MALLA REDDY COLLEGE OF ENGINEERING & TECHNOLOGY
(Autonomous Institution – UGC, Govt. of India)
Sponsored by CMR Educational Society
(Affiliated to JNTU, Hyderabad, Approved by AICTE - Accredited by NBA & NAAC – 'A' Grade - ISO 9001:2008 Certified)
Maisammaguda, Dhulapally (Post Via Hakimpet), Secunderabad – 500100, Telangana State, India.
Contact Number: 040-23792146/64634237, E-Mail ID: mrcet2004@gmail.com,website:www.mrcet.ac.in

MASTER OF TECHNOLOGY
AEROSPACE ENGINEERING

DEPARTMENT OF
AERONAUTICAL ENGINEERING

ACADEMIC REGULATIONS
COURSE STRUCTURE AND SYLLABUS
(Batches admitted from the academic year 2015 - 2016)

Note: The regulations hereunder are subject to amendments as may be made by the Academic Council of the College from time to time. Any or all such amendments will be effective from such date and to such batches of candidates (including those already pursuing the program) as may be decided by the Academic Council.

PRELIMINARY DEFINITIONS AND NOMENCLATURES

"Autonomous Institution /College" means an institution/college designated as autonomous institute / college by University Grants Commission (UGC), as per the UGC Autonomous College Statutes.

- ➤ "Academic Autonomy" means freedom to a College in all aspects of conducting its academic programs, granted by the University for promoting excellence.

- ➤ "Commission" means University Grants Commission.

- ➤ "AICTE" means All India Council for Technical Education.

- ➤ "University" the Jawaharlal Nehru Technological University, Hyderabad.

- ➤ "College" means Malla Reddy College of Engineering & Technology, Secunderabad unless indicated otherwise by the context.

- ➤ "Program" means:

> Master of Technology (M.Tech) degree program
> PG Degree Program: M.Tech

- ➤ "Branch" means specialization in a program like M.Tech degree program in Aeronautical Engineering, M.Tech degree program in Computer Science and Engineering etc.

- ➤ "Course" or "Subject" means a theory or practical subject, identified by its course – number and course-title, which is normally studied in a semester.

- ➤ T–Tutorial, P–Practical, D–Drawing, L-Theory, C-Credits

FOREWORD

The autonomy is conferred on Malla Reddy College of Engineering & Technology (MRCET) by UGC based on its performance as well as future commitment and competency to impart quality education. It is a mark of its ability to function independently in accordance with the set norms of the monitoring bodies like UGC and AICTE. It reflects the confidence of the UGC in the autonomous institution to uphold and maintain standards it expects to deliver on its own behalf and thus awards degrees on behalf of the college. Thus, an autonomous institution is given the freedom to have its own curriculum, examination system and monitoring mechanism, independent of the affiliating University but under its observance.

Malla Reddy College of Engineering & Technology (MRCET) is proud to win the credence of all the above bodies monitoring the quality in education and has gladly accepted the responsibility of sustaining, and also improving upon the values and beliefs for which it has been striving for more than a decade in reaching its present standing in the arena of contemporary technical education. As a follow up, statutory bodies like Academic Council and Boards of Studies are constituted with the guidance of the Governing Body of the College and recommendations of the JNTU Hyderabad to frame the regulations, course structure and syllabi under autonomous status.

The autonomous regulations, course structure and syllabi have been prepared after prolonged and detailed interaction with several experts drawn from academics, industry and research, in accordance with the vision and mission of the college which reflects the mindset of the institution in order to produce quality engineering graduates to the society.

All the faculty, parents and students are requested to go through all the rules and regulations carefully. Any clarifications, if needed, are to be sought at appropriate time and with principal of the college, without presumptions, to avoid unwanted subsequent inconveniences and embarrassments. The Cooperation of all the stake holders is sought for the successful implementation of the autonomous system in the larger interests of the institution and brighter prospects of engineering graduates.

"A thought beyond the horizons of success committed for educational excellence"

PRINCIPAL

MALLA REDDY COLLEGE OF ENGINEERING & TECHNOLOGY

(Autonomous Institution – UGC, Govt. of India)

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(Affiliated to JNTU, Hyderabad, Approved by AICTE - Accredited by NBA & NAAC – 'A' Grade - ISO 9001:2008 Certified)

Maisammaguda, Dhulapally (Post Via Hakimpet), Secunderabad – 500100, Telangana State, India.

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VISION

❖ To establish a pedestal for the integral innovation, team spirit, originality and competence in the students, expose them to face the global challenges and become technology leaders of Indian vision of modern society.

MISSION

❖ To become a model institution in the fields of Engineering, Technology and Management.

❖ To impart holistic education to the students to render them as industry ready engineers.

❖ To ensure synchronization of MRCET ideologies with challenging demands of International Pioneering Organizations.

QUALITY POLICY

❖ To implement best practices in Teaching and Learning process for both UG and PG courses meticulously.

❖ To provide state of art infrastructure and expertise to impart the quality education.

❖ To groom the students to become intellectually creative and professionally competitive.

❖ To channelize the activities and tune them in heights of commitment and sincerity, the requisites to claim the never ending ladder of SUCCESS year after year.

For more information: www.mrcet.ac.in

ACADEMIC REGULATIONS R-15 FOR M. TECH. (REGULAR) DEGREE COURSE

Academic Regulations of R-15 are applicable for the students of M. Tech. (Regular) Course from the Academic Year 2015-16 and onwards. The M.Tech Degree of Malla Reddy College of Engineering & Technology (MRCET), Secunderabad shall be conferred on candidates who are admitted to the program and who fulfill all the requirements for the award of the Degree.

1.0 ELIGIBILITY FOR ADMISSIONS

Admission to the above program shall be made subject to eligibility, qualification and specialization as prescribed by the University from time to time.

Admissions shall be made on the basis of merit/rank obtained by the candidates at the qualifying Entrance Test conducted by the University (or) State Government (or) on the basis of any other order of merit as approved by the University, subject to norms as laid down by the State Govt. from time to time.

2.0 AWARD OF M. TECH. DEGREE

2.1. A student shall be declared eligible for the award of the M. Tech. Degree, if he pursues a course of study in not less than two and not more than four academic years.

2.2. A student, who fails to fulfill all the academic requirements for the award of the degree within four academic years from the year of his admission, shall forfeit his seat in M. Tech. course.

2.3. The student shall register for all 88 credits and secure all the 88 credits.

2.4. The minimum instruction days in each semester are 90.

3.0 A. COURSE OF STUDY

The following specializations are offered at present for the M. Tech. course of study.

1. Aerospace Engineering
2. Computer Science and Engineering
3. Machine Design
4. System and Signal Processing
5. VLSI and Embedded Systems
6. Thermal Engineering

and any other course as approved by the MRCET from time to time.

3.0 B. Departments offering M. Tech. Programmes with specializations are noted below:

Aeronautical Engineering	Aerospace Engineering
Computer Science Engineering	Computer Science Engineering
Electronics & Communication Engineering	System & Signal Processing
Electronics & Communication Engineering	VLSI and Embedded Systems

Mechanical Engineering	Machine Design
Mechanical Engineering	Thermal Engineering

4.0 ATTENDANCE

The programs are offered on a unit basis with each subject being considered a unit.

4.1 A student shall be eligible to write University examinations if he acquires a minimum of 75% of attendance in aggregate of all the subjects.

4.2 Condonation of shortage of attendance in aggregate up to 10% (65% and above and below 75%) in each semester shall be granted by the College Academic Committee.

4.3 Shortage of Attendance below 65% in aggregate shall not be condoned.

4.4 Students whose shortage of attendance is not condoned in any semester are not eligible to write their end semester examination of that class and their registration shall stand cancelled.

4.5 A prescribed fee as determined by the examination branch shall be payable towards condonation of shortage of attendance.

4.6 A student shall not be promoted to the next semester unless he satisfies the attendance requirement of the present semester, as applicable. They may seek readmission into that semester when offered next. If any candidate fulfills the attendance requirement in the present semester, he shall not be eligible for readmission into the same class.

4.7 In order to qualify for the award of the M. Tech. Degree, the candidate shall complete all the academic requirements of the subjects, as per the course structure.

4.8 A student shall not be promoted to the next semester unless he satisfies the minimum academic requirements of the previous semester.

5.0 EVALUATION

The performance of the candidate in each semester shall be evaluated subject-wise, with a maximum of 100 marks for theory and 100 marks for practicals, on the basis of Internal Evaluation and End Semester Examination.

For the theory subjects 75 marks shall be awarded based on the performance in the End Semester Examination and 25 marks shall be awarded based on the Internal Examination Evaluation. The internal evaluation consists of two mid-term examination of 25 marks each covering descriptive paper which consists 5 questions consisting of two parts each (a) and (b), out of which the student has to answer either (a) or (b), not both. Each question carries 5 marks for a total duration of 2 hours. The total marks secured by the student in each mid-term examination are evaluated for 25 marks, and the average of the two mid-term examinations shall be taken as the final marks secured by each candidate.

However, any student scoring internal marks less than 40% will be given a chance to write the internal exam once again after he/she re-registering for the concerned subject and paying stipulated fees as per the norms.

5.1 The end semesters examination will be conducted for 75 marks with 5 questions consisting of two questions each (a) and (b), out of which the student has to answer either (a) or (b), not both and each question carries 15 marks.

> Part A as a compulsory question for 25 marks, Part B is for maximum of 50 marks with 5 questions consisting of two questions each (a) and (b), out of which the student has to answer either (a) or (b), not both and each question in Part B carries 10 marks.

5.2 For practical subjects, 75 marks shall be awarded based on the performance in the End Semester Examinations and 25 marks shall be awarded based on the day-to-day performance as Internal Marks.

5.3 There shall be two seminar presentations during I year I semester and II semester respectively. For seminar, a student under the supervision of a faculty member, shall collect the literature on a topic and critically review the literature and submit it to the department in a report form and shall make an oral presentation before the Departmental Academic Committee consisting of Head of the Department, Supervisor and two other senior faculty members of the department. For each Seminar there will be only internal evaluation of 50 marks. A candidate has to secure a minimum of 50% of marks to be declared successful.

5.4 A candidate shall be deemed to have secured the minimum academic requirement in a subject if he secures a minimum of 40% of marks in the End semester Examination and a minimum aggregate of 50% of the total marks in the End Semester Examination and Internal Examination taken together.

5.5 In case the candidate does not secure the minimum academic requirement in any subject (as specified in 5.4) he has to reappear for the End semester Examination in that subject.

5.6 A candidate shall be given one chance to re-register for each subject provided the internal marks secured by a candidate are less than 50% and so has failed in the end examination. In such a case, the candidate must re-register for the subject(s) and secure the required minimum attendance. The candidate's attendance in the re-registered subject(s) shall be calculated separately to decide upon his eligibility for writing the end examination in those subject(s). In the event of the student taking another chance, his internal marks and end examination marks obtained in the previous attempt stand cancelled.

5.7 In case the candidate secures less than the required attendance in any subject, he shall not be permitted to write the End Examination in that subject. He shall re-register the subject when next offered.

5.8 Laboratory examination for M. Tech. courses must be conducted with two Examiners, one of them being the Laboratory Class Teacher and the second examiner shall be another Laboratory Teacher.

6.0 EVALUATION OF PROJECT/DISSERTATION WORK

Every candidate shall be required to submit a thesis or dissertation on a topic approved by the Project Review Committee.

6.1 A Project Review Committee (PRC) shall be constituted with Principal as Chairperson, Heads of all the Departments offering the M. Tech. programs and two other senior faculty members.

6.2 Registration of Project Work: A candidate is permitted to register for the project work after satisfying the attendance requirement of all the subjects, both theory and practical.

6.3 After satisfying 6.2, a candidate has to submit, in consultation with his project supervisor, the title, objective and plan of action of his project work to the Departmental Academic Committee for approval. Only after obtaining the approval of the Departmental Academic Committee can the student initiate the Project work.

6.4 If a candidate wishes to change his supervisor or topic of the project, he can do so with the approval of the Departmental Academic Committee. However, the Departmental Academic Committee shall examine whether or not the change of topic/supervisor leads to a major change of his initial plans of project proposal. If yes, his date of registration for the project work starts from the date of change of Supervisor or topic as the case may be.

6.5 A candidate shall submit his status report in a bound-form in two stages at least with a gap of 3 months between them.

6.6 The work on the project shall be initiated at the beginning of the II year and the duration of the project is two semesters. A candidate is permitted to submit Project Thesis only after successful completion of theory and practical course with the approval of PRC not earlier than 40 weeks from the date of registration of the project work. For the approval of PRC the candidate shall submit the draft copy of thesis to the Principal through Head of the Department and make an oral presentation before the PRC.

6.7 Three copies of the Project Thesis certified by the supervisor shall be submitted to the College/School/Institute.

6.8 The thesis shall be adjudicated by one examiner selected by the University. For this, the Principal of the College shall submit a panel of 5 examiners, eminent in that field, with the help of the guide concerned and head of the department.

6.9 If the report of the examiner is not favorable, the candidate shall revise and resubmit the Thesis, in the time frame as decided by the PRC. If the report of the examiner is unfavorable again, the thesis shall be summarily rejected.

6.10 If the report of the examiner is favorable, Viva-Voce examination shall be conducted by a board consisting of the Supervisor, Head of the Department and

the examiner who adjudicated the Thesis. The Board shall jointly report the candidate's work as one of the following:

A. Excellent
B. Good
C. Satisfactory
D. Unsatisfactory

The Head of the Department shall coordinate and make arrangements for the conduct of Viva- Voce examination.

