UNIVERSITY OF KERALA

B. TECH. DEGREE COURSE

(2013 SCHEME)

SYLLABUS FOR

VIII SEMESTER

AERONAUTICAL ENGINEERING

SCHEME -2013

VIII SEMESTER

AERONAUTICAL ENGINEERING (S)

Course No	Name of subject	Credits	Weekly load, hours			C A Marks	Exam Duration Hrs	U E Max Marks	Total Marks
			L	T	D/P				
13.801	Aircraft Maintenance and Repair (S)	4	3	1	-	50	4	100	150
13.802	Aircraft Air-conditioning (S)	3	2	1	-	50	4	100	150
13.803	Principles of Management (S)	4	3	1	-	50	3	100	150
13.804	Space Technology (S)	4	3	1	-	50	3	100	150
13.805	Elective IV	4	3	1	-	50	3	100	150
13.806	Elective V	3	3	-	-	50	3	100	150
13.807	Seminar (MNPSU)	2	-	-	2	100	-	-	100
13.808	Project , Viva-Voce and Industrial Visit (MNPSU)	5	-	-	5	100	-	100	200
	Total	**29**	**17**	**5**	**7**	**500**		**700**	**1200**

13.805 Elective IV

13.805.1	Project Management (S)
13.805.2	Reliability Engineering (S)
13.805.3	Aircraft Safety and Regulations (S)
13.805.4	Operations Research (S)
13.805.5	Fracture Mechanics (S)
13.805.6	Industrial Hydraulics (S)

13.806 Elective V

13.806.1	Aircraft Rules and Regulations (S)
13.806.2	Non-Destructive Testing (S)
13.806.3	Statistical Quality Control (S)
13.806.4	Industrial Pollution and Control (S)
13.806.5	Safety Engineering (S)
13.806.6	Aerodynamic Testing Facility (S)
13.806.7	Rockets and Missiles (S)

13.801 AIRCRAFT MAINTENANCE AND REPAIR (S)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objective:

- *To enable the knowledge about the aircraft maintenance and repair practices in the aviation industry*
- *To impart knowledge about the aircraft tools and its operations.*
- *To gain more knowledge on airworthiness of an aircraft.*

Module – I

MAINTENANCE SCHEDULES

Types of maintenance schedules –Mandatory schedules – inspection of aircraft – Components: types of inspections – various aircraft manuals – service letter and service bulleting – Advisory circulars – repair – modifications – reconditioning – history record sheet.

Module – II

ENGINE MAINTENANCE AND REPAIR

Piston/Gas Turbines: Periodical servicing procedures – Engine installation checks, control rigging – Ground running checks, bleeding and performance checks – Engine on condition maintenance – Trouble shooting and rectification – Inspection aftershock landing, Crack detection – Engine preservation and depreservation.

Module – III

MAINTENANCE AND REPAIR OF AIRFRAME AND SYSTEMS

Various types of structures in airframe construction– Braced monocoque, semimonocoque, etc– longerons, stringers, formers, bulkhead, spars and ribs– Landing gear various types, shock struts, nose wheel steering– Ice and rain protection, fire detection warning and extinguishing – Oxygen, air -conditioning and pressurization systems, wheels, tyres, brakes, antiskid system – Inspection and maintenance. Airplane, Jacking and Weighing and C.G. Location. Rigging of control surfaces – Inspection, maintenance.

Module – IV

QUALITY AND AIRWORTHINESS ASSURANCE

Zero defect analogy – Fault tree analysis, bench marking, quality circles – TQM, Six sigma – DGCA (Directorate general of civil aviation) – FAA regulation: Licensing regulations, general regulations, and operations regulations – Aviation Safety Regulation.

References:

1. Michael J. Kores and William A. Watkins, *Aircraft Maintenance and Repair,* McGraw Hill.
2. Pallet E. H. J., Aircraft Instruments, Himalayan Book, New Delhi, 1981.
3. Williams C. A., *Aircraft Instruments*, Galgotia Publications, New Delhi, 1973.
4. Sloley R. W. and Coulthard, Instruments.
5. *Civil Aircraft Inspection Procedures (CAP 459) Pt II Aircraft*, Himalayan Books.
6. *Airframe and Power Plant Mechanic (AC 65-15A) Airframe Hand Book*, Himalayan Books.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Five Short answer questions of 4 marks each. All questions are compulsory. There should be at least one question from each module and not more than two questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

After successful completion of this course, the students will have:

- *Ability to understand tools and maintenance practices in the aviation industry.*
- *Ability to rectification of maintenance practices to ensure airworthiness.*

13.802 AIRCRAFT AIR-CONDITIONING (S)

Teaching Scheme: 2(L) - 1(T) - 0(P) **Credits**: 3

Course Objectives:

The main objectives of this course are

- *To impart the concept of the basic principles, working, scientific analysis and system components of different types of refrigeration and air conditioning systems.*
- *To impart the knowledge of various types of refrigerants, their properties, selection criteria and environmental aspects*

Module – I

Introduction to refrigeration: Brief history and applications – methods of refrigeration – conventional methods – unit of refrigeration - C.O.P. Mechanical Refrigeration – ideal refrigeration cycles – Carnot refrigeration cycle – limitations of reversed Carnot cycle, air refrigeration cycles: Bell Coleman cycle and Brayton Cycle - open and dense air systems – numerical problems.

Air craft refrigeration – necessity of aircraft cooling, advantages of using air as refrigerant in air-crafts, types of air refrigeration system - 1. Simple cooling cycle system 2. Evaporative cooling system. 3. Boot strap air cycle refrigeration system 4. Regenerative cooling system. 5. Reduced ambient type cooling system. Simple numerical problems only, no derivations.

