in project schedules, Gantt Chart, Using Microsoft Project for critical path schedules. **08 Hours**

PART - B

UNIT 5

Resourcing Projects: Abilities needed when resourcing projects, estimate resource needs, creating staffing management plant, project ream composition issues, assign resource to each activity, resource overloads, critical chain project management (CCPM), compress the project schedule, Using Microsoft Project for resource allocation.

Budgeting Projects: Cost planning, cost estimating, cost budgeting, establishing cost control, using Microsoft Project for Project Budgets, **08 hours**

UNIT 6

Project Risk Planning: Risk Management Planning, risk identification, risk analysis, risk response planning, Project Quality Planning and Project Kickoff: Development of quality concepts, project quality management plan, project quality tools, kickoff project, baseline and communicate project management plan, using Microsoft Project for project baselines. **06 Hours**

UNIT 7

Performing Projects: Project supply chain management: - Plan purchasing and acquisitions, plan contracting, contact types, project partnering and collaborations, project supply chain management, Leading and Managing Project Teams – Acquiring, developing, managing and leading the project team, managing stakeholders, managing project conflicts. **07 Hours**

UNIT 8

Determining Project Progress and Results: Project Balanced Scorecard Approach, Internal project, customer, financial issues, Using Microsoft Project to monitor and control projects. Finishing the project: Terminate project early, finish projects on time, secure customer feedback and approval, knowledge management, perform administrative and contract closure, celebrate success and reward participant, provide ongoing support. **06 Hours**

Text Book:

1. **Project Management**, Timothy J Kloppenborg, Cengage Learning, Edition 2009.
2. **Project Management**, A systems approach to planning schuduing and controlling by Harold kerzner, CBS publication.

Reference Books:

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

PRODUCT DESIGN AND MANUFACTURING

Sub Code	:	10AE845	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART –A

UNIT-1 **6 Hours**

INTRODUCTION TO PRODUCT DESIGN: Asimow's model: Definition of product design, Design by Evolution, Design by Innovation, Essential Factors of Product design, Production-Consumption Cycle, Flow and value addition in the Production-Consumption Cycle, the Morphology of design(The seven phases), Primary design phases and flowcharting, role of allowance, process capability and tolerance in detailed design & assembly.

UNIT-2 **6 Hours**

PRODUCT DESIGN PRACTICE AND INDUSTRY: Introduction, product strategies, time to market, analysis of the product, The S's Standardization , Renard series, simplification, role of aesthetics in product design, functional design practice.

UNIT-3 **7 Hours**

REVIEW OF STRENGTH, STIFFNESS AND RIGIDITY CONSIDERATIONS IN PRODUCT DESIGN:

Principal stress trajectories (force-flow lines), balanced design, criteria and objectives of design, material toughness: resilience designing for uniform strength, tension vis-à-vis compression. Review of production process: Introduction, primary processes, machining process, non-traditional machining processes.

UNIT-4 **7 Hours**

DESIGN FOR PRODUCTION- METAL PARTS:

Producibility requirements in the design of machine components, forging design, pressed components design, casting design, and design for machining ease, the role of process engineer, ease of location casting and special casting. Designing with plastic, rubber, ceramics and wood: approach to design with plastics bush

bearings, gears in plastics, rubber parts, design recommendations for rubber parts, ceramic and glass parts.

PART –B

UNIT – 5 **6 Hours**

OPTMIZATION IN DESIGN: Introduction, Siddal's Classification of Design Approaches, Optimisation by Differential Calculus, Lagrange Multipliers, Linear Programming (Simplex Method), Geometric Programming, Johnson's Method Optimum Design.

UNIT – 6 **6 Hours**

ECONOMIC FACTOR INFLUENCING DESIGN: Product value, Design for safety, Reliability and Environmental Considerations, Manufacturing Operations in relation to Design, Economic analysis, Profit and Competitiveness, Break – even Analysis, Economic pf a New Product Design.

UNIT – 7 **6 Hours**

HUMAN ENGINEERING CONSIDERATIONS IN PRODUCT DESGN: Introduction, Human being as Applicator of forces, Anthropometry, Man as occupant of space, The Design of Controls, the design of displays, Man/Machine information exchange.