If the report of the Viva-Voce is unsatisfactory, the candidate shall retake the Viva-Voce examination only after three months. If he fails to get a satisfactory report at the second Viva- Voce examination, he will not be eligible for the award of the degree.

7.0 AWARD OF DEGREE AND CLASS

In assessing the performance of the students in examinations, the usual approach is to award marks based on the examinations conducted at various stages (sessional, mid-term, end-semester etc.,) in a semester. As per UGC Autonomous guidelines, the following system is implemented in awarding the grades and CGPA under the Credit Based Semester System (CBCS).
Letter Grades and Grade Points:
The UGC recommends a 10-point grading system with the following letter grades as given below:

Grades	Points	Marks secured (%)
O (Outstanding)	10	≥ 85
A+(Excellent)	9	80 – 84
A(Very Good)	8	75 – 79
B+(Good)	7	70 – 74
B(Above Average)	6	65 – 69
C(Average)	5	60 – 64
P(Pass)	4	50 – 59
F(Fail)	0	<50
Ab(Absent)	0	-

A student obtaining Grade F shall be considered failed and will be required to reappear in the examination

Computation of SGPA and CGPA
The UGC recommends the following procedure to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

i. The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student, i.e

SGPA (Si) = Σ(Ci x Gi) / ΣCi

where Ci is the number of credits of the ith course and Gi is the grade point scored by the student in the ith course.

ii. The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme, i.e.

CGPA = Σ(Ci x Si) / Σ Ci

where Si is the SGPA of the ith semester and Ci is the total number of credits in that semester.

iii. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

8.0   WITHHOLDING OF RESULTS

If the student has not paid the dues, if any, to the Institute or if any case of indiscipline is pending against him, the result of the student will be withheld and he will not be allowed into the next semester. His degree will be withheld in such cases.

9.0   TRANSITORY REGULATIONS

9.1   Discontinued, detained, or failed candidates are eligible for admission to two earlier or equivalent subjects at a time as and when offered.

10. GENERAL

10.1 Wherever the words he, him, his, occur in the regulations, they include she, her, hers .
10.2 The academic regulation should be read as a whole for the purpose of any interpretation.
10.3 In case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Academic Council of the College is final.
10.4 The College may change or amend the academic regulations or syllabi at any time and the changes or amendments made shall be applicable to all the students with effect from the dates notified by the Academic Council of the College/Affiliating University.

MALPRACTICES RULES
DISCIPLINARY ACTION FOR / IMPROPER CONDUCT IN EXAMINATIONS

S.No	Nature of Malpractices/Improper conduct	Punishment
	If the candidate:	
1. (a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the subject of the examination)	Expulsion from the examination hall and cancellation of the performance in that subject only.
(b)	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that subject only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him.
2.	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination (theory or practical) in which the candidate is appearing.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that Semester. The Hall Ticket of the candidate is to be cancelled and sent to the University.
3.	Impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate who has been impersonated, shall be cancelled in all the subjects of the examination (including practicals and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester. The candidate is also debarred for two consecutive semesters from

		class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him.
4.	Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination.	Expulsion from the examination hall and cancellation of performance in that subject and all the othe subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
5.	Using objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks.	Cancellation of the performance in that subject.
6.	Refuses to obey the orders of the Chief Superintendent/Assistant Superintendent / any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in charge or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the officer-incharge, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the College campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester. The candidates also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case is registered against them.
7.	Leaves the exam hall taking away answer script or	Expulsion from the examination hall

	intentionally tears of the script or any part thereof inside or outside the examination hall.	and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
8.	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester. The candidate is also debarred and forfeits the seat.
9.	If student of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	Student of the colleges expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the College will be handed over to police and, a police case will be registered against them.
10.	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that

		semester.
11.	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that subject and all other subjects the candidate has appeared including practical examinations and project work of that semester examinations.
12.	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the Academic Council of the College (or) affiliating University for further action towards suitable punishment.	

Malpractices identified by squad or special invigilators will entail punishment to the candidates as per the above guidelines.

DEPARTMENT OF AERONAUTICAL ENGINEERING

M.TECH – AEROSPACE ENGINEERING

COURSE STRUCTURE & SYLLABUS

I Year I Semester

S.NO.	SUBJECT CODE	SUBJECT	L	T/P/D	C	MAX MARKS	
						INT	EXT
1	R15D7601	Mathematical Modeling	4	-	3	25	75
2	R15D7602	Engineering Analysis of Flight Vehicles	4	-	3	25	75
3	R15D7603	Rocket and Missile Technology	4	-	3	25	75
4	R15D7604 R15D7605 R15D7606	Elective-1 1) Fundamentals of Aerospace Engineering * 2)Aerodynamics of Flight Vehicles 3)Flight Vehicle Structures	4	-	3	25	75
5	R15D7607 R15D7608 R15D7609	Elective-2 1)Modeling and Simulation of Fluid Flows 2)Computational Structural Analysis 3)Integrated Aircraft systems	4	-	3	25	75
6	R15D7610 R15D7611 R15D7612	Open Elective-I 1)Continuum Mechanics 2)Air-breathing Propulsion 3)Rotorcraft Aerodynamics	4	-	3	25	75
7	R15D7681	Digital Simulation Lab-I	-	3	2	25	75
8	R15D7682	Technical Seminar - II	-	-	2	50	
	Total		24	3	22	225	525

NOTE: *Fundamentals of Aerospace Engineering

(*Required to be taken by all students other than B.Tech Aeronautical/ Aerospace Engineering degree holders)*

I Year II Semester

S.NO.	SUBJECT CODE	SUBJECT	L	T/P/D	C	MAX MARKS	
						INT	EXT
1	R15D7613	Aircraft Control and Simulation	4	-	3	25	75
2	R15D7614	Aerospace Sensors and Measurement System	4	-	3	25	75
3	R15D7615	Computational Approaches to Aerospace Vehicle Design	4	-	3	25	75
4	R15D7616 R15D7617 R15D7618	Elective-III 1)Aero-thermodynamics of Hypersonic Flight 2) Advanced Topics in Air Traffic Management Systems 3)Spacecraft Dynamics and Control	4	-	3	25	75
5	R15D7619 R15D7620 R15D7621	Elective-IV 1) Communication Navigation and Surveillance Systems 2)Space Transportation Systems 3)Dynamics and Control of Structures	4	-	3	25	75
6	R15D7622 R15D7623 R15D7624	Open Elective- II 1) Tactical Missile Design 2)High Angle of Attack Aerodynamics 3)Optimal Control	4	-	3	25	75
7	R15D7683	Digital Simulation Lab-II	-	3	2	25	75
8	R15D7684	Technical Seminar-II	-	-	2	50	
		Total	24	3	22	225	525

II Year I Semester

S.NO.	SUBJECT CODE	SUBJECT	L	T/P/D	C	MAX MARKS	
						INT	EXT
1	-	Project Review Seminars	-	-	4	-	-
2	-	Project Work	-	-	18	-	-
		Total	-	-	22	-	-

II Year II Semester

S.NO.	SUBJECT CODE	SUBJECT	L	T/P/D	C	MAX MARKS	
						INT	EXT
1	-	Project Work	-	-	22	-	-
2	-	Project Viva-voce	-	-	-	-	-
		Total	-	-	22	-	-

MALLA REDDY COLLEGE OF ENGINEERING & TECHNOLOGY

I Year M. Tech, ASP-I SEM

L	T/P/D	C
4	-	3

(R15D7601) MATHEMATICAL MODELING

UNIT-I: **INTRODUCTION TO MODELING AND SINGULAR PERTURBATION METHODS**
Definition of a model, Procedure of modeling: problem identification, model formulation, reduction, analysis, Computation, model validation, Choosing the model, Singular Perturbations: Elementary boundary layer theory, Matched asymptotic expansions, Inner layers, nonlinear oscillations

UNIT-II: **VARIATIONAL PRINCIPLES AND RANDOM SYSTEMS**
Variational calculus: Euler's equation, Integrals and missing variables, Constraints and Lagrange multipliers, Variational problems: Optics-Fermat's principle, Analytical mechanics: Hamilton's principle, Symmetry: Noether's theorem, Rigid body motion, Random systems: Random variables, Stochastic processes, Monte Carlo method

UNIT-III: **FINITE DIFFERENCES: ORDINARY AND PARTIAL DIFFERENTIAL EQUATIONS**
ODE: Numerical approximations, Runge-Kutta methods, Beyond Runge-Kutta, PDE: Hyperbolic equations-waves, Parabolic equations-diffusion, Elliptic equations-boundary values
CELLULAR AUTOMATA AND LATTICE GASES
Lattice gases and fluids, Cellular automata and computing

UNIT- IV: **FUNCTION FITTING AND TRANSFORMS**
Function fitting: Model estimation, Least squares, Linear least squares: Singular value decomposition, Non-linear least squares: Levenberg-Marquardt method, Estimation, Fisher information, and Cramer-Rao inequality, Transforms:Orthogonal transforms, Fourier transforms, Wavelets, Principal components
FUNCTION FITTING ARCHITECTURES
Polynomials: Pade approximants, Splines, Orthogonal functions, Radial basis functions, Over-fitting, Neural networks: Back propagation, Regularization

UNIT-V: **OPTIMIZATION AND SEARCH**
Multidimensional search, Local minima, Simulated annealing, Genetic algorithms
FILTERING AND STATE ESTIMATION
Matched filters, Wiener filters, Kalman filters, Non-linearity and entrainment, Hidden Markov models

TEXT BOOK

1. *The Nature of Mathematical Modeling*, Neil Gershenfeld, Cambridge University Press, 2006, ISBN 0-521-57095-6

REFERENCE BOOKS

1. *Mathematical Models in the Applied Sciences*, A. C. Fowler, Cambridge University Press, 1997, ISBN 0-521-46140-5
2. *A First Course in Mathematical Modeling*, F. R. Giordano, M.D. Weir and W.P. Fox, 2003, Thomson, Brooks/Cole Publishers

3. *Applied Numerical Modeling for Engineers*, Donald De Cogan, Anne De Cogan, Oxford University Press, 1997

MALLA REDDY COLLEGE OF ENGINEERING & TECHNOLOGY

I Year M. Tech, ASP-I SEM

L	T/P/D	C
4	-	3

(R15D7602) ENGINEERING ANALYSIS OF FLIGHT VEHICLES

UNIT-I: **THE MORPHOLOGY OF FLIGHT VEHICLES**
Introduction, Key factors affecting vehicles configuration, some representative flight vehicles.

UNIT-II: **EQUATIONS OF MOTION FOR RIGID FLIGHT VEHICLES**
Definitions, Vector and Scalar realizations of Newton's second law, The tensor of inertia, Choice of vehicle axes, Principal axes, Stability axes, Aerodynamic axes, Orientation of the vehicle relative to the ground; flight path determination, Gravitational terms in the equations of motion, The state vector, Equations of motion; Aerodynamic Approximations; stability derivatives; Estimation of stability derivatives: Longitudinal.
INTRODUCTION TO VEHICLE AERODYNAMICS
Aerodynamics contributions to X, Y and M, dimensionless coefficients defined, equations of perturbed longitudinal motion.

UNIT-III: **AIRCRAFT DYNAMICS**
Equations of Motion of Aircraft including forces and moments of control surfaces, Dynamics of control surfaces
STATIC STABILITY, TRIM STATIC PERFORMANCE AND RELATED SUBJECTS
Impact of stability requirements on design and longitudinal control, Static performance

UNIT-IV: **DYNAMIC PERFORMANCE OF SPACECRAFT WITH RESPECT TO NON-ROTATING PLANETS**
Introduction, Numerical integration of ordinary differential equations, Simplified treatment of boost from a non-rotating planet, An elementary look at staging, Equations of boost from a rotating planet.

UNIT-V: **DYNAMIC PERFORMANCE OF SPACECRAFT**
Equations of Motion of Launch Vehicles with respect to a rotating planet, Motion of Spacecraft with respect to a rotating planet.
DYNAMIC PERFORMANCE-ATMOSPHERIC ENTRY
Equation of motion, Approximate analysis of gliding entry into a planetary atmosphere.

TEXT BOOK

1. *Engineering Analysis of Flight Vehicles*, Holt Ashley, Dover Publications, 1992

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(R15D7603) ROCKET AND MISSILE TECHNOLOGY

UNIT-I: INTRODUCTION

Rockets and military missiles – function, types, role, mission, mission profile, thrust profile, propulsion system, payload, staging, control and guidance requirements Performance measures, design, construction ,operation-similarities and differences .Some famous space launch vehicles and strategic missiles.