Module – II

Vapour compression refrigeration – working principle and essential components- simple vapour compression refrigeration cycle – representation of cycle on T-S and p-h charts – simple numerical problems.

Multi pressure systems – multi compression and multi evaporator systems – inter cooling – flash inter cooling and flash gas removal.

Vapour Absorption System –working principle - calculation of max COP – description and working of NH3 – water and Li Br - comparison with vapour compression system. No numerical problems.

Module – III

Refrigerants and their properties – nomenclature of refrigerants - selection of refrigerants – environmental aspects.

Introduction to air conditioning -Psychrometric properties and processes – psychrometric chart - adiabatic mixing – sensible heating and cooling, – humidifying, dehumidifying and combinations – sensible heat factor – bypass factor – ADP – concept of RSHF and GSHF – simple numerical problems.

Module – IV

Refrigeration system components: Compressors – general classification - working principle – comparison– advantages and disadvantages. Reciprocating compressors - single and

multistage compressors – work of compression - effect of clearance - effect of inter cooling - optimum pressure ratio – efficiencies. No numerical problems.
Condensers and cooling towers – classification – working principle. Evaporators – classification –working principle. Expansion devices – types – working principle. Air conditioning systems components: filters, grille – grille accessories – dampers, diffusers, registers, fans and blowers, AHUs. AC system controls – thermostat and humidistat.

References

1. Arora C. P.,*Refrigeration and Air Conditioning,* Tata McGraw-Hill Publishing Company Ltd.
2. Arora S. C., Domkundwar, *A Course in Refrigeration and Air conditioning*, Dhanpatrai.
3. Stoecker W. F., *Refrigeration and air conditioning*, Tata McGraw-Hill Publishing Company Ltd.
4. Manohar Prasad, *Refrigeration and Air Conditioning*, New Age publishers.
5. Dossat, *Principles of Refrigeration*, Pearson Education
6. Ananthanarayanan, *Basic Refrigeration and Air-Conditioning*, Tata McGraw-Hill Publishing Company Ltd.
7. Norman Harris, *Modern Air Conditioning Practice*, McGraw Hill
8. ASHRAE *Handbook*.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course outcome:

At the end of the course students will have:

- *Knowledge about the basic principle of refrigeration and air conditioning, components and their controls.*
- *Ability to solve problems based on the working principles.*

13.803 PRINCIPLES OF MANAGEMENT (S)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objectives:

- *To introduce the basics of principles of management and its need.*
- *To impart knowledge about the different methods and processes in management.*

Module – I

Evolution of Scientific management:-Principles and functions of scientific management, Concept of pre modern, modern and post-modern management, Levels and skills of management.
Organizational structure:-Authority, responsibility and span of control - system concept of management – Line, Line and staff, project and matrix organization.

Module – II

Formation of companies: Proprietary Partnership and joint stock companies – private limited, public limited companies, cooperative organizations and Government organizations.
Facilities planning:-Selection of site- factors to be considered – plant layout, different types, process, product, fixed group technology layout. Layout planning, computerized planning techniques.

Module – III

Personal management:-objectives and function-recruitment, selection, orientation and training of workers – Industrial safety and health-Labour welfare –Industrial psychology – Labour legislation.
Sales management:-Objectives and function - forecasting of demand different methods (simple problems). Marketing: Concepts, marketing environment, -Market segmentation-marketing mix-product life cycle.

Module – IV

Quantitative techniques in management:-linear programming and its application in management, transportation and assignment problems
Decision making: statistical decision theory, decision tree, Game theory and its applications.
Queing theory: Single server models- network theory – CPM – crashing of networks, PERT – probability of completion.

References:

1. Chabra T. N., *Principles & Practice of Management*, Dhanpat Rai Pub.
2. Mahajan M., *Industrial Engineering & Production Management*, Dhanpat Rai Pub.
3. Khanna O. P., *Industrial engineering and management*.

4. Hillier and Lieberman, *Fundamentals of Operation Research*.
5. Basu C.R., *Business Organization & Management*, Tata McGraw Hill.
6. Tripathi and Reddy, *Principles of Management*, Tata McGraw Hill.
7. Fraidoon Mazda, *Engineering Management*, Pearson Edn. Asia.
8. Bernaud W Taylor III, *Introduction to Management Science*, Pearson Edn, Asia.
9. Koontz and Weihrich, *Essentials of Management*, THM

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

Students successfully completing this course will have

- *Ability to solve problems on management principles.*
- *Knowledge about the basic structure of an organization.*

13.804 SPACE TECHNOLOGY (S)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objectives :

- *To introduce the fundamentals of space technology*
- *To impart knowledge about the orbital maneuvres and relate to real missions.*
- *To enable the students to read about latest space missions and understand the crux of the same.*

Module – I

INTRODUCTION TO CO ORDINATE SYSTEMS

The ecliptic and celestial equatorial planes-Reference Frames – Motion in accelerated reference plane - Euler angles and transformations- Time intervals and Epoch – International Atomic Time (TAI), Universal Time (UT), Greenwich Mean Solar Time (GMST) and Sidereal Time.

Module – II

ROCKET PROPULSION AND FUNDAMENTALS OF ORBITAL MECHANICS

Rocket propulsion fundamentals, rocket dynamics and ascent flight mechanics, chemical rockets, multi-staging and optimization, Electrical rockets. Fundamentals of orbital mechanics (two body motion, circular and escape velocity, motion in elliptic, hyperbolic and parabolic orbits).

Module – III

KEPLERIAN AND NON KEPLARIAN MOTIONS

Conics and relations, Vis-viva equation, Kepler equation, orbital elements, Orbit determination, Lambert Problem, Different Methods of solution to Lambert problem; Non-Keplerian Motion: Perturbing acceleration-Earth aspherical potential, oblateness, third body effects, atmospheric drag effects, application of perturbations.