UNIT – 8 **8 Hours**

VALUE ENGINEERING AND PRODUCT DESIGN: Introduction, Historical perspective, what is value? Nature and measurement of value, Normal degree of value, Importance of value, The value analysis job plan, Creativity, Steps to problems –solving and value analysis, Value analysis Test, Value Engineering idea Generation Check – list Cost Reduction through value engineering case study on Tap Switch Control Assembly, material and Process selection in value Engineering. Modern approaches to product design: Concurrent design and Quality Function Deployment (QFD)

Text Books:

1. **Product Design and Manufacturing**, A.C. Chitale and R.C. Gupta, PHI 4th Edition, 2007
2. **Product Design & Development,** Karl T.Ulrich & Steven D, Epinger, Tata Mc Graw Hill, 3rd Edition, 2003

Reference Books:

1. **New Product Development,** Tim Jones Butterworth Heinmann, Oxford, mc 1997
2. **New Product Development,** Design & Analysis , Roland Engene Kinetovecz, Jon eiley & Sons, Inc, N.Y. 1990

ARTIFICIAL INTELLIGENCE

Sub Code	:	10AE846	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART - A

UNIT - 1

Artificial Intelligence: Introduction, definition, underlying assumption, importance f A1, AI and related fields. **06 Hours**

UNIT - 2

Space Representation: Defining a problem. Production systems and its characteristics, Search and Control strategies – Generate and Test, Hill Climbing, Best – first Search, Problem reduction, Constraint Satisfaction, Means – Ends Analysis. **07 Hours**

UNIT - 3

Knowledge Representation Issues: Representations and Mappings, Types of knowledge – Procedural Vs Declarative, Logic programming. Forward Vs Backward reasoning, Matching. **07 Hours**

UNIT - 4

Use Of Predicate Logic: Representing simple facts, Instance and Isa relationships, Syntax and Semantics for Prepositional logic, FQPL and properties of Wffs, Conversion to Clausal form, Resolution, Natural deduction. **06 Hours**

PART - B

UNIT - 5

Statistical And Probabilistic Reasoning: Symbolic reasoning under uncertainty, Probability and Bayes' theorem, Certainity factors and Rule based systems, Bayesian Networks, Shafer Theory, Fuzzy Logic. **07 Hours**

UNIT - 6

Expert Systems: Structure and uses, Representing and using domain knowledge, Expert System Shells. Pattern recognition Learning classification patterns, recognizing and understanding speech. Introduction to knowledge Acquisition, Types of Learning. **07 Hours**

UNIT - 7

Typical Expert Systems: MYCIN, Variants of MYCIN, PROSPECTOR, DENDRAL, PUFF, ETC. **06 Hours**

UNIT - 8

Introduction To Machine Learning: Perceptrons, Checker Playing Examples, Learning Automata, Genetic Algorithms, Intelligent Editors.

06 Hours

Text Books:

1. **Artificial Intelligence,** Elaine Rich & Kevin Knight, 3rd Ed., M/H 1983.
2. **Introduction to AI & ES,** Dan W. Patterson, Prentice Hall of India, 1999.

Reference Books:

1. **Principles of Artificial Intelligence**, Springer Verlag, Berlin, 1981.
2. **Artificial Intelligence in business, Science & Industry**, Wendy B. Ranch
3. **A guide to expert systems,** Waterman, D.A., Addison – Wesley inc. 1986
4. **Building expert systems,** Hayes, Roth, Waterman, D.A. Addison – Wesley, 1983

COMPUTER INTEGRATED MANUFACTURING

Sub Code	:	10AE847	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART-A

UNIT - 1

Computer Integrated Manufacturing Systems: Introduction, Automation definition, Types of automation, CIM, processing in manufacturing, Production concepts, Mathematical Models-Manufacturing lead time, production rate, components of operation time, capacity, Utilization and availability, Work-in-process, WIP ratio, TIP ratio, Problems using mathematical model equations.

8 Hours

UNIT - 2

High Volume Production System: Introduction Automated flow line-symbols, objectives, Work part transport-continuous, Intermittent, synchronous, Pallet fixtures, Transfer Mechanism-Linear-Walking beam,. roller chain drive, Rotary-rack and pinion, Rachet & Pawl, Geneva wheel, Buffer storage, control functions-sequence, safety, Quality, Automation for machining operation. **6 Hours**

UNIT - 3

Analysis Of Automated Flow Line & Line Balancing: General terminology and analysis, Analysis of Tranfer Line without storage upper bound approach, lower bound approach and problems, Analysis of Transfer lines with storage

buffer, Effect of storage, buffer capacity with simple problem, Partial automation-with numerical problems, flow lines with more than two stages, Manual Assembly lines, line balancing problem. **6 Hours**

UNIT - 4

Minimum Rational Work Element: Work station process time, Cycle time, precedence constraints. Precedence diagram, Balance delay methods of line balancing-largest Candidate rule, Kilbridge and Westers method, Ranked positional weight method, Numerical problems covering L above methods and computerized line balancing. **6 Hours**