UNIT-II: SOLID AND LIQIUD PROPULSION SYSTEMS

Solid propellant rocket motors, principal features .applications, solid propellants, types, composition, properties, performance. Propellantgrain, desirableproperties, grainconfiguration, preparation. loading. structural design of grain .Combustion instabilities. Liners, insulators and inhibitors-function, requirements, materials. Rocket motor casing –materials. Nozzles –types, design- construction, thermal protection. Igniters, types, construction. Description of modern solid boosters I) Space Shuttle SRB II) the Arienne SRB

Liquid propellants –types, composition, properties. Performance .Propellant tanks, feed systems – pressurisation, turbo-pumps-valves and feed lines, injectors, starting and ignition .Engine cooling support structure. Control of engine starting and thrust build up. System calibration, integration and optimization –safety and environmental concerns combustion instabilities. Description of the space shuttle main engine .Propellant slosh, propellant hammer, geysering effect in cryogenic rocket engines. Tsiolskovsky's rocket equation in the absence of gravity, vertical motion in the earth's gravitational field , inclined motion , flight path at constant pitch angle , motion in the atmosphere , the gravity turn-the culmination altitude, Multi staging. Earth launch trajectories –vertical segment , the gravity turn ,constant pitch trajectory , orbital injection. Actual launch vehicle trajectories –types. Examples, the Mu-3-S-II. Ariane, Pegasus launchers, Reusable launch vehicles – future launchers –launch assist technologies

UNIT-III: AERODYNAMICS OF ROCKETS AND MISSILES AND ATTITUDE CONTROL

Classification of missiles, Airframe components of rockets and missiles. Forces acting on a missile while passing through atmosphere, method of describing aerodynamic forces and moments .lateral aerodynamic moment ,lateral damping moment , longitudinal moment of a rocket, lift and drag forces, drag estimation ,body up wash and down wash in missiles. Rocket dispersion. re-entry body design considerations Rocket thrust vector control – methods of thrust vector control for solid and liquid propulsion systems, thrust magnitude control .thrust termination; stage separation dynamics , separation techniques

UNIT-IV: MATERIALS AND ROCKET TESTING

Criteria for selection of materials for rockets and missiles- requirements for choice of materials for propellant tanks, liners, insulators, inhibitors, at cryogenic temperatures, requirements of materials at extremely high temperatures, requirements of materials for thermal protection and for pressure vessels.Ground testing and flight testing-

types of tests, test facilities and safeguards monitoring and control of toxic materials, instrumentation and data management. Ground testing, flight testing, trajectory monitoring, post accident procedures. Description of a typical space launch vehicle launches procedure.

UNIT-V: ALTERNATIVE PROPULSION SYSTEMS AND FLIGHT VEHICLES

Hybrid propulsion system .Ramjet propulsion and its performance and limitations, the scramjet engine – construction , flow process , drag components , fuel injection systems , applications , components performance analysis –Hypersonic transport vehicles, missions , trajectories, sounding rockets , cruise missiles , unmanned Aerial Vehicles and drones , Micro Aerial Vehicles – applications of these vehicles

TEXT BOOKS

1. Sutton, GP. and Biblarz, *., Rocket Propulsion Elements*,7th edition, Wiley-Interscience, 2000.
2. Cornelisse, J.W., Schoyer H.F.R. and Wakker. K.F.,*Rocket propulsion and space flight dynamics* ,pitman 1979
3. Turner ,M.J.L., *Rocket and Spacecraft Propulsion* ,springer ,2001
4. Hill ,PG. and Peterson ,CR, *Mechanics and Thermodynamics of propulsion* , 2nd edition , Addison Wesley ,1992

REFERNCE BOOKS

1. Anderson JD., *Introduction to flight* 5th edition ,Tata McGraw Hill ISBN: 0-07-006082-4
2. *James all the world flight vehicles* Jones aviation publications London

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(R15D7604) FUNDAMENTALS OF AEROSPACE ENGINEERING
(ELECTIVE-I)

UNIT-I: **INTRODUCTION TO AEROSPACE ENGINEERING**
Brief history of Aeronautics, Anatomy of the Airplane, Anatomy of a Space Vehicle, The Nature of Aerodynamic forces and dimensional analysis; Theory and experiment: wind tunnels, Atmosphere: Properties of U.S. standard atmosphere, Definitions of altitude,

UNIT-II: **INCOMPRESSIBLE ONE DIMENSIONAL FLOWS AND COMPRESSIBLE FLUIDS**
Continuity equation, Bernoulli's equation, Application of Bernoulli's equation: Airspeed indicators and wind tunnels, One-dimensional compressible flow concepts, Speed of sound, Compressible flow equations in a variable-area stream tube, Application to airspeed measurement, Applications to channels and wind tunnels
 TWO-DIMENSIONAL FLOW AND FINITE WING: Limitations of one-dimensional flow equations, Theory of lift: circulation, Airfoil pressure distribution, Helmholtz vortex theorems, Simulating the wing with a vortex line, Downwash, Elliptic lift distribution, Lift and drag: momentum and energy, Slope of finite wing lift curve, Verification of Prandtl wing theory, Additional effects of wing vortices, Search for reduced induced drag

UNIT-III: **EFFECTS OF VISCOSITY, TOTAL DRAG**
Boundary layer, Boundary layer on bluff bodies, Creation of circulation, Laminar and turbulent boundary layers: skin friction, Nature of Reynolds number, Effect of turbulent boundary layer on separation; Parasite drag, Drag due to lift, Importance of aspect ratio; Prediction of drag divergence Mach number, Sweptback wings, Total drag, Supersonic flow: shock waves and Mach waves, Supersonic wing lift and drag, Area rule, Supersonic aircraft,
AIRFOILS, WINGS AND HIGHLIFT SYSTEMS: Early airfoil development, Modern airfoils, Supersonic airfoils, Airfoil pitching moments, Effects of sweepback on lift, airfoil characteristics, Airfoil selection and wing design; Airfoil maximum lift coefficient, Leading and trailing edge devices, Effect of sweepback, Deep stall, Effect of Reynolds number, Propulsive lift

UNIT-IV: **AERODYNAMIC PERFORMANCE, STABILITY AND CONTROL**
Level flight performance, Climb performance, Range, Endurance, Energy-state approach to airplane performance, Takeoff performance, landing performance; Static longitudinal stability, Dynamic longitudinal stability, Dynamic lateral stability, Control and Maneuverability: turning performance, Control systems, Active controls

UNIT-V: **AEROSPACE PROPULSION AND AIRCRAFT STRUCTURES**
Aerospace Propulsion: Piston engines, Gas turbines, Speed limitations of gas turbines: ramjets, Propellers, Overall propulsion efficiency, Rocket engines, Rocket motor performance, Propulsion-airframe integration; Aircraft structures: Importance of structural weight and integrity, Development of aircraft structures, Importance of fatigue, Materials, Loads, Weight estimation
ROCKET TRAJECTORIES, ORBITS AND REENTRY
 Rocket trajectories, Multistage rockets, Escape velocity, Circular orbital or satellite velocity, Elliptical

orbits, Orbital maneuvers.

TEXT BOOK

1. *Fundamentals of Flight*, Richard S. Shevell, Pearson Education Publication, ISBN 81-297-0514-1, 1989

REFERENCE BOOK

1. *Introduction to Flight*, John D. Anderson, Jr., Tata McGraw-Hill Publishing Company, Fifth Edition, Fifth Edition, 2007, ISBN 13: 978-0-07-066082-3

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(R15D7605) AERODYNAMICS OF FLIGHT VEHICLES
(ELECTIVE-I)

UNIT-I: REVISION OF BASICS LEARNT AT UNDER GRADUATE LEVEL IN BRIEF

AERODYNAMIC CHARACTERISTICS OF AIRFOILS: Vortex sheet, Vortex sheet in thin-airfoil theory, Planar wing, Properties of symmetrical airfoil, Properties of cambered airfoil, Flapped airfoil, Numerical Solution of thin airfoil problem, Airfoil of arbitrary thickness and camber

UNIT II: THE FINITE WING
Flow fields around finite wings, Downwash and induced drag, Fundamental equations of finite-wing theory, Elliptical lift distribution, Arbitrary circulation distribution, Twisted wing: Basic and Additional lift, Approximate calculation of additional lift, Winglets, Stability and trim of wings, Higher approximations, The complete airplane, Interference effects,

AIRFOILS IN COMPRESSIBLE FLOWS
 Boundary conditions, subsonic airfoils Prandtl-Glauert transformation, Critical Mach number, Drag divergence Mach number, Airfoils in transonic flow, Airfoils in supersonic flow

UNIT-III: **WINGS AND WING-BODY COMBINATIONS IN COMPRESSIBLE FLOW**
Wings and bodies in compressible flows: Prandtl-Glauert-Goethert transformation, Influence of sweepback, Design rules for wing-fuselage combinations

LAMINAR BOUNDARY LAYER IN COMPRESSIBLE FLOW
Conservation of energy in the boundary layer, Rotation and entropy gradient in the boundary layer, Similarity considerations for compressible boundary layers, Solution of energy equation for Prandtl number unity, Temperature recovery factor, Heat transfer versus skin friction, Velocity and temperature profiles and skin friction, Effects of pressure gradient

UNIT-IV: **FLOW INSTABILITIES AND TRANSITION FROM LAMINAR TO TURBULENT FLOW**
 Gross effects, Reynolds experiment, Tollmien-Schlichting instability and transition, Natural laminar flow and laminar flow control, Stability of vortex sheets, Transition phenomenon, Methods for experimentally detecting transition, Flow around spheres and circular cylinders

TURBULENT FLOWS
Description of turbulent field, Statistical properties, Conservation equations, Laminar sub-layer, Fully developed flows in tubes and channels, Constant-pressure turbulent boundary layer, Turbulent drag reduction, Effects of pressure gradient, Stratford criterion for turbulent separation, Effects of compressibility on skin friction, Reynolds analogy: Heat transfer and temperature recovery factor, Free turbulent shear flows

AIRFOIL DESIGN, MULTIPLE SURFACES, VORTEX LIFT, SECONDARY FLOWS, VISCOUS EFFECTS
Airfoil design for high C_{lmax}, multiple lifting surfaces, Circulation control, Stream wise vorticity, Secondary flows, Vortex lift strakes, Flow about three-dimensional bodies, unsteady lift

UNIT-V: UNSTEADY AERODYNAMICS
Unsteady lifting force coefficient, Unsteady aerodynamics of slender wings, Compressible Unsteady aerodynamics, Equations of motion, Boundary condition, Moving coordinate system, Navier Stoke

equations, Aerodynamic forces and moments, Turbulence modelling, Numerical Problems

INCOMPRESSIBLE FLOW OVER AN AIRFOIL

Steady flow, Unsteady flow, Simple Harmonic Motion, Lowey's problem: returning Wake problem, Arbitrary motion and Wagner Function, Gust problem and Kussner function. Numerical Problems

INCOMPRESSIBLE FLOW OVER WINGS

 Steady flow: Lifting line theory (results), Weissinger's L – method, Low aspect ratio wings, unsteady flow: Reissner's Approach, Numerical solutions, Numerical Problems

TEXT BOOKS

1. *Foundations of Aerodynamics*: Bases of Aerodynamic Design, Arnold M. Kuethe and Chuen- Yen Chow, John Wiley & Sons, Inc., Fifth Edition, 1997, ISBN: 978-0-471-12919-6

2. *Fundamentals of Modern Unsteady Aerodynamics*, Gulcat, Ulgen, Springer, Publications, ISBN 978-3-642-14761-6

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(R15D7606) FLIGHT VEHICLE STRUCTURES
(ELECTIVE-I)

UNIT-I: AIRCRAFT STRUCTURAL MATERIALS
Aluminium Alloys, Steel, Titanium, plastic, glass, composite materials, properties of materials, Testing of Engineering Materials : Tensile test, Compression test, Bending Stress, Shear Test, Hardness Test, Impact Test, Stress- Strain Curve. Strain Hardening, Creep Relaxation

STRUCTURAL COMPONENTS AND LOADS OF AIRCRAFT
Loads on Structural components, Function of structural components, Fabrication of structural components, Connections; Airworthiness: Factors of Safety- flight envelope, Load factor determination, Airframe loads: Aircraft inertia loads, Symmetric maneuver loads, Normal accelerations associated with various types of maneuvers, Gust loads

UNIT-II: SHEAR FLOW AND SHEAR CENTER IN OPEN AND CLOSED THIN WALL SECTIONS
Open Sections: Shear center and elastic axis, Concept of shear flow, Beams with one axis of symmetry; Closed Sections: Bradt-Batho formula, Single and multi-cell closed box structures, Semi monocoque and mono cocque structures, Shear flow in single and multi cell mono cocque and semi mono cocque box beams subject to torsion

UNIT-III: THIN PLATE THEORY
Bending of thin plates: Pure bending of thin plates, Plates subjected to bending and twisting, Plates subject to distributed transverse load, Combined bending and in-plane loading of a thin rectangular plate, Bending of thin plates having a small initial curvature, Energy method for bending of thin plates

UNIT-IV: BENDING, SHEAR AND TORSION OF THIN-WALLED BEAMS-I
Bending and Open Thin-Walled Beams: Symmetrical bending, Unsymmetrical bending, Deflections due to bending, Calculation of section properties, Applicability of bending theory, Temperature effects
STRESS ANALYSIS OF AIRCRAFT COMPONENTS
Wing spars, Fuselages, Wings, Fuselage frames and wing ribs, laminated composite structures

UNIT-V: SMART MATERIALS AND ADAPTIVE STRUCTURES
Smart Materials Technologies and Control Applications: Control requirements, Smart Materials-Piezoelectric elements, Electrostrictive elements, Magentostrictive transducers, Electrorheological fluids, Shape memory alloys, Fiber optic sensors, Applications of smart materials, Adaptive Structures: Adaptive aerospace structures-Structural Health Monitoring (SHM), Shape control and active flow, Damping of vibration and noise, Smart skins, Systems

TEXT BOOK
1. *Aircraft Structures for Engineering Students*, Fourth Edition, T. H. G. Megson, Butterworth-Heinemann, Elsevier Ltd, 2007

REFERENCE BOOKS
1. *Mechanics of Aircraft Structures*, Second Edition, C. T. Sun**,** John Wiley & Sons, 2006
2. *Theory and Analysis of Flight Structures***,** Robert M. Rivello, McGraw-Hill, 1969
3. *Airplane Structural Analysis and Design*, Earnest E. Sechler, Lois G. Dunn, Dover Publications, 1963
4. *Mechanics of Elastic Structures*, J. T. Oden and E. A. Ripperger, McGraw-Hill, 1981
5. *Smart Material Structures*: Modeling, Estimation and Control, H. T. Banks, R. C. Smith, Y. Wang, John Wiley & Sons, 1996
6. *Adaptive Structures*: Engineering Applications, David Wagg, Ian Bond, Paul Weaver and Michael Friswell (editors), John Wiley & Sons, 2007

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(R15D7607) MODELLING AND SIMULATION OF FLUID FLOWS
(Elective-II)

UNIT-I: **BASIC EQUATIONS OF FLUID DYNAMICS AND DYNAMICAL LEVELS OF APPROXIMATION**
General form of a conservation law, Mass conservation equation, Momentum conservation law or equation of motion, Energy conservation equation; Navier–Stokes equations, Approximations of turbulent flows, Thin shear layer approximation, Parabolized Navier–Stokes equations, Boundary layer approximation, Distributed loss model, Inviscid flow model: Euler equations, Potential flow model.