Module – IV

FUNDAMENTALS OF ORBITAL MANEUVERS

Orbit Maneuvers: Hohmann transfer, Inclination change maneuvers, combined maneuvers, bi-elliptic maneuvers; Lunar / Interplanetary Trajectories: Concept of sphere of influence.

References:

1. Rudolf X Mayer, *Elements of Space Technology*, Academic Press, Sandiego, 1999.
2. Howard D. C., *Orbital Mechanics for Engineering Students*, 2/e, Elsevier, 2004.
3. Chobotov V. A., *Orbital Mechanics*. 3rd ed. AIAA, 2002

4. Hale Francis J., *Introduction to Space Flight*, Prentice hall, 1994.
5. Escobal P. R., *Methods of Orbit Determination*, Krieger Publishing, 1976.
6. Tewari A., *Atmospheric and Space Flight Dynamics*, Birkhauser, 2007.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course Outcome:

Students successfully completing this course will have

- *Ability to understand terminology of state of the art space technologies*
- *Ability to design orbital maneuvers qualitatively.*

13.805.1 PROJECT MANAGEMENT (S) (Elective IV)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objectives:

- *To deal with projects and decisions on capital investment or capital project.*
- *To give an exposure to the major aspects of a project.*

Module – I

Planning- Capital Expenditures-Phases of capital budgeting-Levels of decision making-Facets of Project analysis- Feasibility Study-Objectives of Capital Budgeting- Resource Allocation framework-Key criteria- Elementary Investment Strategies-Portfolio Planning tools-Generation of Project ideas- Monitoring the environment- Corporate Appraisal- Scouting for project ideas-Preliminary screening- Project rating index-Sources of positive net present value.

Module – II

Analysis- Market and demand analysis-Situational analysis and specification of objectives-Collection of secondary information- Conduct of market survey- Characterization of market-Demand forecasting- Market planning- Technical analysis- Material inputs and utilities-Manufacturing process-Product Mix- Plant capacity-Location and site- machineries and equipment.

Module – III

Structures and civil works-Project charts and layouts-Work schedule- Financial analysis-cost of project- means of finance-Estimates of sales and production-Cost of production- working capital requirements and its financing-Profitability projections- break-even point- projected cash flow statements and balance sheets.

Project cash flows- Basic principles for measuring cash flows-Components of cash flow- cash flow illustrations- Viewing a project from different points of view-time value of money-Future value of money- single amount- Future value of an annuity- Present value of a single amount-present value of an annuity.

Module – IV

Cost of capital- cost of debt capital- Cost of preference capital-rate of return-Cost of external equity and retained earnings-Determination of weights- Appraisal criterion- Net present value-Cost benefit ratio- Internal rate of return-Urgency-payback period.

Implementation- Forms of project organization- Project planning-Project control- Human aspects of project management.- Network techniques- development of Network-Time estimation-Critical path determination-Scheduling under limited resources-PERT model-

CPM model- Network cost system-Project review- initial; review- Performance evaluation-Abandonment analysis.

References

1. Dennis Lock, *Project Management*, Grower Publications.
2. Prasanna Chandra, *Financial Management Theory and Practice*, Tata McGraw Hill Publishers.
3. Parameswar P. Iyer, *Engineering Project Management*, Vikas Publishers.
4. Gido and Clements, *Success/iii Project Management*, Vikas Publishers.
5. Amrine H. T. and John A. Ritchey, *Manufacturing Organization and Management*, Pearson Education.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course outcome:

- *Ability to comprehend the market analysis*
- *Ability to manage different projects at various levels.*

13.805.2 RELIABILITY ENGINEERING (S) (Elective IV)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objectives:

- *To make students learn about the reliability and reliability aspects of a product.*
- *To implement knowledge on the importance of reliability in industries.*

Module – I

Introduction to Reliability: Concepts of Reliability, Probability and statistics in Reliability engineering, Probability distributions, Point Estimations, Interval Estimation, Goodness-of-fit tests, Statistics of Extremes, Markov Chain.

Module – II

Failure data Analysis: Reliability and rates of failure, Reliability function, expected life, failure rate, hazard function. Evaluation of fault mode and failure mode: Fault tree analysis, Event tree analysis, effect analysis and criticality analysis.

Module – III

System Reliability, Reliability improvement, Reliability allocation, cost aspects in reliability, Availability and maintainability.

Module – IV

Case studies from industries demonstrating Reliability aspects. Computer aspects in Reliability and Reliability engineering.

References

1. Balaguruswamy E., *Reliability Engineering*, Tata McGraw-Hill Publishing Company Limited, New Delhi, 1984.
2. Lewis E. E., *Introduction to Reliability Engineering*, John Wiley & Sons, New York, 1987.
3. O'Connor Patric D. T., *Practical Reliability Engineering*, 3/e Revised, John Wiley & Sons, 1995.
4. Stamatis D. H., *Failure Mode and Effect Analysis*, Productivity Press India (P) India, Madras, 1997.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course outcome:

- *Ability to comprehend the reliability aspects of different products.*
- *Ability to solve problems based on different methods in reliability.*

13.805.3 AIRCRAFT SAFETY AND REGULATIONS (S) (Elective IV)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objectives:

To impart knowledge about the civil air rules and regulations which are being followed by Directorate General of Civil Aviation.

Module – I

C.A.R. SERIES 'A' & C.A.R. SERIES 'B'

C.A.R. SERIES 'A' Procedure for civil air worthiness requirements and responsibility operators vis-à-vis air worthiness directorate – Responsibilities of operators / owners- Procedure of CAR issue – amendments etc.– Objectives and targets of airworthiness directorate – Airworthiness regulations and safety oversight of engineering activities of operators.

