BANGABANDHU SHEIKH MUJIBUR RAHMAN
AVIATION AND AEROSPACE UNIVERSITY (BSMRAAU)

# COURSE CURRICULUM
# OF
# BACHELOR OF SCIENCE IN
# AERONAUTICAL ENGINEERING

## 1ST EDITION, 1ST REVISION (FOR BATCH-1)

DEPARTMENT OF AEROSPACE ENGINEERING (ASE)
BANGABANDHU SHEIKH MUJIBUR RAHMAN
AVIATION AND AEROSPACE UNIVERSITY (BSMRAAU)

# PREFACE

Bangabandhu Sheikh Mujibur Rahman Aviation and Aerospace University (BSMRAAU) is the first-ever specialized University in the aviation sector of Bangladesh. This university aims to establish itself as a state-of-the-art institution in the field of engineering by providing world-class quality education to the students in the field of Aviation and Space. The university started her journey since 28 February 2019 but the *Launching of Academic Program* started from this university since 03 February 2020 with the induction of undergraduate program in Aeronautical Engineering. BSMRAAU offers both undergraduate and graduate programs in the field of aerospace and aeronautical sciences and engineering. This syllabus is for the undergraduate students of Aerospace Engineering (Aeronautical), which is offered under the Department of Aerospace Engineering (ASE) at BSMRAAU. Although this curriculum has been written mainly for the students, however, the student advisers and teachers will also be benefitted as a reference document.

This curriculum provides general information about the undergraduate B.Sc. in Aerospace Engineering (Aeronautical) programme. It provides the course outline detailing semester wise courses. In addition, the lists of core courses, courses offered by other departments and optional (elective) courses are also illustrated along with a detailed course outline. It is important to note that, the course outline presented is subject to review and modification as the courses progress so that our offered courses adapt with the latest developments in the respective fields and are suitable for the undergraduate students. According to the policy of BSMRAAU, the syllabus will be revised every 3 years. This is the 1$^{st}$ revised modification of curriculum undergraduate Aerospace program made basing on the miss-match with the pre-requisite courses, addition of elective courses for technological adaptation and guidance by the Board of Accreditation for Engineering and Technical Education (BAETE).

We thank all members of the curriculum committees along with other members of BSMRAAU for the sincere suggestions and efforts which made a significant contribution to the development of this curriculum. We look forward to further suggestions to enrich the curriculum.

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August 2022
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## COMMITTEE OF MEMBERS

This curriculum of Bachelor of Science in Aeronautical Engineering (Aerospace) of Bangabandhu Sheikh Mujibur Rahman Aviation and Aerospace University (BSMRAAU) is prepared by the committee as under:

| | | |
|---|---|---|
| **Convenor** | Group Captain Dr. GM JAHANGIR ALAM, psc, PhD | Head of the Department<br>Department of Aerospace Engineering<br>Bangabandhu Sheikh Mujibur Rahman Aviation and Aerospace University (BSMRAAU) |
| **Members (Internal)** | Air Commodore (LPR) Md Abdus Salam, BPP, psc | Faculty Member<br>Department of Aerospace Engineering<br>Bangabandhu Sheikh Mujibur Rahman Aviation and Aerospace University (BSMRAAU) |
| | Assistant Professor Saiaf Bin Rayhan | Faculty Member<br>Department of Aerospace Engineering<br>Bangabandhu Sheikh Mujibur Rahman Aviation and Aerospace University (BSMRAAU) |
| **Specialized Member** | Air Commodore (LPR) Md Afzal Hossain, ndc, psc | Specialized Member<br>Bangladesh University of Engineering and Technology (BUET) |
| **Members (External)** | Professor Dr. Mohammad Ali, PhD | Specialized Teacher<br>Department of Mechanical Engineering<br>Bangladesh University of Engineering and Technology (BUET) |
| **Specialized Member** | Air Commodore Md Aminul Haque, ndc, psc | Specialized Member<br>Officer Commanding<br>216 Maintenance Repair and Overhauling Unit (MROU), Bangladesh Air Force (BAF) |
| **Co-opted Members** | Group Captain Md Nurul Huda | Deputy Examination Controller<br>Bangabandhu Sheikh Mujibur Rahman Aviation and Aerospace University (BSMRAAU) |
| | Assistant Professor Dr. Kamrul Hassan, PhD | Head of the Department<br>Department of Science and Humanities<br>Bangabandhu Sheikh Mujibur Rahman Aviation and Aerospace University (BSMRAAU) |

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# CHAPTER 1

# 1 UNDERGRADUATE AERONAUTICAL ENGINEERING PROGRAMME

## 1.1 Introduction

Aerospace and Avionics Engineering plays a vital role in all fields of modern human activities. These fields have established themselves as important branches of engineering. These fields at the same time integrate other fields of engineering for application in aerospace. The Aeronautical engineering programme of BSMRAAU has two majors; Aerospace, and Avionics. The undergraduate programme provides an excellent technical background for persons who want to work in the field of Aeronautics, Astronautics and Avionics. In addition to lectures and practical sessions in the classroom, the undergraduate programme also includes industrial/educational visits to different reputed industries/places both home and abroad. The new generation of Aerosapce and Avionics engineers is encouraged to undertake research and development activities in the above areas and this department is committed to the study and analysis of fundamental as well as applied problems.

## 1.2 Study Programmes

The Department of Aerospace Engineering offers the degree of B.Sc Engineering in Aeronautical Engineering (Aerospace). The courses and syllabus followed by this department for the above degree is appropriate to the needs of recent developments in the world and the requirement of local industry. The syllabus is designed to contain all the necessary study materials so that a graduate can face engineering problems readily after graduation. The syllabus is subject to be reviewed and amendments every three years by a "committee of courses" comprising the best academicians and experts of the field of Aerospace and Avionics Engineering coming from BSMRAAU and other leading Universities and Organizations.