UNIT II: **MATHEMATICAL NATURE OF THE FLOW EQUATIONS AND THEIR BOUNDARY CONDITIONS**
Simplified models of a convection–diffusion equation, Definition of the mathematical properties of a system of PDEs, Hyperbolic and parabolic equations: characteristic surfaces and domain of dependence, Time-dependent and conservation form of the PDEs, Initial and boundary conditions

UNIT III: DISCRETIZATION TECHNIQUES
Finite Difference Method for Structured Grids: Basics of finite difference methods, Multidimensional finite difference formulas, Finite difference formulas on non-uniform grids, General method for finite difference formulae, Implicit finite difference formulae; Finite Volume Method: Conservative discretization, Basis of finite volume method, Practical implementation of finite volume method; Introduction to Finite Element Method: Finite element definition of interpolation functions, Finite element definition of the equation discretization: integral formulation, Method of weighted residuals or weak formulation, Galerkin method, Finite element Galerkin method for a conservation law; Structured and Unstructured Grid Properties: Structured grids, Unstructured grids, Surface and volume estimations, Grid quality and best practice guidelines

UNIT IV: **ANALYSIS OF NUMERICAL SCHEMES**
Consistency, stability and error analysis of numerical schemes: Basic concepts and definitions, Von Neumann method for stability analysis, New Leapfrog, Lax-Fredrichs and Lax-Wendroff schemes for the linear convection equation, Spectral analysis of numerical errors; General Properties and High Resolution Numerical Schemes: General formulation of numerical schemes, Generation of new schemes with prescribed order of accuracy, Monotonicity of numerical schemes, Finite volume formulation of schemes and limiters
TIME INTEGRATION METHODS FOR SPACE DISCRETIZED EQUATIONS
Analysis of space-discretized systems, Analysis of time integration schemes, Selection of time integration methods, Implicit schemes for multidimensional problems: Approximate factorization method

UNIT V: **ITERATIVE METHODS FOR RESOLUTION OF ALGEBRAIC SYSTEMS**
Basic iterative methods, Overrelaxation methods, Preconditioning techniques, Nonlinear problems, Multigrid method.
NUMERICAL SIMULATION OF INVISCID FLOWS
Euler equations, Potential flow model, Numerical solutions for the potential equation, Finite

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volume discretization of the Euler equations, Numerical solutions for the Euler equation
NUMERICAL SOLUTIONS OF VISCOUS LAMINAR FLOWS Navier-Stokes Equations for laminar flows, Density based methods for viscous flows, Numerical solutions with the density-based method, Pressure correction method, Numerical solutions with pressure correction method.

TEXT BOOK

1. *Numerical Computation of Internal and External Flows*, Second Edition, Charles Hirsch, Elsevier Publication, 2007

REFERENCE BOOKS

1. *Computational Fluid Dynamics: The Basics with Applications*, John David Anderson, McGraw Hill, 1995
2. Computational Fluid Mechanics and Heat Transfer, 2nd Edition, John C. Tannehill, Dale A. Anderson, Richard H. Pletcher, Taylor & Francis, 1997.

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(R15D7608) COMPUTATIONAL STRUCTURAL ANALYSIS
(Elective-II)

UNIT I: **STRUCTURAL MECHANICS-BASIC THEORY, STRUCTURAL MECHANICS-FINITE ELEMENTS**
Modeling of Material Behavior, Finite Element Formulation Based on the Stationary Functional Method,. One-Dimensional Line Elements, Two-Dimensional Plane Elements, Three-Dimensional Solid Elements, Isoparametric Quadrilateral and Hexahedron Elements, Torsion of Prismatic Shafts, Plate Bending Elements, Shell Elements, Areas of Analysis, Application of the Galerkin Method.

UNIT- II: **SPINNING STRUCTURES, DYNAMIC ELEMENT METHOD**
Derivation of Equation of Motion, Derivation of Nodal Centrifugal Forces, Derivation of Element Matrices; Bar Element, Beam Element, Rectangular Pre-stressed Membrane Element, Plane Triangular Element, Shell Element.

UNIT –III: **GENERATION OF SYSTEM MATRICES, SOLUTION OF SYSTEM EQUATIONS**
Coordinate Systems and Transformations, Matrix Assembly, Imposition of Deflection Boundary Conditions, Matrix Bandwidth Minimization, Sparse Matrix Storage Schemes; Formulation and Solution of System Equation, Sparse Cholesky Factorization.

UNIT –IV: **EIGENVALUE PROBLEMS, DYNAMIC RESPONSE OF ELASTIC STRUCTURES**
Free Vibration Analysis of Undamped Nonspinning Structures, Free Vibration Analysis of Spinning Structures, Quadratic Matrix Eigenvalue Problem for Free Vibration Analysis, Structural Stability Problems, Vibration of Prestressed Structures, Vibration of Damped Structural Systems, Solution of Damped Free Vibration Problem; Method of Modal Superposition, Direct Integration Methods, Frequency Response Method; Response to Random Excitation.

UNIT V

NONLINEAR ANALYSIS, STRESS COMPUTATIONS AND OPTIMIZATION
Geometric Nonlinearity, Material Nonlinearity, Numerical Examples; Line Elements, Triangular Shell Elements, Solid Elements, Optimization, Examples of Applications of Optimization.
HEAT TRANSFER ANALYSIS OF SOLIDS, COMPUTATIONAL LINEAR AEROELASTICITY AND AEROSERVOELASTICITY
Heat Conduction, Solution of System Equations, Numerical Examples, Coupled Heat Transfer and Structural Analysis.; Formulation of Numerical Procedure, Numerical Example
CFD-BASED AEROELASTICITY AND AEROSERVOELASTICITY
Computational Fluid Dynamics, Time-Marched Aeroe1astic and Aeroservoe1astic Analysis,
ARMA Model in Aeroelastic and Aeroservoelastic Analysis, Numerical Examples

TEXT BOOK

1. *Finite Element Multidisciplinary Analysis*, K.K.Gupta and J.L.Meek, Second Edition, AIAA, Education Series, 2003.

REFERENCE BOOK

1. *Finite Element Analysis – Theory and Application with ANSYS*, Saeed Moaveni, Second Edition, Prentice Hall, 2003

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(R15D7609) INTEGRATED AIRCRAFT SYSTEMS (ELECTIVE-II)	4	-	3

UNIT – I: AIRCRAFT SYSTEMS
System - definition, examples, attributes – process, input, output, feedback, external influence. Systems engineering, application to engineering systems. Aircraft systems – principal components – airframe systems, vehicle (utility) systems, avionics systems, mission systems. Subsystems – purpose, description, safety aspects, integration, design drivers. The product life cycle – stages – the engineering processes.

UNIT – II: AIRCRAFT HYDRAULIC SYSTEMS
Hydraulic system services, the hydraulic circuit, actuation, the hydraulic fluid, hydraulic piping, hydraulic pump, fluid conditioning, the reservoir, emergency power sources. Aircraft applications, examples of B Ae, Airbus, Boeing implementations. The landing gear system for retraction, steering, braking and anti-skid.
ELECTRICAL SYSTEMS
Aircraft electrical system characteristics, power (AC and DC) generation, Power generation control, voltage regulation, parallel operation, supervisory and protection functions. Modern electrical power generation types, Electrical power quality. Primary power distribution, power conversion and energy storage. Secondary power distribution, power switching, load protection. Electrical loads, motors and actuators, lighting, heating, subsystem controllers, ground power. Emergency power generation. Typical civil transport aircraft electrical systems examples. Electrical load management system. Aircraft electrical wiring.

UNIT – III: ENGINE CONTROL AND FUEL SYSTEMS
The engine control problem, control system parameters, example systems, design criteria. Engine starting, air flow, fuel flow & ignition control, engine rotation, throttle levers, engine indications. Integrated flight and propulsion control.
Characteristics of aircraft fuel systems, fuel system components – fuel transfer pumps, fuel booster pumps, fuel transfer valves, non-return valves. Fuel quantity measurement systems. Fuel system operation modes - fuel pressurization, engine feed, fuel transfer, use of fuel as heat sink, external fuel tanks, fuel jettison, in-flight refueling. Integrated civil aircraft fuel systems.
PNEUMATIC SYSTEMS AND ENVIRONMENTAL CONTROL SYSTEMS.
Use of pneumatic power in aircraft, Sources of pneumatic power, the engine bleed air, engine bleed air control. Users of pneumatic power, wing and engine anti-ice, engine start, thrust reversers, hydraulic system, pitot-static systems.
The need for controlled environment in aircraft. Sources of heat. Environmental control system design, ram air cooling, fuel cooling, engine bleed, bleed flow and temperature control. Refrigeration systems, air cycle and vapour cycle systems, turbo fan, boot strap, reversed boot strap systems. Humidity control. Air distribution systems. Cabin pressurisation, g tolerance, rain dispersal, anti-misting and demisting. In-flight entertainment systems

UNIT – IV: FLIGHT CONTROL SYSTEMS
Principles of flight control, flight control surfaces, control surface actuation, flight control linkage systems, trim and feel. Power control, mechanical, direct drive, electromechanical, electro-hydrostatic

actuation, multiple redundancy. The fly by wire system. Airbus and Boeing implementations, Inter-relationship of flight control, guidance and vehicle management systems.

Advanced systems - integrated flight and propulsion control, Vehicle management systems. All-electric aircraft concept, more-electric aircraft power generation concepts. Impact of stealth design- examples

SYSTEMS SAFETY, DESIGN AND DEVELOPMENT

Safety considerations – function, performance, integrity, reliability, dispatch availability, Economy considerations – maintainability, product support. Failure severity categorization, design assurance levels. Integration of aircraft systems

Systems design, specifications and requirement, regulations. Design guidelines and certification techniques. Safety assessment processes - functional hazard analysis, preliminary systems safety analysis, systems safety analysis, common cause analysis. Requirements capture. Fault tree analysis, failure modes and effects analysis, component reliability, dispatch reliability, Markov analysis.

UNIT – V: **SYSTEMS ARCHITECTURE, INTEGRATION**

Architectural representation of systems, merits, definitions, types, architecture modeling and trade-off. Systems integration, definitions, levels of integration, examples, management o f systems integration. Aircraft system example

Verification of system requirements, tools - modeling, simulation, test rigs and prototypes, Modeling techniques - types of models and simulations. Test rigs and prototypes. Declaring verification.

Need for interoperability of evolving systems. Forward compatibility and backward compatibility, Factors affecting compatibility. System configurations. representation. configuration control – need, the process.

TEXT BOOKS

1. *Aircraft Systems: Mechanical, Electrical and Avionics Subsystems Integration*, Moir, I. and Seabridge, A., AIAA Education Series, AIAA, 2001, ISBN: 1-56347506-5
2. *Design and Development of Aircraft Systems – An Introduction*, Moir, I., and Seabridge, A., AIAA Education Series, AIAA, 2004, ISBN: 1-56347-722-X.
3. *Civil Avionics Systems*, Moir, I. and Seabridge, A., AIAA Education Series, AIAA, 2002, ISBN 1-56347589-8

REFERENCE BOOKS

1. *Ground Studies for Pilots: Flight Instruments and Automatic Flight Control Systems*, Harris, D., sixth edition, Blackwell Science, 2004, ISBN 0-632-05951-6.
2. *Aircraft Electrical Systems*, Pallet, E. H. J., Indian Edition, The English Book Store, New Delhi, 1993, ISBN81-70002-059-X
3. *Pneumatic and Hydraulic Systems*, Bolton, W.,Butterworth Heinemann.
4. *Aircraft Instruments & Integrated Systems*, Pallett, E.H.J., Longman Scientific & Technical, 1996.

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(R15D7610) CONTINUUM MECHANICS
(OPEN ELECTIVE-I)

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UNIT I: INTRODUCTION, VECTORS AND TENSORS

Background and Overview, Vector Algebra - Definition of a Vector, Scalar and Vector Products, Plane Area as a Vector, Components of a Vector, Summation Convention, Transformation Law for Different Bases; Theory of Matrices - Definition, Matrix Addition and Multiplication of a Matrix by a Scalar, Matrix Transpose and Symmetric Matrix, Matrix Multiplication, Inverse and Determinant of a Matrix; Vector Calculus - Derivative of a Scalar Function of a Vector, The del Operator, Divergence and Curl of a Vector, Cylindrical and Spherical Coordinate Systems, Gradient, Divergence and Curl Theorems; Tensors- Dyads and Polyads, Nonion Form of a Dyadic, Transformation of Components of a Dyadic, Tensor Calculus, Eigenvalues and Eigenvectors of Tensors

UNIT II: KINEMATICS OF CONTINUA

Introduction, Description of Motion- Configurations of a Continuous Medium, Material Description, Spatial Description, Displacement Field; Analysis of Deformation- Deformation gradient tensors, Isochoric, Homogeneous and Inhomogeneous Deformations, Change of volume and surface; Strain Measures-Cauchy-Green deformation tensors, Green Strain tensor, Physical Interpretation of the Strain Components, Cauchy and Euler Strain Tensors, Principal Strains; Infinitesimal Strain Tensor and Rotation Tensor- Infinitesimal Strain Tensor, Physical Interpretation of Infinitesimal Strain Tensor Components, Infinitesimal Rotation Tensor, Infinitesimal Strains in Cylindrical and Spherical Coordinate Systems; Rate of Deformation and Vorticity Tensors- Definitions, Relationship between D and E, .Polar Decomposition Theorem, Compatibility Equations, Change of Observer- Material Frame Indifference.