C.A.R. SERIES 'B': Issue approval of cockpit check list, MEL, CDL – deficiency list (MEL & CDL) – preparation and use of cockpit checklist and emergency list.

Module – II

C.A.R. SERIES 'C' & C.A.R. SERIES 'D'

C.A.R. SERIES 'C' : Defect recording – reporting – investigation – rectification and analysis – Flight report; Reporting and rectification of defects observed on aircraft – Analytical study of in-flight readings & recordings –Maintenance control by reliability Method.

C.A.R. SERIES 'D' : Reliability Programmes (Engines) – Aircraft maintenance programme& their approval – On condition maintenance of reciprocating engines – TBO – Revision programme – Maintenance of fuel and oil uplift and consumption records – Light aircraft engines; Fixing routine maintenance periods and component TBOs – Initial & revisions.

Module – III

C.A.R. SERIES 'E' & C.A.R. SERIES 'F'

C.A.R. SERIES 'E': Approval of organizations in categories A, B, C, D, E, F, & G - Requirements of infrastructure at stations other than parent base.

C.A.R. SERIES 'F': Procedure relating to registration of aircraft – Procedure for issue – revalidation of Type Certificate of aircraft and its engines – propeller – Issue / revalidation of Certificate of Airworthiness – Requirements for renewal of Certificate of Airworthiness.

Module – IV

C.A.R. SERIES 'L'& 'M' & C.A.R. SERIES 'T'& 'X'

C.A.R. SERIES 'L'& 'M': Issue of AME License, its classification and experience requirements – Mandatory Modifications / Inspections.

C.A.R. SERIES 'T'& 'X': Flight testing of (Series) aircraft for issue of C of A – Flight testing of aircraft for which C of A had been previously issued – Registration Markings of aircraft –

Weight and balance control of an aircraft – Provision of first aid kits & Physician's kit in an aircraft – Use furnishing materials in an aircraft – Concessions – Aircraft log books – Document to be carried on board on Indian registered aircraft – Procedure for issue of tax permit – Procedure for issue of type approval of aircraft components and equipment including instruments.

References

1. *Aircraft Manual (India) Volume* – Latest Edition, The English Book Store, 17-1, Connaught Circus, New Delhi.
2. *Advisory Circulars* from DGCA 2003.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course outcome:

- *Knowledge on the civil air rules and regulations which are being followed by Directorate General of Civil Aviation.*

13.805.4 OPERATIONS RESEARCH (S) (Elective IV)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objectives:

To introduce basic concepts of LPP, Sequencing, game theory, inventory etc.

Module – I

Development – definition– characteristics and phases – types of models – operation research models – applications.

ALLOCATION: Linear programming problem formulation – graphical solution – simplex method- artificial variables techniques -two–phase method, big-m method – duality principle.

TRANSPORTATION PROBLEM: Formulation – optimal solution, unbalanced transportation problem – degeneracy, assignment problem – formulation – optimal solution - variants of assignment problem- travelling salesman problem.

SEQUENCING – Introduction – flow –shop sequencing – n jobs through two machines – n jobs through three machines – job shop sequencing – two jobs through 'm' machines.

Module – II

REPLACEMENT: Introduction – replacement of items that deteriorate with time – when money value is not counted and counted – replacement of items that fail completely, group replacement.

THEORY OF GAMES: Introduction – mini. max (max. mini) – criterion and optimal strategy – solution of games with saddle points – rectangular games without saddle points – 2 x 2 games – dominance principle – m x 2 & 2 x n games -graphical method.

Module – III

WAITING LINES: Introduction – single channel – poison arrivals – exponential service times – with infinite population and finite population models– multichannel – poison arrivals – exponential service times with infinite population single channel poison arrivals.

INVENTORY : Introduction – single item – deterministic models – purchase inventory models with one price break and multiple price breaks – shortages are not allowed – stochastic models – demand may be discrete variable or continuous variable – instantaneous production. Instantaneous demand and continuous demand and no set up cost.

Module – IV

DYNAMIC PROGRAMMING: Introduction – Bellman's principle of optimality – applications of dynamic programming- capital budgeting problem – shortest path problem – linear programming problem.

SIMULATION: Definition – types of simulation models – phases of simulation– applications of simulation – inventory and queuing problems – advantages and disadvantages – simulation languages.

References

1. Sharma S.D., *Operations Research,* Kedarnath
2. Hiller and Libermann, *Introduction to O.R,* TMH.
3. Natarajan A. M., P. Balasubramani and A. Tamilarasi, *Operations Research,* Pearson Education.
4. Maurice Sasieni, Arthur Yaspan and Lawrence, *Operations Research: Methods & Problems*, Friedman
5. Pannerselvam R., *Operations Research,* PHI Publications.
6. Wagner, *Operations Research,* PHI Publications.
7. Sharma J. K., *Operation Research*, MacMillan.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course outcome:

Ability to comprehend the application of LPP, Game Theory, Inventory, Simulation etc.

13.805.5 FRACTURE MECHANICS (S) (Elective IV)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objectives:

- *To understand the importance of fracture mechanics in aerospace applications.*
- *To be able to predict the fracture life of a component.*
- *To be able to model the fracture mechanisms.*

Module – I

Introduction: Significance of fracture mechanics - Griffith energy balance approach - Irwin's modification to the Griffith theory - stress intensity approach - crack tip plasticity - fracture toughness - sub critical crack growth - influence of material behaviour - modes I, II & III - mixed mode problems
Linear elastic fracture mechanics (LEFM): Elastic stress field approach - mode I elastic stress field equations - expressions for stresses and strains in the crack tip region - finite specimen width.