PART-B

UNIT - 5

Automated Assembly Systems: Design for automated assembly systems, types of automated assembly system, Parts feeding devices-elements of parts delivery system-hopper, part feeder, Selectors, feed back, escapement and placement analysis of Multistation Assembly Machine analysis of single station assembly. **Automated Guided Vehicle System:** Introduction, Vehicle guidance and routing, System management, Quantitative analysis of AGV's with numerical problems and application. **8 Hours**

UNIT - 6

Computerized Manufacturing Planning System: Introduction, Computer Aided Process Planning, Retrieval types of process planning, Generative type of process planning, Material requirement planning, Fundamental concepts of MRP inputs to MRP, Capacity planning. **6 Hours**

UNIT - 7

CNC Machining Centers: Introduction to CNC, elements of CNC, CNC machining centers, part programming, fundamental steps involved in development of part programming for milling and turning. **6 Hours**

UNIT - 8

Robotics: Introduction to Robot configuration, Robot motion, programming of Robots end effectors, Robot sensors and Robot applications.

6 Hours

Text Books:

1. **Automation, Production system & Computer Integrated manufacturing,** M. P. Groover Person India, 2007 2nd edition.
2. **Principles of Computer Integrated Manufacturing**, S. Kant Vajpayee, Prentice Hall India.

Reference Books:

1. **Computer Integrated Manufacturing**, J. A. Rehg & Henry. W. Kraebber.
2. **CADICAM** by Zeid, Tata McGraw Hill.

AIRCRAFT SYSTEMS AND INSTRUMENTATION

Sub Code	:	10AE848	IA Marks	:	25
Hrs/ Week	:	04	Exam Hours	:	03
Total Hours	:	52	Exam Marks	:	100

PART A

Unit 1. **06 Hrs**

Flight Control Systems

Primary and secondary flight controls. Flight control linkage system. Conventional Systems, Power assisted and fully powered flight controls. Power control unit – Mechanical, Electro-hydraulic. Advanced actuation concepts.

Unit 2. **07 Hrs**

Mechanical Systems

Hydraulic fluid. Hydraulic system and components. Study of typical workable system. Power packs. Hydraulic actuators. Pneumatic system and components. Use of bleed air. Emergency lowering of landing gear and braking. Shock absorbers - Retraction mechanism.

Unit 3. **07 Hrs**

Aircraft Fuel and Engine Systems

Characteristics of aircraft fuel system. Gravity feed and pressure feed. A generalized fuel system. Fuel pumps-classification. Fuel control unit. Engine starting sequence. Starting and Ignition systems. Engine oils and a typical lubricating system.

Unit 4. **06 Hrs**

Environmental Control and Emergency Systems

Air-conditioning system, vapour cycle system, deicing and anti-icing system. Fire detection- warning and suppression. Crew escape aids.

PART B

Unit 5. **06 Hrs**

Aircraft Instruments

Instruments displays, panels & layouts. Instrumentation grouping. Navigation instruments, Radio instruments. Hydraulic and Engine instruments

Unit 6. **07 Hrs**

Air Data Instruments

Basic air data system and probes. Mach meter, Air speed indicator, Vertical speed indicator. Barometric pressure sensing. Altimeter. Air data alerting system- angle of attack sensing, stall warning, Mach warning, altitude alerting system.

Unit 7. **07 Hrs**

Gyroscopic Flight Instruments

The gyroscope and its properties. Limitations of a free gyroscope. Drift. Gyroscopic flight. Instruments -Pneumatic, and Electric. Direction indicator, Turn and Bank Indicator.

Unit 8. **06 Hrs**

Engine Instruments

Study of various types of engine instruments- RPM, Pressure, Temperature, Fuel flow, Fuel quantity, and vibrations.

Text Books

1. Ian Moir and Allan Seabridge,' Aircraft Systems: Mechanical, Electrical and Avionics-Subsystem Integration', AIAA Educational Series, 2001.
2. Pallet, E.H.J., "Aircraft Instruments and Integrated Systems", Longman Scientific and Technical, Indian reprint 1996.
3. William A Neese, 'Aircraft Hydraulic Systems', Himalayan Books; 2007.

References

1. Lalit Gupta and O P Sharma,' Aircraft Systems (Fundamentals of Flight Vol. IV)', Himalayan Books; 2006.
2. Treager, S., "Gas Turbine Technology", McGraw-Hill, 1997.
3. R. W. Sloley and W. H. Coulthard, 'The aircraft Engineers Handbook, No 4, INSTRUMENTS', Sterling Book House, 6th Edition, 2005.
4. S R Majumdar,' Pneumatic Systems', Tata McGraw Hill Publishing Co.; 1995.

Scheme of Examination:

Four questions from Part A and Four questions from Part B to be set. Students have to answer any FIVE full questions out of EIGHT questions, choosing at least 2 questions from part A and 2 questions from part B.