UNIT III: STRESS MEASURES

Introduction, Cauchy Stress Tensor and Cauchy's Formula, Transformation of Stress Components and Principal Stresses- Transformation of Stress Components, Principal Stresses and Principal Planes, Maximum Shear Stress. Other Stress Measures - Preliminary Comments, First Piola- Kirchhoff Stress Tensor, Second Piola- Kirchhoff Stress Tensor, Equations of Equilibrium.

CONSERVATION OF MASS, MOMENTA AND ENERGY

Introduction, Conservation of Mass - Preliminary Discussion, Material Time Derivative, Continuity Equation in Spatial Description, Continuity Equation in Material Description ,Reynolds Transport Theorem. Conservation of Momenta - Principle of Conservation of Linear Momentum, Equation of Motion in Cylindrical and Spherical Coordinates, Principle of Conservation of Angular Momentum, Thermodynamic Principles - Introduction, The First Law of Thermodynamics: Energy Equation, Special Cases of Energy Equation, Energy Equation for One-Dimensional Flows , The Second Law of Thermodynamics.

UNIT IV: CONSTITUTIVE EQUATIONS

Introduction, Elastic Solids - Generalized Hooke's Law, Material Symmetry, Monoclinic Materials, Orthotropic Materials, Isotropic Materials, Transformation of Stress and Strain Components, Nonlinear Elastic Constitutive Relations, Constitutive Equations for Fluids - Ideal Fluids, Viscous Incompressible Fluids, Non-Newtonian Fluids, Heat Transfer - General Introduction, Fourier's Heat Conduction Law,

Newton's Law of Cooling, Stefan-Boltzmann Law, Electromagnetics - Maxwell's Equation, Constitutive Relations.

LINEARIZED ELASTICITY

Governing Equations, The Navier Equations, The Beltrami-Michell Equations, Types of Boundary Value Problems and Superposition Principle. Clapeyron's theorem and Reciprocity Relations - Clapeyron's theorem, Betti's Reciprocity Relations, Maxwell's Reciprocity Relation, Solution Methods, Types of Solution Methods, Example: Rotating Thick Walled Cylinder; Two-Dimensional Problems, Airy Stress Function, End Effects: Saint-Venant's Principle, Torsion of Noncircular Cylinders. Principle of Minimum Total Potential Energy - Total Potential Energy Principle, Derivation of Navier's Equations, Castiglian's Theorem I . Hamilton's Principle-Hamilton's Principle for a Rigid Body, Hamilton's Principle for a Continuum

UNIT V: **FLUID MECHANICS AND HEAT TRANSFER**

Governing Equations- Preliminary Comments, Summary of Equations, Viscous Incompressible Fluids, Heat Transfer; Fluid Mechanics Problems - Inviscid Fluid Statics, Parallel Flow (Navier-Stokes Equations), Problems with Negligible Convective Terms; Heat Transfer Problems- Heat Conduction in a Cooling Fin, Axisymmetric Heat Conduction in a Circular Cylinder, Two-Dimensional Heat Transfer, Coupled Fluid Flow and Heat Transfer

LINEAR VISCOELASTICITY

Preliminary Comments- Initial Value Problem, the Unit Impulse, and the Unit Step Function, The Laplace Transform Method, Spring and Dashpot Models - Creep Compliance and Relaxation Modulus, Maxwell Element , Kelvin-Voigt Element, Three-Element Models , Four-Element Models , Integral Constitutive Equations, Hereditary Integrals, Hereditary Integrals for Deviatoric Components, The Correspondence Principle, Elastic and Viscoelastic Analogies

TEXT BOOK

1. *An Introduction to Continuum Mechanics*, J.N. Reddy, Cambridge University Press, 2007

REFERENCE BOOKS

1. *Continuum Mechanics*, George. E. Mase, Schaum's Outline Series, McGraw-Hill Book Company, 1969
2. *Continuum Mechanics*, Ellis H. Dill, CRC Press, 2006
3. Continuum Mechanics for Engineers, Second Edition, George E. Mase, G.Thomas Mase CRC Press,1999
4. *Computational Continuum Mechanics*, Ahmed A. Shabana, Cambridge University Press, 2008
5. *Introduction to Computational Mechanics*, Fourth Edition, W. Michael Lai, David Rabin and Erhard krempl, .Elsevier Inc, 2010
6. *Introduction to the Mechanics of a Continuous Medium*, Lawrence E. Malvern, Prentice-Hall, 1969
7. *A First Course in Continuum Mechanics,* Y. C. Fung, Prentice Hall, 1994

MALLA REDDY COLLEGE OF ENGINEERING & TECHNOLOGY

	L	T/P/D	C
I Year M. Tech, ASP-I SEM

(R15D7611) AIR-BREATHING PROPULSION   4   -   3
(OPEN ELECTIVE-I)

UNIT-I: **FUNDAMENTALS OF JET PROPULSION**
Aircraft Propulsion, Thermodynamic relations and cycles involved, Classification of Air breathing Engines, Ideal and Real Cycle Analysis - Turbojet and Turbofan, Effects of Altitude, Mach number, Aircraft Performance and Engine Performance analysis, Aircraft Engine Design, Methods employed for Thrust Augmentation and Jet Engine Noise suppression.

UNIT-II: **INLETS AND NOZZLES**
Types of Inlets, Combined Area Changes and Friction, Supersonic Inlet Design Considerations, Engine Starting, Effect of Additive Drag, Types of nozzles, Performance Map, Non-ideal equations for Various Nozzles, Effects of Pressure Ratios on Engine Performance, Performance Maps, Methods and advantages in reversing the Thrust, Types of Thrust Vectoring.
COMBUSTION CHAMBER
Classification of combustion chamber, Process of Combustion, factors affecting combustion, Chemical Kinetics, Properties of various fuels used in aviation, Flame Stabilization, Ignition and Engine Starting, Adiabatic Flame Temperature, Pressure Losses, Design and Optimization, Performance Maps.

UNIT-III: COMPRESSORS AND TURBINES
Classification of Compressors, Euler's Turbo-Machinery Equations, components of axial flow compressor, stage, Velocity Triangles, Single-Stage Energy Analysis, Variable Stators, Radial Equilibrium and Streamline Analysis Method; Centrifugal Compressors- Geometry, Velocity triangles, Impeller Design, Performance Maps;
Axial Flow Turbines- Geometry, Single-Stage Energy analysis, Velocity Triangles, Performance Maps, Thermal Limits of Blades and Vanes, Numerical problems and Performance Analysis.
RAMJETS
Working principle of Ramjet engine, Combustors for liquid fuel ramjet engines, Combustion Instability and its Suppression, Solid fuel Ramjet Engines, Test bed of Ramjet engine, Advancements in ramjets-Ram-rockets- Performance analysis, Ducted and Shrouded types, Air-augmented rockets, Integrated ramjet-rocket systems, Nozzle-less solid propellant rockets and Integrated Ramjet-rocket boosters, Dump combustors. Problems related to combustion, CFD techniques and guide lines required in designing and development of combustor employed in ramjets.

UNIT-IV: **HYPERSONIC AIR-BREATHING PROPULSION**
Hypersonic Air-breathing Propulsion, SCRAM jet engines-Methods of Analysis, Hypersonic Intakes, Supersonic Combustors, Engine Cooling and Materials Problem, CFD Applications, Liquid Air-cycle Engines, Space Plane Applications, Experimental and Testing Facilities, The Shock tube and shock Tunnel, Hypersonic wind tunnel.

UNIT-V: **DESIGN OF GAS TURBINE ENGINE**
Aircraft Mission Analysis, Engine Selection- Performance and Parametric Analysis, Sizing the Engine, Major Considerations in Engine Component Design - Rotating Turbo-machinery, Combustion Systems, Inlets and Exhaust Nozzles

SYSTEM MATCHING AND ANALYSIS

Matching of Gas Turbine Components, Cycle Analysis of one and two spool engines, Gas Generator, Component Modeling, Solution of Matching Problem, Dynamic or Transient behavior, Matching of Engine and Aircraft, Use of Matching and Cycle analysis in Second stage design

TEXT BOOKS

1. *Fundamentals of Jet Propulsion with applications*, Ronald D. Flack, Cambridge University Press, 1st Edition, 2005.
2. *Elements of Propulsion*: Gas turbines and Rockets, Jack D. Mattingly, AIAA Education series, 2nd Edition, 2006
3. *Aircraft Engine Design*, Jack D. Mattingly, AIAA Education Series, 2nd Edition, 2008.
4. *Hypersonic Airbreathing Propulsion*, William H. Heiser, David T. Pratt, AIAA Education Series, 1st Edition, 1994
5. Aircraft propulsion , Ahmed sayeed,
6. *Gas Turbine theory*, Cohen H., Rogers G.F.C, Saravanamutto H., Longman Publication, 4th Edition, 2003

REFERENCE BOOK
1. *Gas Tables*, Third edition E. RathaKrishnan, University press.

MALLA REDDY COLLEGE OF ENGINEERING & TECHNOLOGY

I Year M. Tech, ASP-I SEM

	L	T/P/D	C

(R15D7612) ROTORCRAFT AERODYNAMICS
(OPEN ELECTIVE-I)

L **4** — T/P/D **-** C **3**

UNIT-I: **FUNDAMENTALS OF ROTOR AERODYNAMICS, BLADE ELEMENT ANALYSIS**
Momentum theory analysis in hovering flight, Disk loading and power loading, Induced inflow ratio, Thrust and power coefficients, Comparison of theory with measured rotor performance, Non-ideal effects on rotor performance, Figure of merit, Induced tip loss, Rotor solidity and blade loading coefficients, Momentum analysis in axial climb and descent, Momentum analysis in forward flight, Blade Element Analysis in hover and axial flight, forward flight

UNIT-II: **ROTATING BLADE MOTION**
Types of rotors, Equilibrium about the flapping hinge and lead-lag hinge, Equations of motion for a flapping blade, Blade feathering and the swashplate, Dynamics of a lagging blade with a hinge offset, Coupled flap-lag motion, Coupled pitch-flap motion, Other types of rotors, Introduction to rotor trim
HELICOPTER PERFORMANCE: Hovering and axial climb performance, Forward flight performance, Performance analysis, Autorotational performance, Vortex ring state(VRS), Ground effect, Performance in maneuvering flight, Factors influencing performance degradation

UNIT-III: **AERODYNAMIC DESIGN OF HELICOPTERS**
Overall design requirements, Conceptual and preliminary design processes, Design of the main rotor, Fuselage aerodynamic design issues, Empennage design, Role of wind tunnels in aerodynamic design, Design of tail rotors, Other anti-torque devices, High speed rotorcraft, Smart rotor systems, Human-powered helicopter, Hovering micro air vehicles **AERODYNAMICS OF ROTOR AIRFOILS:** Helicopter rotor airfoil requirements, Reynolds number and Mach number effects, Airfoil shape definition, Airfoil pressure distribution, Aerodynamics of a representative airfoil section, Pitching moment and related issues, Drag, Maximum lift and stall characteristics, Advanced rotor airfoil design, Representing static airfoil characteristics, Circulation controlled airfoils, Very low Reynolds number airfoil characteristics, Effects of damage on airfoil performance

UNIT-IV: **UNSTEADY AIRFOIL BEHAVIOR**
Sources of unsteady aerodynamic loading, Concepts of blade wake, Reduced frequency and reduced time, Unsteady attached flow, Principles of quasi-steady thin airfoil theory, Theodorsen's theory, Returning wake-Loewy's problem, Sinusoidal gust-Sear's problem, Indicial response-Wagner's problem, Sharp edged gust-Kussner's problem, Traveling sharp edged gust- Milne's problem, Time varying incident velocity, Indicial method for subsonic compressible flow, Non-uniform vertical velocity fields, Time-varying incident Mach number, Unsteady aerodynamics of flaps, Principles of noise produced by unsteady forces,

UNIT-V: **DYNAMIC STALL**
 Flow morphology of dynamic stall, Dynamic stall in the rotor environment, Effects of forcing conditions on dynamic stall, Modeling of dynamic stall, Torsional damping, Effects of sweep angle, airfoil shape on dynamic stall, Three dimensional effects on dynamic stall, Time-varying velocity effects on dynamic stall, Prediction of in-flight airfoils, Stall control
ROTOR WAKES AND BLADE TIP VORTICES, ROTOR-AIRFRAME INTERACTIONAL

AERODYNAMICS

Characteristics of rotor wake in hover and forward flight, Vortex models of rotor wake, Aperiodic wake developments, General dynamic inflow models, Descending flight and vortex ring state, Wake developments in maneuvering flight; Rotor-fuselage interactions, Rotor-empennage interactions, Rotor-tail rotor interactions

TEXT BOOK

1. *Principles of Helicopter Aerodynamics,* Second Edition, J. Gordon Leishman, Cambridge University Press, 2006, ISBN 0-521-85860-7