Module – II

Superposition of stress intensity factors (SIF) – SIF solutions for well-known problems such as centre cracked plate, single edge notched plate, and embedded elliptical cracks Crack tip plasticity: Irwin plastic zone size - Dugdale approach - shape of plastic zone - state of stress in the crack tip region - influence of stress state on fracture behaviour
Energy balance approach: Griffith energy balance approach - relations for practical use - determination of SIF from compliance - slow stable crack growth and R-curve concept - description of crack resistance LEFM testing: Plane strain and plane stress fracture toughness testing - determination of R-curves - effects of yield strength and specimen thickness on fracture toughness - practical use of fracture toughness and R-curve data.

Module – III

Elastic plastic fracture mechanics (EPFM): Development of EPFM - J-integral – crack opening displacement (COD) approach - COD design curve - relation between J and COD - tearing modulus concept - standard JIC test and COD test
Fatigue crack growth**:** Description of fatigue crack growth using stress intensity factor - effects of stress ratio and crack tip plasticity - crack closure - prediction of fatigue crack growth under constant amplitude and variable amplitude loading - fatigue crack growth from notches - the short crack problem.

Module – IV

Sustained load fracture: Time-to-failure (TTF) tests - crack growth rate testing -experimental problems - method of predicting failure of a structural component -practical significance of sustained load fracture testing

Practical problems: Through cracks emanating from holes - corner cracks at holes -cracks approaching holes - fracture toughness of weldments - service failure analysis - applications in pressure vessels - pipelines and stiffened sheet structures.

References

1. Ewalds H. L. and Wanhill R. J. H., *Fracture Mechanics*, Edward Arnold Edition.
2. Broek D., *Elementary Engineering Fracture Mechanics,* Sijthoff & Noordhoff International Publishers.
3. Kare Hellan, *Introduction to Fracture Mechanics*, McGraw Hill Book Company.
4. Prashant Kumar, *Elements of Fracture Mechanics*, Wheeler Publishing.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course outcome:

- *Prediction the fracture life of an aerospace component.*
- *Development of a thorough understanding of fracture mechanisms*

13.805.6 INDUSTRIAL HYDRAULICS (S) (Elective IV)

Teaching Scheme: 3(L) - 1(T) - 0(P) **Credits**: 4

Course Objectives:

- *To have a basic understanding of hydraulic components and circuits*
- *To be able to read and interpret industrial hydraulic circuits*

Module – I

Introduction to fluid power – Hydraulics and Pneumatics systems – Fluid power systems – Fundamentals of fluid mechanics – Measurement of physical parameters – Hydraulic symbols .Fluid power pumps and motors – Types of pumps – Characteristics.

Module – II

Hydraulic cylinders and rams – Fluid power pumping systems and components. Pressure accumulators – Functions – Fluid reservoirs – Filter in hydraulic circuits. Loading and replacement of filter elements – Materials for filters.

Module – III

Fluid temperature control – Fluid pressure control –control valves – Sequence valve – Counterbalance valve-unloading valve – Friction control valve – Servo systems.

Module – IV

Industrial hydraulic circuits - Circuit design for – shaper, grinder, material handling equipments, processes - Miscellaneous circuits.

References

1. John J. Pippenger and Tyler G. Hicks, *Industrial Hydraulics,* McGraw Hill, 1970.
2. Joji Parambath, Industrial Hydraulic Systems: Theory and Practice, Universal-Publishers, 2016
3. Ravi Doddannavar, Andries Barnard, Jayaraman Ganesh, Practical Hydraulic Systems: Operation and Troubleshooting for Engineers and Technicians, Elsevier, 2009.
4. Peter Rohner, Industrial hydraulic control, HydraulicSupermarket.com, 2005.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course outcome:

- *Thorough understanding of symbols and characters in a hydraulic circuits*
- *Ability to design a hydraulic circuit in the view point of a new need.*

13.806.1 AIRCRAFT RULES AND REGULATIONS (S) (Elective V)

Teaching Scheme: 3(L) - 0(T) - 0(P) **Credits**: 3

Course Objectives:

To impart knowledge about the civil air rules and regulations which are being followed by Directorate General of Civil Aviation.

Module – I

GENERAL CONDITIONS OF FLYING

Use and operation of aircraft – Registration and nationality and registration marks – Prohibited flight – Licensing of personnel – Type of aircraft to be included in rating – Flights to qualify for extension of a licence – Flights for testing and other non-revenue specific special purposes. –Documents to be carried in aircraft – Carriage of cock-pit check list in aircraft.

Module – II

GENERAL SAFETY CONDITIONS

Dangerous flying – Assault and other acts of interference against a crew member – Assault and other acts endangering safety or jeopardizing good order and discipline – Prohibition of intoxicated persons entering aircraft – Carriage of persons suffering from mental disorders or epilepsy in aircraft – Carriage of prisoners in aircraft – Carriage of animals, birds and reptiles in aircraft – Smoking in aircraft – Fuelling of aircraft, Housing of aircraft – Dropping of articles and descents by parachutes – Carriage of persons in unauthorized part of aircraft – Minimum age for sole control of aircraft –Maximum age limit for professional pilots –Acts likely to imperil safety of aircraft – Prohibition of operating civil aircraft causing sonic boom – Prohibition on the use of portable electronic devices – Adoption of the Convention and Annexes – Safety Management Systems.

Module – III

REGISTRATION AND MARKING OF AIRCRAFT

Certificate of registration – Nature of application – Aircraft imported by air – Change in ownership – Aircraft destroyed or withdrawn from use – Registration fees – Register of aircraft – Nationality and Registration marks, how to be affixed – Use of State marks.

Module – IV

PERSONNEL OF AIRCRAFT

Licensing authority – Carriage of operating crew – Carriage of a cabin crew – Disqualification from holding or obtaining a license – Medical standards – Period of validity of medical fitness and Licenses – Proof of competency – Checks, test and examinations – Approved Training Organization – Licenses and their renewal – Pilot not to fly for more than 125 hours during any period of 30 consecutive days – Aircraft not registered in India – Validation of

foreign licenses – Minimum age for holding a license – Minimum educational qualification for holding a license – Fees and other charges.

References

1. *Aircraft Manual* (India) Volume – Latest Ed., The English Book Store, 17-1, Connaught Circus, New Delhi.
2. *Advisory Circulars* from DGCA 2003.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course outcome:

At the end of this course the students will be able to understand the civil air rules and regulations which are being followed by Directorate General of Civil Aviation.

13.806.2 NON DESTRUCTIVE TESTING (S) (Elective V)

Teaching Scheme: 3(L) - 0(T) - 0(P) **Credits**: 3

Course Objectives:

- *To impart knowledge in various methods of Non Destructive Testing.*
- *To appreciate the importance of NDT in Aerospace engineering.*

Module – I

VISUAL INSPECTION AND EDDY CURRENT TESTING: Scope and advantages of NDT, Comparison of NDT with DT, classifications of NDT Visual Inspection Equipment used for visual inspection -Magnifying Glass Magnifying Mirror, Microscope Borescope , endoscopes or endoprobes Flexible Fiber Optic Borescope , Video Imagescope .Eddy Current Testing-Principle, Advantages, Disadvantages Factors Affecting Eddy Current Response-Material Conductivity Permeability - Frequency- Geometry-Proximity (Lift off)-Typical Applications, limitations ,Types of Probes.

Module – II

LIQUID PENETRANT TESTING: Liquid penetration testing- Introduction, Principle, Equipment, Procedures, Characteristics of penetrants- developers — Evaluation — hazards Precautions, advantages, limitations and applications.

Module – III

MAGNETIC PARTICLE TESTING: Principle of Magnetic Particle Testing-different methods to generate magnetic fields -Magnetic Particle Testing Equipment- Magnetic Particle Testing Procedures Method of De-Magnetization-Magnetic Particle Medium-Evaluation of Indications and Acceptance Standards- magnetic particle test- applications, advantages and limitations.

Module – IV

RADIOGRAPHIC TESTING: X-ray radiography principle, equipment & methodology - Type of Industrial Radiation sources and Application-Radiographic exposure Factors and Technique-GAMA Ray and X-Ray Equipment- Radiographic Procedure — Radiograph Interpretation, Radiography Image Quality Indicators-Radiographic Techniques- Film Processing-Methods of Viewing Radiographs-Radiographic Testing Procedures for welds. Precautions against radiation hazards.

Introduction, Principle of operation Type of Ultrasonic Propagation- Ultrasonic probes, Types of Transducers -Ultrasonic Testing Techniques. Method for Evaluating Discontinuities-Ultrasonic Testing Procedures for different component -applications, advantages and

limitations, Documentation, Applications in inspection of castings, forgings, Extruded steel parts, bars, pipes, rails and dimensions measurements.

References

1. American Metals Society, *Non-Destructive Examination and Quality Control*, Metals HandBook, Vol.17, 9th Ed, Metals Park, OH, 1989.
2. Bray, Don. E and Stanley, Roderic K*, Nondestructive Evaluation: A Tool in Design*, *Manufacturing, and Service. Revised*, CRC Press New York, Edition 1997.
3. www.ndt-ed.org
4. Prasad J., C. G. K. Nair, Non-*Destructive Testing and Evaluation of Materials*, Tata McGraw Hill Education Private Limited.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course outcome:

- *Ability to suggest mode of NDT tests for different materials*
- *Ability to interpret different acceptance standards.*

13.806.3 STATISTICAL QUALITY CONTROL (S) (Elective V)

Teaching Scheme: 3(L) - 0(T) - 0(P) **Credits**: 3

Course Objectives:

- *To have an understanding of the basics of quality control*
- *To be able to use modern tools in statistical quality control.*
- *To develop a scientific base for reliability.*

Module – I

Introduction, definition of quality, basic concept of quality, definition of SQC, benefits and limitation of SQC, Quality assurance, Quality cost-Variation in process- factors – process capability – process capability studies and simple problems – Theory of control chart- uses of control chart – Control chart for variables – X chart, R chart and s chart.

Module – II

Control chart for attributes –control chart for proportion or fraction defectives – p chart and np chart – control chart for defects – C and U charts, State of control and process out of control identification in charts.
The concept of Acceptance sampling, Economics of inspections, Lot by lot sampling – types – probability of acceptance in single, double, multiple sampling techniques – The Operating characteristic curve– producer's Risk and consumer's Risk.

Module – III

AQL, LTPD, AOQL concepts-standard sampling plans for AQL and LTPD- uses of standard sampling plans. Minimum inspection per lot, Formulation of Inspection lots and selection of samples.
Life testing – Objective – failure data analysis, Mean failure rate, mean time to failure, mean time between failure, hazard rate, system reliability, series, parallel and mixed configuration – simple problems.

Module – IV

Maintainability and availability – simple problems. Reliability improvements – techniques-use of Pareto analysis – design for reliability – redundancy unit and standby redundancy – Optimization in reliability – Product design – Product analysis – Product development – Product life cycles.

References

1. Grant, Eugene L., *Statistical Quality Control*, McGraw-Hill.
2. Srinath L. S., *Reliability Engineering*, Affiliated East West Press.
3. Monohar Mahajan, *Statistical Quality Control*, DhanpatRai & Sons.