MALLAREDDY COLLEGE OF ENGINEERING & TECHNOLOGY

	L	T/P/D	C
I Year M. Tech, ASP-I SEM			
(R15D7681) DIGITAL SIMULATION LAB – I	0	3	2

I. MATLAB/ SIMULINK FUNDAMENTALS FOR AEROSPACE APPLICATIONS

MATLAB introduction, Plotting and graphics: Plot, log and semi-log plots, polar plots,Subplots, axis, mesh, contour diagrams, flow diagrams, movies, MATLAB Toolboxes: Continuous transfer functions, root locus, Nichols chart, Nyquist chart, linear quadratic regulator, state-space design, digital design, Aerospace toolbox; M Cells, Structures and M-files, MEX-files,

Standard Simulink libraries, Simulink aerospace blockset, Building Simulink linear models: transfer function modeling in Simulink, zero pole model, state-space model; Simulink LTI viewer and usage of it, equivalent Simulink LTI models, Single-Input, Single-Output(SISO) design tool, Building Multi-Input, Multi –Output models, Building Simulink S-functions; Stateflow introduction: Opening, executing, and saving stateflow models, constructing a simple stateflow model, using a stateflow truth table

II. SOFTWARE DEVELOPMENT FOR SIMULATION OF FLUID FLOWS

Generation of structured and unstructured grids in two and three dimensions Solution of Burgers equation using explicit MacCormack method
Blasius solution for laminar boundary layer over a flat plate Riemann solver for shock tube problem

III. FLOW SIMULATION USING FLUENT

Simulation of Flow past airfoils and wings
Simulation of Compressible flow in convergent-divergent nozzle
Simulation of compressible flow in a compressor

REFERENCES

1. *Basic MATLAB, Simulink, and State Flow, Richard Colgren*, AIAA Education Series, 2007
2. *Introduction to Simulink with Engineering Applications*, Steven T. Karris, Orchard Publications, 2006, ISBN –9744239-8-X
3. *Computational Fluid Mechanics and Heat Transfer,* Second Edition, John C. Tannehill, Dale A. Anderson, Richard H. Pletcher, Taylor & Francis Publication, 1997.
4. *Computational Fluid Dynamics,* T. J. Chung, Cambridge University Press, 2002

MALLA REDDY COLLEGE OF ENGINEERING & TECHNOLOGY

I Year M. Tech, ASP-II SEM

L	T/P/D	C
4	-	3

(R15D7613) AIRCRAFT CONTROL AND SIMULATION

UNIT-I: **THE KINEMATICS AND DYNAMICS OF AIRCRAFT MOTION**
Vector Kinematics, Matrix Analysis of Kinematics, Geodesy, Earth's Gravitation, Terrestrial Navigation, Rigid-Body Dynamics.

UNIT-II: **MODELING THE AIRCRAFT**
Basic Aerodynamics, Aircraft Forces and Moments, Static Analysis, The Nonlinear Aircraft Model, Linear Models and the Stability Derivatives.
MODELING, DESIGN AND SIMULATION TOOLS
 State Space Models, Transfer Function Models, Numerical Solution of the State Equations, Aircraft Models for Simulation, Steady State Flight, Numerical Linearization, Feedback control, Aircraft dynamic behavior.

UNIT-III: **AIRCRAFT DYNAMICS AND CLASSICAL CONTROL DESIGN**
Aircraft Rigid Body Modes, The Handling Qualities Requirements, Stability Augmentation Systems, control augmentation system, auto pilots and Nonlinear Simulation.

UNIT-IV: **MODERN DESIGN TECHNIQUES**
Assignment of Closed-Loop Dynamics, Linear Quadratic Regulator with Output Feedback, Tracking a Command, Modifying the Performance Index, Model Following Design, Linear Quadratic Design with Full State Feedback, Dynamic Inversion Design.

UNIT-V: **ROBUSTNESS AND MULTIVARIABLE FREQUENCY DOMAIN TECHNIQUES**
Multivariable Frequency Domain Analysis, Robust Output Feedback Design, Observers and the Kalman Filter.
DIGITAL CONTROL
 Simulation of Digital Controllers, Discretization of Continuous Controllers, Modified Continuous Design, Implementation Considerations.

TEXT BOOK
1. *Aircraft Control and Simulation,* Brian L. Stevens and Frank L. Lewis, John Wiley & Sons, 2003

MALLA REDDY COLLEGE OF ENGINEERING & TECHNOLOGY

L   T/P/D   C

I Year M. Tech, ASP-II SEM

4   -   3

(R15D7614) AEROSPACE SENSORS AND MEASUREMENT SYSTEMS

UNIT-I: **INTRODUCTION TO EXPERIMENTAL METHODS**
Characteristics of Measuring systems:: Readability, Sensitivity, Hysteresis, Accuracy, Precision: Calibration, Standards, Experiment planning, Causes and types of experimental errors, Statistical analysis of experimental data

UNIT II: **FLOW MEASUREMENTS**
Pressure Measurement: Manometer, Pressure transducers, Scanning valves; Temperature Measurement: Thermometers, Thermocouples, Thermopiles, Keil probes; Velocity Measurement: Pitot probes, Hot wires, 7 hole probes, Laser Doppler Velocimetry (LDV), Particle Image Velocimetry (PIV), Doppler Global Velocimetry(DGV) ; Turbulence Measurements: LDV, Hot wire anemometers, Root Mean Square(RMS), Spectrum;
FLOW VISUALIZATION
Path-, Streak-, Stream-, and Time lines, Direct visualization, Surface flow visualization, Flow field visualization, Data driven visualization

UNIT-III: **FORCES AND MOMENTS FROM WIND TUNNEL BALANCE MEASUREMENTS:** Types of wind tunnels, Aeronautical wind tunnels, Wind tunnel data systems, Balances, Balance requirements and specifications, External balances and internal balances
STRESS AND STRAIN MEASUREMENTS
Stress and strain, Strain measurements, Strain gauge types, Basic characteristics of of a strain gage, Electrical resistance strain gauges, Rosette analysis, Strain gauge sensitivity, Stress gauges

UNIT IV: **MOTION AND VIBRATION MEASUREMENT**
Two simple vibration instruments, Principles of seismic instrument, Practical considerations for seismic instruments, Sound measurements
MOTION AND INERTIAL MEASUREMENTS
Applications of accelerometer sensors, Acceleration sensing principles, Pendulous accelerometer (open and closed loop), Micro-machined accelerometer, Piezoelectric accelerometer, Rate gyroscope principles, Rate-integrating gyroscope principles, Micro-gyro sensors, Laser gyros

UNIT-V: **SPACECRAFT ATTITUDE DETERMINATION SENSORS**
Infrared earth sensors-Horizon Crossing Sensors, Sun sensors, Star sensors, Rate and rate integrating gyros, Magnetometers

TEXT BOOKS

1. *Experimental Methods for Engineers,* Seventh Edition, J. P. Holman, Tata McGraw Hill, 2004
2. *Measurement Systems-Application and Design,*5th Edition, Ernest O Doebelin, Dhanesh N Manik, Tata McGraw Hill, 2007
3. *Low-Speed Wind Tunnel Testing,* Jewel B Barlow, William H. Rae,Jr. , Alan Pope, John Wiley,

Third Edition, 1999
4. *Spacecraft Dynamics and Control-A Practical Engineering Approach,* Marcel J. Sidi, Cambridge University Press, 1997

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	L	T/P/D	C

I Year M. Tech, ASP-II SEM

4   -   3

(R15D7615) COMPUTATIONAL APPROACHES TO AEROSPACE VEHICLE DESIGN

UNIT-I: **PRINCIPLES OF AEROSPACE DESIGN**
Historical Perspective on aerospace design, Traditional manual approaches to design and design iteration, Design teams, Advances in modeling techniques, Tradeoffs in aerospace system design, Design automation, evolution and innovation, Design search and optimization, Take-up of computational methods, Design oriented Analysis: Geometry modeling and design parameterization, Computational mesh generalization, Analysis and design of coupled systems

UNIT-II: **ELEMENTS OF NUMERICAL OPTIMIZATION-I**
Single variable optimizers- line search, Multi variable optimizers: Population versus single point methods, Gradient based methods, Noisy/Approximate function values, Non-gradient based algorithms, Termination and convergence aspects, Constrained optimization, Problem transformations, Lagrange multipliers, Feasible directions method, Penalty function methods, Combined Lagrangian and penalty function methods, Sequential quadratic programming, Chromosome repair

UNIT-III: **ELEMENTS OF NUMERICAL OPTIMIZATION-II**
Meta models and Response surface methods: Global versus local meta models, Meta modeling tools, Simple RSM examples, Combined approaches-Hybrid searches and meta heuristics, Multi-objective optimization, Multi-objective weight assignment techniques, Methods for combining goal functions, fuzzy logic and physical programming, Pareto set algorithms
Sensitivity Analysis: Finite-difference methods, Complex variable approach, Direct methods, Adjoint mehods, Semi-analytical methods, Automatic differentiation

UNIT-IV: **APPROXIMATION CONCEPTS**
Local approximations, Multipoint approximations, Black-box modeling, Generalized linear models, Sparse approximations techniques, Gaussian process interpolation and regression, Data parallel modeling, Design of experiments, Surrogate modeling using variable fidelity models, Reduced basis methods
DESIGN SPACE EXPLORATION-SURROGATE MODELS
 Managing surrogate models in optimization: Trust regions, Space mapping approach, Surrogate assisted optimization using global models, Managing surrogate models in evolutionary algorithms

UNIT-V: **DESIGN IN THE PRESNCE OF UNCERTAINTY**
Uncertainty modeling and representation, Uncertainty propagation, Taguchi methods, Welch-Sacks method, Design for six sigma, decision theoretic formulations, Reliability-based optimization, Robust design using information-gap theory, Evolutionary algorithms for robust design

 MULTI-DISCIPLINARY OPTIMIZATION
 Multi-disciplinary analysis, Fully integrated optimization, System decomposition and optimization, Simultaneous analysis and design, Distributed analysis optimization formulation, Collaborative optimization, Concurrent subspace optimization, Co-evolutionary architectures

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TEXT BOOK

1. *Computational Approaches for Aerospace Design-The Pursuit of Excellence*, Andy J. Keane, Prasanth B. Nair, John Wiley & Sons, 2005, ISBN 10:0-470-85540-1

MALLA REDDY COLLEGE OF ENGINEERING & TECHNOLOGY

I Year M. Tech, ASP-II SEM

L	T/P/D	C
4	-	3

(R15D7616) AEROTHERMODYNAMICS OF HYPERSONIC FLIGHT
(ELECTIVE-III)

UNIT I: **GENERAL CHARACTERIZATION OF HYPERSONIC FLOWS**
Defining hypersonic flow, Characterizing hypersonic flow using fluid dynamicphenomenon. Basic Equations of Motion**:** Equilibrium and non-equilibrium flows, Equilibrium conditions, Dependent variables, Transport properties, Continuity, momentum and energy equations, General form of the equations of motion in conservation form.

UNIT II: **DEFINING THE AEROTHERMODYNAMIC ENVIRONMENT**
Empirical correlations complemented by analytical techniques, General comments about CFD, Computations based on a two layer flow model, Techniques treating entire shock layer in a unified fashion, Calibration and validation of the CFD codes
EXPERIMENTAL MEASUREMENTS OF HYPERSONIC FLOWS
Ground-based simulation of hypersonic flows, Ground-based hypersonic facilities, Experimental data and model design considerations, Flight tests, Importance of interrelating CFD, ground-test data and flight-test data

UNIT III: **STAGNATION-REGION FLOW FIELD**
Stagnating streamline, Stagnation-point convective heat transfer, Radiative heat flux
PRESSURE DISTRIBUTION:
Newtonian flow models, Departure from the Newtonian flow field, Shock-Wave / Boundary Layer (Viscous) Interaction for two-dimensional compression Ramps, Tangent-Cone and Tangent-Wedge approximations, Need for more sophisticated models, Pressure distributions for a reacting gas, Pressures in separated regions

UNIT IV: **BOUNDARY LAYER AND CONVECTIVE HEAT TRANSFER**
Boundary Conditions, Metric or equivalent cross-section radius, Convective heat transfer and skin friction, Effects of surface catalycity, Base heat transfer in separated flow
VISCOUS INTERACTIONS:
Compression ramp flows, Shock/Shock interactions, Flow field perturbations around swept fins, Corner flows, Examples of Viscous Interactions for Hypersonic Vehicles: X-15, Space shuttle orbiter, Hypersonic air-breathing aircraft

UNIT V: **AERODYNAMIC FORCES AND MOMENTS & DESIGN CONSIDERATIONS OF HYPERSONIC VEHICLES**
Newtonian Aerodynamic Coefficients, Re-entry capsule aerodynamics, Shuttle orbiter aerodynamics, X-15 Aerodynamics, Hypersonic aerodynamics of research plane, Dynamic stability considerations; Design Considerations: Reentry vehicles, Design philosophy, Design considerations for rocket-launched/glide reentry vehicles, airbreathing vehicles, combined rocket/airbreathing powered vehicles, Design of a new vehicle

TEXTBOOK

1. *Hypersonic Aerothermodynamics*, John J. Bertin, AIAA Education Series, 1994.

REFERENCE BOOKS
1. *Hypersonic and High Temperature Gas Dynamics*, Second Edition, J. D. Anderson, AIAA Eucation Series, 2006
2. *Basics of Aerothermodynamics*, Ernst Heinrich Hirshchel, Springer-Verlag, 2005

MALLA REDDY COLLEGE OF ENGINEERING & TECHNOLOGY

I Year M. Tech, ASP-II SEM

L	T/P/D	C
4	-	3

(R15D7617) ADVANCED TOPICS IN AIR TRAFFIC MANAGEMENT SYSTEMS
(ELECTIVE-III)

UNIT- I: **AIR TRAFFIC MANAGEMENT**
Introduction: Air traffic services provided to aircraft operators, Government responsibilities, Flight rules and airspace organization, Airways and procedures, Phases of flight, Subsystems of ATM system, Facilities and operation, System capacity, Airborne collision avoidance systems, Future trends, Capacity driven operational concept of ATM.