4. Gupta R. C., *Statistical Quality Control*, Khanna Publishers.
5. Besterfield D. H., *Quality Control*, Prentice Hall.
6. Sharma S. C., *Inspection Quality Control and Reliability*, Khanna Publishers.
7. Danny Samson, *Manufacturing & Operations Strategy*, Prentice Hall.
8. Connor P. D. T. O., *Practical Reliability Engineering*, John Wiley.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course outcome:

At the end of this course the students will be able to

- *Apply quality principle to real life problems.*
- *Visualize and interpret data in quality perspective.*
- *Use control charts efficiently.*

13.806.4 INDUSTRIAL POLLUTION AND CONTROL (S) (Elective V)

Teaching Scheme: 3(L) - 0(T) - 0(P) **Credits**: 3

Course Objectives:

- *To imbibe the idea of pollution control and how it can be achieved.*
- *To understand the standards for emission control*
- *To develop the foundation for sustainable industrial ecology.*

Module – I

Environmental aspects - Impact of environment - Environmental quality – Role of environmental engineer. Air quantity - Definition, Characteristics and prospective - Types of our air pollutants - effect of air pollution on men and environment - Formation of air pollutants from combustion of fossil fuels and parameters controlling the formation.

Module – II

Water pollution from tanneries and other industries - Engineered systems for waste water treatment and disposal - Control systems and instrumentation for pollution control.

Module – III

Definition, characteristics - Types and sources of solid waste - Solid waste management - generation, collection, storage and processing techniques - Solid waste disposal.

Module – IV

Methods and equipment's for industrial waste treatment - Pollution thermal power plants and nuclear power plants - Sources and control methods - Emission from SI and CI engines - Evaporative emission control –Exhaust treatment devices - Noise pollution and their control.

References

1. Howard S. Peavy, Donald R.Rowe, and George Tchobanoglous, *Environmental Engineering*, Mc Graw Hill, New Delhi, 1985.
2. Stern A. C., H. C. Wonter, R. W. Boubce and W. P. Lowry, *Fundamental of Air Pollution*, Academic Press, 1973.
3. Ikken P. A., R. J. Swart and S. Zwerves, *Climate and Energy*, McGraw Hill, New Delhi, 1989.
4. Metcalf and Eddy Inc, *Waste Water Engineering Treatment and Disposal* Second Edition, McGraw Hill, New York, 1979.
5. Wark Kenneth and Cecil F. Warner, *Air Pollution: Its Origin and Control*, Dun Dunnellers, New York, 1976.

6. Tchobanoglous G., H. Theisan and R. Elaisen, *Solid Water: Engineering Principles and Management Issues*, McGraw Hill, New York, 1977.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course outcome:

- *Ability to distinguish between sources of pollution and their impacts.*
- *Ability to device new control methods aimed at reducing pollution.*

13.806.5 SAFETY ENGINEERING (S) (Elective V)

Teaching Scheme: 3(L) - 0(T) - 0(P) **Credits**: 3

Course Objectives:

- *To develop an understanding of the safety regulations for different scenarios*
- *To understand the importance of safety in engineering*
- *To imbibe safety as a prime factor to be monitored in an industry.*

Module – I

Introduction to the development of industrial safety and management – History and development of Industrial safety – implementation of factories Act – formation of various council – safety and productivity – safety organizations safety committees – safety committees structure – roll of management and roll of Govt. in industrial safety - safety analysis.

Module – II

Operational safety (Hot Metal Operation): Hot metal operation – safety in Cutting – safety in welding – safety in Boilers- Pressure vessels – Furnace (all types) - Heat treatment processes shops – electroplating – grinding – forming processes- rolling – forging - surface hardening – casting – Moulding – coiling.

Module – III

Operational safety (cold metal operation): Safety in handling of portable power tools – hand grinder - machining shop – drilling – polishing machine – safety in assembly shop – material handling – dock safety – safety in generation and distribution of power – distribution and handling of industrial gases – safety in inspection – safety in chemical laboratories – ammonia printing – safety in power press – safety in sewage – disposal and cleaning. Safety in Industrial pollution and control – working at height.

Module – IV

Accident prevention and protective equipments: Personal protective equipment – survey the plant for locations and hazards – part of body to be protected. Education and training in safety – prevention causes and cost of accident. Housekeeping – first aid – firefighting equipment – Accident reporting – investigations. Industrial psychology in accident prevention – safety trials. The Acts which deal the safety and industrial hygiene: Features of Factory Act – explosive Act – boiler Act – ESI Act – workman's compensation Act – industrial hygiene – occupational safety – diseases prevention – ergonomics. Occupational diseases, stress, fatigue. Health, safety and the physical environment. Engineering methods of controlling chemical hazards, safety and the physical environment: Control of industrial noise and protection against it- Code and regulations for worker safety and health.

References

1. Ray Asfahl C*., Industrial Safety and Health Management*, Fifth Edition, Prentice Hall, 2003.
2. Willie Hammer, *Occupational Safety Management and Engineering*, 5th Edition, Prentice Hall, 2000.
3. *Occupational Safety Manual* – BHEL.
4. Krishnan N.V., Safety in Industry, Jaico Publishers House, 1996.
5. John Ridley, *Industrial Safety and the Law*, P. M. C. Nair Publishers, Trivandrum, 1998.
6. John Channing, *Safety Law for Occupational Health and Safety*, Butterworth-Heinemann, 1999.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course outcome:

At the end of this course the students will be able to

- *Read and understand different safety regulations*
- *Suggest new amendments to safety regulations in the existing world.*

13.806.6 AERODYNAMIC TESTING FACILITY (S) (Elective V)

Teaching Scheme: 3(L) - 0(T) - 0(P) **Credits**: 3

Course Objectives:

To present the measurement techniques involved in aerodynamic testing.

Module – I

Low speed wind tunnels-estimation of energy ratio and power required supersonic wind tunnels-calculation of running time and storage tank requirements.
Estimation of flow angularity and turbulence factor-calculation of CL and CD on aero foils from pressure distribution- CD from wake survey-Test section average velocity using traversing rakes-span wise load distribution for different taper ratios of wing.

Module – II

Mach number estimation in test section by pressure measurement and using a wedge – preliminary estimates of blowing and running pressures, nozzle area ratios, and mass flow for a given test section size and Mach number-starting problem and starting loads.

Module – III

Hot wire anemometer and laser Doppler anemometer for turbulence and velocity measurements-Use of thermocouples and pyrometers for measurement of static and total temperatures-Use of pressure transducers, Rota meters and ultrasonic flow meters.

Module – IV

Pitot-static tube correction for subsonic and supersonic Mach numbers - boundary layer.
Velocity profile on a flat plate by momentum-integral method.
Calculation of CD from wall shear stress - Heating requirements in hypersonic wind tunnels - Re-entry problems.

References

1. Rae W. H. and Pope A., *Low Speed Wind Tunnel Testing*, John Wiley, 1984.
2. Pope A. and L. Goin, *High Speed Wind Tunnel Testing*, John Wiley, 1985.
3. Rathakrishnan E., *Instrumentation, Measurement and Experiments in Fluids*, CRC Press, London, 2007.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course outcome:

Ability to perform various measurement involved in aerodynamic testing.

13.806.7 ROCKETS AND MISSILES (S) (Elective V)

Teaching Scheme: 3(L) - 0(T) - 0(P) **Credits**: 3

Course Objectives:

- *To introduce basic concepts of design of rockets and missiles.*
- *To estimate the trajectory of rockets and missiles.*

Module – I

ROCKETS SYSTEM

Ignition system in rockets- types of igniters- Igniter design considerations-Design consideration of Liquid rocket combustion chamber, injector propellant feed lines, Valves, Propellant Tanks Outlet and Helium pressurized and turbine feed systems, Propellant Slash and Propellant Hammer-Elimination of Geysering effect in missiles- Combustion system of solid rockets.

Module – II

AERODYNAMICS OF ROCKETS AND MISSILES

Airframe components of rockets and missiles- Forces acting on a missile while passing through atmosphere-Classification of missiles- Methods of describing aerodynamic forces and moments-Latera Aerodynamic moment-Lateral Damping moment and Longitudinal moment of a rocket- Lift and Drag forces- Drag estimation-Body Up wash and Downwash in missiles-Rocket Dispersion numerical problems.

Module – III

ROCKET MOTION IN FREE SPACE AND GRAVITATIONAL FIELD

One dimensional and two dimensional rocket motions in free space and homogeneous gravitational fields- Description of vertical, inclined and gravity turn trajectories- Determination of range and altitude- Simple approximations to Burnout velocities.

Module – IV

STAGING OF ROCKETS

Staging and control of rockets and missiles- Rocket Vector Control Methods- Thrust determination-SITVC- Multistaging of rockets-Vehicle Optimization-Stage Separation Dynamics- Separation Techniques. Selection of materials- Special requirements of materials to perform under adverse conditions.

References

1. Sutton G. P., *et. al., Rocket Propulsion Element*, John Wiley & Sons Inc., New York, 1993.

2. Mathur M. and R. P. Sharma, *Gas Turbines and Jet Rocket Propulsion*, Standard Publishers, New Delhi, 1998.
3. CorneJisse J. W., *Rocket Propulsion and Space Dynamics*, J.W. Freeman & Co. Ltd., London, 1982.
4. Parket E. R., *Materials for Missiles and Spacecrafts*, McGraw Hill Book Co. Inc., 1982.

Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

30% - Assignments (minimum 2) such as home work, problem solving, literature survey, seminar, term-project, software exercises, etc.

20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours *Maximum Total Marks: 100*

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.

Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course outcome:

- *Ability to comprehend the aerodynamics of rockets and missiles in all conditions.*
- *Ability to comprehend the various components of rockets and missiles.*

13.807 SEMINAR (MNPSU)

Teaching Scheme: 0(L) - 0(T) - 2(P) **Credits**: 2

Course Objective:

The main objective of this course is to provide experience in presentations and to improve their communication skills.

The student shall present a seminar on a topic which is of high relevance to Mechanical Engineering. A seminar report must be submitted at the end of the semester. The topic of the seminar shall be different from the topic of his/her project work which is being done during seventh and eighth semesters.

Internal Continuous Assessment *(Maximum Marks-100)*

40% - Assessment by the Guide
40% - Assessment by the Committee.
20% - Regularity in the class

Course Outcome:

After completion of this course the students will be able to

- *Acquire the basic skills to perform literature survey and present papers*
- *Acquire communication skills*

13.808 PROJECT, VIVA-VOCE AND INDUSTRIAL VISIT (MNPSU)

Teaching Scheme: 0(L) - 0(T) - 5(P) **Credits**: 5

Course Objective:

- *To do a detailed study on a selected topic based on current journals or published papers.*
- *To impart the ability to perform as an individual as well as a team member in completing a project work.*

The project work (project phase 1) started in the seventh semester, shall be continued (project phase 2) in the eight semester. The student/s must submit the final project report at the end of the eight semester. At least two evaluations should be conducted by a panel consisting of project coordinator/senior faculty, project guide, and a faculty specialized in the area. The students may be assessed individually and in groups.

Internal Continuous Assessment *(Maximum Marks-100)*

The distribution of marks is as follows:

Work Assessed by Guide:	*50%*
Assessed by a three member committee:	*50%*

University Examination Pattern:

Viva-Voce *Maximum Total Marks: 100*

Marks shall be awarded based on the overall performance, Project report, Seminar report, Subject knowledge and general awareness in the field of Mechanical Engineering

Course Outcome:

After completion of this course the students will be able to

- *Acquire the basic skills to perform literature survey and present papers*
- *Acquire communication skills and improve their leadership quality as well as the ability to work in groups.*