UNIT-II: **ECONOMICS OF CONGESTION**
Impact of ATM on airspace user economic performance, Effects of schedule disruptions on the economics of airline operations, modeling of an airline operations control center.
COLLABORATIVE DECISION MAKING
Effect of shared information on pilot controller and controller- controller interactions, Modeling of distributed human decision making in traffic flow management operations.

UNIT-III: **AIRPORT OPERATIONS AND CONSTRAINTS**
Analysis, modeling and control of ground operations at airports, Collaborative optimization of arrival and departure traffic flow management strategies at airports.
AIRSPACE OPERATIONS AND CONSTRAINTS
Performance measures of air traffic services, Identification of airport and airspace capacity constraints.

UNIT-IV: **SAFETY AND FREE FLIGHT**
Accident risk assessment for advanced air traffic management, Airborne separation assurance systems. Human factors
COGNITIVE WORKLOAD ANALYSIS AND ROLE OF AIR TRAFFIC CONTROLLER: Task load measures of air traffic controllers, Technology enabled shift in controller roles and responsibilities.

UNIT-V: **AIRCRAFT SELF SEPARATION**
Cooperative optimal airborne separation assurance in free flight airspace, Automatic dependent surveillance broadcast system - operational evaluation.

TEXT BOOKS
1. *Fundamentals of Air Traffic Control*, Fourth edition, Nolan, M.S., Thomson Learning, 2004, ISBN-13:978-0-534-39388-5.
2. *Air Transportation Systems Engineering*, Donohue, G. L. et al., (Editors), AIAA, 20003, ISBN 1-56347-474-3
3. *Avionics Navigation Systems*, Keyton, M. and Fried, W. R., John Wiley, 2001, ISBN 0-471-54795-6

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I Year M. Tech, ASP-II SEM

L	T/P/D	C
4	-	3

(R15D7618) SPACECRAFT DYNAMICS AND CONTROL
(ELECTIVE-III)

UNIT-I: **ORBIT DYNAMICS**
Basic physical principles, Two body problem, Moment of momentum, Equation of motion of a particle in a central force field, Time and Keplerian orbits, Keplerian orbits in space, Perturbed orbits: Non-Keplerian orbits, Perturbing forces and their influence on the orbit, Perturbed geostationary orbits, Euler – Hill equations.

UNIT-II: **ORBITAL MANEUVERS**
Single-impulse orbit adjustment., Multiple-impulse orbit adjustment, Geostationary orbits, Geostationary orbit corrections .
ATTITUDE DYNAMICS AND KINEMATICS
Angular momentum and inertia matrix, Rotational kinetic energy of a rigid body, Moment of inertia matrix in selected axis frame, Euler's moment equations, Characteristics of rotational motion of a spinning body, Attitude kinematics equations of motion of a spinning body, Attitude dynamic equations of motion for a nonspinning satellite

UNIT-III: **GRAVITY GRADIENT STANILIZATION**
Basic attitude control equation, Gravity gradient attitude control
SINGLE- AND DUAL-SPIN STABILIZATION
Attitude stabilization during the ΔV stage, Active nutation control,
Estimation of fuel consumed during active nutation control, Despinning and denutation of a satellite, Single spin stabilization, dual spin stabilization

UNIT-IV: **ATTITUDE MANEUVERS IN SPACE**
Equations for basic control laws, Control with momentum exchange devices, Magnetic attitude control, Magnetic unloading of momentum exchange devices, Time-optimal attitude control, Technical features of the reaction wheel.
MOMENTUM-BIASED ATTITUDE STABILIZATION
Stabilization with and without active controls, Roll-yaw attitude control with two momentum wheels, Reaction thruster attitude control

UNIT-V: **REACTION THRUSTER ATTITUDE CONTROL**
Set up of reaction thruster control, Reaction torques and attitude control loops, feed back control loops, Reaction attitude control via pulse width modulation, Reaction control system using only four thrusters, Reaction control and structural dynamics.

TEXT BOOK
1. *Spacecraft Dynamics and Control*, Marcel J. Sidi, Cambridge University Press, 1997

REFERENCES
1. *Modern Spacecraft Dynamics & Control*, M. H. Kaplan, Wiley, 1976,

2. *Space Vehicle Dynamics and Control.*, B. Wie, AIAA, 1998
3. *Spacecraft Attitude Determination and Control*, J. R. Wertz, editor, D. Reidel Publishing, 1978

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I Year M. Tech, ASP-II SEM

L	T/P/D	C
4	-	3

(R15D7619) COMMUNICATION, NAVIGATION AND SURVEILLANCE SYSTEMS (ELECTIVE-IV)

UNIT-I: **ROLE OF NAVIGATION IN FLIGHT VEHICLE MISSION - NAVIGATION SYSTEMS**
Introduction: Definitions of navigation and surveillance, Guidance versus navigation, Categories of navigation, Civil and military aircraft, Phases of flight,, Evolution of avionics, Human navigator; Navigation Equations: Geometry of the Earth, Coordinate frames, Dead-reckoning computations, DR Positioning computing, Terrain-matching navigation, Course computation, Navigation errors, Digital charts, Software development

UNIT-II: **TERRESTRIAL-RADIO-NAVIGATION SYSTEMS**
General principles, System design considerations, Point source systems, hyperbolic systems
SATELLITE RADIO NAVIGATION: System configuration, Basics of satellite radio navigation, Orbital mechanics and clock characteristics, Atmospheric effects on satellite signals, NAVSTAR Global Positioning System, Global Orbiting Navigation Satellite System(GLONASS), GNSS integrity and availability

UNIT-III: **INERTIAL NAVIGATION**
Principles of Inertial navigation system, alignment Instruments, Platforms, Mechanization equations, **INS** Errors and Mixed systems, Alignment, Fundamental limits
AIR-DATA INSTRUMENTS & SYSTEMS, ATTITUDE AND HEADING REFERENCES
Air-Data Systems: Air-data measurements, Air-data equations, Air-data systems, Specialty designs, Calibration and system test; Attitude and Heading References: Basic instruments, Vertical references, Heading-direct indicating compass and direction indicators, gyro magnetic compass horizontal simulation indicators, altitude- and alignment –Datum compasess,magnetic compass deviation, compass switching procedures

UNIT-IV: **DOPPLER AND ALTIMETER RADARS, LANDING SYSTEMS**
 Doppler Radars: Functions and applications, Doppler radar principles and design approaches, Signal characteristics, Doppler radar errors, Equipment configurations, Radar Altimeters: Functions and applications, General principles, Pulsed radar altimeters, FM-CW radar altimeter, Phase-coded pulsed radar altimeters; Landing Systems: Low-visibility operations, Mechanics of landing, Automatic landing systems, Instrument landing systems, Microwave-landing system, Satellite landing systems, Carrier landing systems,

UNIT-V: **MULTISENSOR INTEGRATED NAVIGATION SYSTEMS**
Inertial system characteristics, Integrated stellar-inertial systems, Integrated Doppler- inertial systems, Airspeed-damped inertial system, Integrated stellar-inertial-doppler system, Position update of an inertial system, Noninertial GPS multisensor navigation systems, Filtering of measurements, Kalman filter basics, Open-loop and closed loop Kalman filter mechanizations, GPS-INS mechanization, Practical considerations, Federated system architecture

AIR TRAFFIC MANAGEMENT

Services provided to aircraft carriers, Government responsibilities, Flight rules and airspace organization, Airways and procedures, Phases of flight, Subsystems, Facilities and operations, System capacity, Airborne Collision Avoidance Systems

TEXT BOOKS

1. *Avionics Navigation Systems,* Second Edition, Myron Kayton and Walter R.Freid, John Wiley & Sons, Inc, 1997, ISBN 0-471-54795-6
2. *Civil Avionics Systems,* Moir, I and Seabridge, A, AIAA Education Series, AIAA, 2002, ISBN 1-56347589-8

MALLA REDDY COLLEGE OF ENGINEERING & TECHNOLOGY

I Year M. Tech, ASP-II SEM

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4	-	3

(R15D7620) SPACE TRANSPORTATION SYSTEMS
(ELECTIVE-IV)

UNIT-I: **INDIAN SPACE TRANSPORTATION SYSTEM DEVELOPMENT**
Introduction, Systems engineering definition, System engineer, Systems engineering cycle, Systems engineering process, Doctrine of successive refinement, Tools and methodologies, Systems analysis, Modeling, and the trade study process, Basic launch vehicle system trade analysis methodology, System effective studies.
Evolution of ISRO, organization and structure of ISRO, Goals, objectives, evolution of Indian carrier rockets-PSLV, GSLV, Chandrayan, Mangalyan

UNIT II: **TRANSPORTATION SYSTEM ARCHITECTURE, INFRASTRUCTURES AND U.S. SPACE SHUTTLE**
Introduction, Historical drivers for space infrastructure, Political considerations, National mission model, Private sector and commercialization, Development of commercial space transportation architecture and system concepts, Cost drivers for space transportation architecture options, Recommended improvements to space transportation architectures, Planning for future space infrastructure, Transportation Infrastructure for moon and mars missions U.S. Space Shuttle: Introduction, Historical background, Development of shuttle system, Orbiter development, Current shuttle vehicle and operations, Shuttle evolution and future growth,

UNIT-III: **EXPENDABLE SPACE TRANSPORTATION SYSTEMS AND REUSABLE SPACE LAUNCH VEHICLES**
Introduction, Expendable launch vehicle design, History behind existing Expendable Launch Vehicles, Evolving the expendable launch vehicle, Reusable space launch vehicles: Background—Previous efforts at hypersonic flight, Early aerospace plane conceptual studies, The X-series of research aircraft, Challenges facing manned aerospace planes, Manned reusable systems development programs-Past and Ongoing., NASA reusable launch vehicle studies in 1990s., Hypersonic waveriders, Importance of vehicle health management, Future reusable space launch vehicles
OPERATIONS AND SUPPORT SYSTEMS
Introduction, Launch operations definition, Shuttle mission operations, Facility requirements for launch operations, Obstacles to streamlining launch operations, Evolutionary launch operations strategies, Designing for future expendable launch vehicle launch operations, Improving Existing Launch Operations, Future launch operations

UNIT IV: SYSTEMS AND MULTIDISCIPLINARY DESIGN OPTIMIZATION
Introduction, Launch vehicle conceptual design problem, Modeling needs, Optimization strategies and applications, Collaborative work environment of the future
SYSTEMS TECHNOLOGY DEVELOPMENT
Introduction, Vehicle technologies, Propulsion technologies, Ground and mission operations technologies, Assessing technological options, Technology transfer and commercialization, Applying a commercial development process for access to space

UNIT V: PROGRAM PLANNING, MANAGEMENT, AND EVALUATION
Introduction, Management Trends, Good Project Management as Team Building and a Balancing Act, Types of Project Management, Configuration Management, Risk Management, Earned value management, Total Quality Management, Managing ultra-large projects

FUTURE SYSTEMS
Introduction, Next generation space transportation systems, Accelerator concepts, nuclear fission and fusion based concepts, Antimatter-based propulsion concepts, Solar propulsion concepts, Laser and beamed energy propulsion Concepts, Magnetic Monopoles Concept, Field and Quantum Effect Propulsion Concepts.

Text Book

1. *Space Transportation: A Systems Approach to Analysis and Design*, Walter Hammond, AIAA Education Series, American Institute of Aeronautics and Astronautics, Inc, 1999.

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(R15D7621) DYNAMICS AND CONTROL OF STRUCTURES
(ELECTIVE-IV)

UNIT-I: **NEWTONIAN MECHANICS**
Newton's Second Law, Impulse and Momentum, Moment of a Force and Angular Momentum, Work and Energy, Systems of Particles, Rigid Bodies, Euler's Moment Equations.

UNIT-II: **PRINCIPLES OF ANALYTICAL MECHANICS**
Degree of Freedom and Generalized Coordinates, The Principle of Virtual Work, D'Alembert's Principle, Hamilton's Principle, Lagrange's Equations of Motion, Hamilton's Canonical Equations, Motion in the Phase Space, Lagrange's Equations of Motion in Terms of Quasi-Coordinates.
CONCEPTS FROM LINEAR SYSTEM THEORY
Concepts from System Analysis, Frequency Response, Response by Transform Methods, The Transfer Function, Singularity Functions, Response to Singularity Functions, Response to Arbitrary Excitation, The Convolution Integral, State Equations. Linearization about Equilibrium, Stability of Equilibrium Points , Response by the Transition Matrix, Computation of the Transition Matrix, The Eigen value Problem, Response by Modal Analysis, State Controllability, Output Equations, Observability, Sensitivity of the Eigen solution to Changes in the System Parameters, Discrete-Time Systems.

UNIT-III: **LUMPED-PARAMETER STRUCTURES**
Equations of Motion for Lumped-Parameter Structures, Energy Considerations, The Algebraic Eigen value Problem, Free Response, Qualitative Behavior of the Eigen solution, Computational Methods for the Eigen solution, Modal Analysis for the Response of Open-Loop Systems.
CONTROL OF LUMPED-PARAMETER SYSTEMS. CLASSICAL APPROACH
Feedback Control Systems, Performance of Control Systems, The Root-Locus Method, The Nyquist Method, Frequency Response Plots, Bode Diagrams, Relative Stability. Gain Margin and Phase Margin, Log Magnitude-Phase Diagrams, The Closed-Loop Frequency Response. Nichols Charts, Sensitivity of Control Systems to Variations in Parameters, Compensators, Solution of the State Equations by the Laplace Transformation

UNIT-IV: **CONTROL OF LUMPED-PARAMETER SYSTEMS. MODERN APPROACH**
Feedback Control Systems, Pole Allocation Method, Optimal Control, The Linear Regulator Problem, Algorithms for Solving the Riccati Equation, The Linear Tracking Problem, Pontryagin's Minimum Principle, Minimum-Time Problems, Minimum-Time Control of Time-Invariant Systems Minimum-Fuel Problems, Simplified On-Off Control, Control Using Observers, Optimal Observers. The Kalman-Bucy Filter, Direct Output Feedback Control, Modal Control

UNIT-V: **DISTRIBUTED-PARAMETER STRUCTURES, EXACT AND APPROXIMATE METHODS**
BOUNDARY-Value Problems, The Differential Eigen value Problems, Rayleigh's Quotient, The Rayleigh-Ritz Method, The Finite Element Method, The Method of Weighted Residuals; Substructure of Un damped Structures, Damped Structures.
CONTROL OF DISTRIBUTED STRUCTURES

Closed-Loop Partial Differential Equation of Motion, Modal Equations for Un damped Structures, Mode Controllability and Observability, Closed-Loop Modal Equations, Independent Modal-Space Control, Coupled Control, Direct Output Feedback Control,

Systems with Proportional Damping, Control of Discretized Structures, Structures with General Viscous Damping.

TEXT BOOK

1. *Dynamics and Control of Structures*, Leonard Meirovitch, John Wiley & Sons, 1990

REFERENCE BOOKS

1. *Introduction to Structural Dynamics and Aeroelasticity*, Dewey. H. Hodges, G.Alvin Pierce- Cambridge University Press, 2002
2. *Structural Dynamics in Aeronautical Engineering*, Maher N. Bismarck-Nasr, AIAA Education Series, 1999
3. *Adaptive Structures: Engineering Applications*, David Wagg, Ian Bong, Paul Weaver, Michael Friswell (eds) , John Willey & Sons, Ltd, 2007

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(R15D7622) TACTICAL MISSILE DESIGN
(OPEN ELECTIVE-II)

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UNIT-I: INTRODUCTION / KEY DRIVERS IN DESIGN PROCESS
Tactical Missile characteristics, Conceptual design process, Examples of State-of-the-Art missiles, Aerodynamic configuration sizing parameters, Examples of alternatives in establishing mission requirements, Baseline missile

UNIT-II: AERODYNAMIC CONSIDERATIONS IN TACTICAL MISSILE DESIGN
Missile diameter tradeoff, Nose fineness tradeoff, Boat-tail, Lifting body versus axi-symmetric body, Wings versus no wings, Normal force prediction for surfaces, Wing aerodynamic center prediction, Wing drag prediction, Surface plan form geometry tradeoffs, Flight control alternatives, Maneuver alternatives, Roll orientation, Static stability, Tail area sizing, Stability and control conceptual design criteria, Body buildup

PROPULSION CONSIDERATIONS IN TACTICAL NISSILE DESIGN
Propulsion alternatives assessment, Ideal ramjet Mach number and temperature technology limit, Ramjet specific impulse prediction, Ramjet thrust prediction, Ramjet engine/booster integration, Ramjet inlet options, Ramjet inlet spillage, Inlet shock loss, Ramjet missile drag due to booster integration, Fuel alternatives, Rocket motor performance, Solid motor grain alternatives, Solid rocket thrust control, Solid propellant material alternatives, Motor case alternatives, Rocket nozzle material alternatives

UNIT-III: WEIGHT CONSIDERATIONS IN TACTICAL MISSILE DESIGN
Benefits of lighter weight missile, Subsystem weight sensitivity to flight performance, Missile weight prediction, Centre-of-gravity and moment-of-inertia prediction, Factor of safety, Micro-Machined Electro-Mechanical Systems(MEMS), Manufacturing processes, Airframe material alternative, Aerodynamic heating prediction, Insulation trades, Insulation material alternatives, Structure design, Seeker dome materials, Thermal stress, Localized aerodynamic heating

FLIGHT PERFORMANCE CONSIDERATIONS IN TACTICAL MISSILE DESIGN
Flight performance envelope, Equations of motion modeling, Driving parameters for flight performance, Cruise flight performance, Steady state flight, Flight trajectory shaping, Turn radius, Coast flight performance, Boost flight performance, Intercept lead angle and velocity, Comparison with performance requirements

UNIT-IV: MEASURES OF MERIT AND LAUNCH PLATFORM INTEGRATION
Robustness, Warhead lethality, Miss distance, Carriage and launch observables, Other survivability considerations, Reliability, Cost, Launch platform integration

Sizing Examples: Air-to-Air range requirements, Wing sizing for maneuverability, Weight and miss distance harmonization, Ramjet missile range robustness, Ramjet propulsion/fuel alternatives, Ramjet missile surface impact velocity, Computer-Aided sizing for conceptual design, Verification process

UNIT-V: DEVELOPMENT PROCESS, SUMMARY AND LESSONS LEARNED
Development Process: Technology Assessment/Roadmap, Phases of Development/Design maturity, Tactical-missile follow-on programs, Subsystem integration, Examples of technology development,

Examples of State-of-the-Art advancement, New technologies for tactical missiles; Summary and Lessons Learned: Iterate-the-System-of-Systems Analysis, Exploit diverse skills, Apply creative skills, Identify high-payoff measures of merit, Start with a good baseline design, Conduct balanced tradeoffs, Evaluate a broad range of alternatives, Refine the design, Evaluate technology risk, Maintain real-time documentation, Develop good documentation, Utilize group skills, Balance the tradeoff of importance versus priority, Iterate the configuration design, Configuration sizing conceptual design criteria

TEXT BOOK

1. *Tactical Missile Design,* Eugene L. Freeman, First Edition, AIAA Education Series, 2001

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(R15D7623) HIGH ANGLE OF ATTACK AERODYNAMICS
(OPEN ELECTIVE-II)

UNIT-I: **DESCRIPTION OF FLOWS AT HIGH ANGLES OF ATTACK**
Introduction, Finite lifting wing of medium and high aspect ratio at low subsonic speeds, Low aspect ratio rectangular wing at low subsonic speeds, Slender delta type wings, Flow over elongated slender bodies, Aircraft type configurations, Vortex breakdown, Non-steady aerodynamics at high angles of attack on slender configurations, Effect of separation at **high angles of attack in hypersonic flows**

UNIT-II: **TOPOLOGY OF SEPARATING AND REATTACHING VORTICAL FLOWS**
Equations for vortical flows, Topological concepts for the analysis of vortical flows,
LINEAR AERODYNAMICS OF WINGS AND BODIES
Equations for potential subsonic flows, Equations for the lifting wing at low speeds, Linear panel methods for the calculation of the subsonic aerodynamic coefficients for wings and bodies, Low and higher order linear panel methods for subsonic and supersonic flows, Comparison of various panel methods

UNIT-III: **VORTEX FLOWS AND THE ROLLED UP VORTEX WAKE**
Vortex core of the rolled up wake, Rolled up tip vortices, Rolling up of vortex wake behind wings, Bursting of rolled up vortices
Nonlinear Aerodynamics Of Wings And Bodies At High Angles Of Attack: Analytical and semi-empirical methods for calculations of the non-linear aerodynamic characteristics

UNIT-IV: **NONLINEAR PANEL METHODS FOR AIRCRAFT AND MISSILE CONFIGURATIONS AT HIGH ANGLES OF ATTACK**
Nonlinear Vortex Lattice Method (NVLM) for subsonic flows, Free vortex sheet method for subsonic flows, NVLM for supersonic flows
SOLUTIONS OF EULER EQUATIONS FOR FLOWS OVER CONFIGURATIONS AT HIGH ANGLES OF ATTACK
Euler equations, Numerical methods of solution of the Euler equations: Grid generation methods, Finite volume methods, Finite difference methods, finite element methods, multigrid calculations with Cartesian grids and local refinements, Euler computations on three-dimensional configurations at high angles of attack

UNIT-V: **SOLUTIONS OF NAVIER-STOKES EQUATIONS FOR FLOWS OVER CONFIGURATIONS AT HIGH ANGKES OF ATTACK:**
Formulation of the Navier-Stokes equations, Numerical methods for solutions of Navier-Stokes equations, Method of solution of the thin layer equations, Grid topology, boundary and initial conditions, Solutions of Navier-Stokes equations for flows in three-dimensional configurations at high angles of attack

TEXT BOOK

1. *High Angle of Attack Aerodynamics-Subsonic, Transonic, and Super sonic Flows*, Josef Rom, Springer-Verlag, 1992

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(R15D7624)OPTIMAL CONTROL
(OPEN ELECTIVE-II)

UNIT-I: **INTRODUCTION TO OPTIMIZATION**
Classification of systems, Parameter Optimization: Distance problem, General parameter optimization problem, Optimal Control Theory: Distance problem, Acceleration problem, Navigation problem, General optimal control problem, Conversion of an optimal control problem into a parameter optimization problem, Necessary conditions and sufficient conditions

UNIT-II: **PARAMETER OPTIMIZATION-I**
Unconstrained Minimization: Taylor series and differentials, Function of one, two and n independent variables; Constrained Minimization-Equality Constraints: Function of two constrained variables-Direct and Lagrange Multiplier approaches, Distance problem, Function of n constrained variables
PARAMETER OPTIMIZATION-II
Constrained Minimization-Inequality Constraints: Boundary minimal points, Introduction to slack variables, Function of two variables, Eliminating bounded variables, Examples of linear programming, General problem, Minimization Using Matrix Notation: Matrix algebra, Matrix calculus, Function of n independent variables, Function of n constrained variables

UNIT-III: **DIFFERENTIALS IN OPTIMAL CONTROL AND CONTROLLABILITY**
Differentials in Optimal Control: Standard optimal control problem, Differential of the state equation, Relation between δ and d, Differential of the final condition, Differential of the integral,: Controllability: Fixed final time, Solution of the linear equation, controllability condition, Controllability-free final time, Navigation problem
FIXED FINAL TIME- FIRST DIFFERENTIAL, TESTS FOR A MINIMUM AND SECOND DIFFERENTIAL
Fixed Final Time-First Differential: First differential conditions-with and without final state constraints, First integral, Acceleration problem, Navigation problem, Minimum distance on a sphere, Fixed Final Time-Tests for a Minimum: Weierstrass condition, Legendre-Clebsch condition; Fixed Final Time-Second Differential: Second differential, Legendre-Clebsch condition, Neighboring optimal paths, Neighboring optimal paths on a sphere, Second differential condition, Acceleration problem, Navigation problem, Minimum distance on a sphere, Minimum distance between two points on a sphere, Other sufficient conditions

UNIT-IV: **FREE FINAL TIME, FREE INITIAL TIME AND STATES**
Free Final Time: First differential conditions, Tests for a minimum, second differential, neighboring optimal paths, second differential conditions, Distance and navigation problems, Free Initial Time and States: Problem statement, First differential conditions, Tests for a minimum, Second differential conditions, Minimum distance from a parabola and a line, Parameters as states, Navigation problem

UNIT-V: **CONTROL DISCONTINUITIES AND PATH CONSTRAINTS**
Control Discontinuities Problem statement, First differential conditions, Tests for s minimum, Second differential, Neighboring optimal path, Second differential conditions, Supersonic airfoil of minimum

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pressure drag; Path Constraints: Integral constraint, State equality constraint, Control inequality constraint, Acceleration problem, State inequality constraint

Approximate Solutions of Optimal Control Problems: Optimal control problem with a small parameter, Application to a particular problem, Application to a general problem, Solution by the sweep method, Navigation problem

TEXT BOOK

1. *Optimal Control Theory for Applications,* David G. Hull, Springer-Verlag, 2003, ISBN: 0-387-40070-2

REFERENCE BOOK

1. *Applied Optimal Control-Optimization, estimation and Control,* Arthur E. Bryson, Jr and Yu-Chi Ho, Taylor & Francis, 1975, ISBN 10: 0891162285

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(R15D7682) DIGITAL SIMULATION LAB-II

I   SOFTWARE DEVELOPMENT FOR THE FOLLOWING USING FINITE ELEMENT METHODS

Thin walled beams Plate
bending
Beams analysis
Trusses analysis
Thin shells analysis

II   AEROSPACE STRUCTURAL ANALYSIS USING ANSYS

Structural analysis of aircraft wing
Structural analysis of aircraft wing (Composite material)
Analysis of fuselage
Rocket motor case analysis
Structural and thermal analysis of rocket nozzles
Fractural mechanics of crack propagation

III. SIMULATION EXPERIMENTS IN DYNAMICS AND CONTROL USING MATLAB AND SIMULINK

Simulation of Aircraft motion-longitudinal dynamics, lateral dynamics
Six-degrees-of-freedom simulation of aircraft motion with illustration of F-16 model
Simulation of reentry vehicle dynamics for ballistic reentry and maneuvering reentry
Simulation of non-linear control system for controlling roll dynamics of a fighter aircraft
Simulation of the following relating to satellite attitude dynamics:
- Torque free rotation of axisymmetric and asymmetric spacecraft
- Attitude maneuvers of spin-stabilized spacecraft

REFERENCES

1. *Engineering Analysis with ANSYS Software,* Y. Nakasone, S.Yoshimoto, T. A. Stolarski, Elsevier Publication, 2006
2. *Atmospheric and Space Flight Dynamics,* Ashish Tewari, Birkhauser Publication, 2007
   Modern Control Design with MATLAB and Simulink, A. Tewari