## 1.3 Educational Objectives

The undergraduate aerospace engineering degree programme is designed to achieve the following objectives:

a. Our graduates will be technically proficient and effective leaders and entrepreneurs. They will display high professional and ethical standards in aerospace engineering and related fields, and within industry, academia, and government.

b. Our graduates will create new knowledge and engineering practices and develop products and services that have a global impact. They will collaborate with international partners and engage in culturally diverse teams.

c. Our graduates will be life-long learners, continually developing their leadership, critical thinking, and problem-solving skills. They will be actively engaged in the acquisition and advancement of knowledge and technical expertise through research and development, and through active participation in professional societies, graduate studies, conferences, and symposia.

d. Our graduates will transfer the knowledge gained from their aerospace engineering degrees to new fields that intersect with aerospace engineering such as robotics, medicine, and clean energy.

## 1.4 Vision and Mission of the Department

### 1.4.1 Vision of the Department

To create skilled and competent professionals in the field of Aeronautical Engineering with high morals to meet the national and global needs through creative research and innovations.

### 1.4.2 Mission of the Programme

Department of Aerospace and Avionics Engineering, BSMRAAU is working with the following missions in mind:

a. To provide state-of-the-art education in Aerospace and Avionics Engineering, to produce qualified engineers, capable of solving real-world problems to meet the needs of industry and society.

b. To contribute towards the creation of new knowledge through research and innovation in relevant fields of Aerospace and Avionics engineering and allied fields to address emerging national and global issues for well-being of the society.

c. To enable students in attaining required ethics with an attitude of entrepreneurial skills, ethical values and social consciences.

d. To embed leadership qualities amongst the students to follow successful professional career paths and to pursue advanced studies in Aerospace and Avionics engineering.

## 1.5 Programme Objectives/Programme Educational Objectives (PEO)

a. Our graduates will be able to solve critical technical problems related to Aeronautical Engineering.

b. Our graduates will be able to build up successful professional careers in the field of aviation (civil and military), government organizations, academia and military in the associated field.

c. Our graduates will be able to pursue continuous learning through professional development, practical training and specialized certifications.

d. Our graduates will be able to undertake post graduate and doctorate and excel in academic and research careers.

e. Our graduates will be able to positively contribute in national and global socio-economic development.

## 1.6 Learning Outcomes/Programme Outcomes (PO)

Based on the suggestion of Board of Accreditation for Engineering and Technical Education (BAETE), Bangladesh, the Bachelor in Aeronautical Engineering (AE) programme will have following learning outcomes:

a. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems.

b. Problem analysis: Identify, formulate, research the literature and analyse complex engineering problems and reach substantiated conclusions using first principles of mathematics, the natural sciences and the engineering sciences.

c. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety as well as cultural, societal and environmental concerns.

d. Investigation: Conduct investigations of complex problems, considering design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions.

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

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

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

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

i. Individual work and teamwork: Function effectively as an individual and as a member or leader of diverse teams as well as in multidisciplinary settings.

j. Communication: Communicate effectively about complex engineering activities with the engineering community and with society at large. Be able to comprehend and write effective reports, design documentation, make effective presentations and give and receive clear instructions.

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

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

### 1.7 Programme Objectives/Programme Educational Objectives (PEO)

| No | POs Statement | PEO-I | PEO-2 | PEO-3 | PEO-4 | PEO-5 |
|---|---|---|---|---|---|---|
| I. | **Engineering knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems. | **Yes** | No | No | No | No |
| 2. | **Problem analysis:** Identify, formulate, research the literature and analyze complex engineering problems and reach substantiated conclusions using first principles of mathematics, the natural | **Yes** | **Yes** | No | No | No |

| No | POs Statement | PEO-I | PEO-2 | PEO-3 | PEO-4 | PEO-5 |
|---|---|---|---|---|---|---|
| | sciences and the engineering sciences. | | | | | |
| 3. | **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for public health and safety as well as cultural, societal and environmental concerns. | **Yes** | **Yes** | No | No | **Yes** |
| 4. | **Investigation:** Conduct investigations of complex problems, considering design of experiments, analysis and interpretation of data and synthesis of information to provide valid conclusions. | **Yes** | No | No | **Yes** | No |
| 5. | **Modern tool usage:** Create, select and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex engineering problems with an understanding of the limitations. | **Yes** | No | No | No | No |
| 6. | **The engineer and society:** Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice. | No | **Yes** | No | No | **Yes** |
| 7. | **Environment and sustainability:** Understand and evaluate the sustainability and impact of professional engineering work in the solution of complex engineering problems in societal and environmental contexts. | No | **Yes** | No | No | **Yes** |
| 8. | **Ethics:** Apply ethical principles and commit to professional ethics, responsibilities and the norms of the engineering practice. | No | **Yes** | No | No | **Yes** |
| 9. | **Individual work and teamwork:** Function effectively as an individual and as a member or leader of diverse teams as well as in multidisciplinary settings. | No | **Yes** | No | No | **Yes** |
| 10. | **Communication:** Communicate effectively about complex engineering activities with the engineering community and with society at large. Be able to comprehend and write effective reports, design documentation, make effective presentations and give and receive clear instructions. | No | **Yes** | **Yes** | No | **Yes** |
| 11. | **Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work as a member or a leader of a team to manage projects in multidisciplinary environments. | No | **Yes** | No | No | **Yes** |
| 12. | **Life-long learning:** Recognize the need for and have the preparation and ability to engage in independent, life-long learning in the broadest context of technological change. | No | No | **Yes** | **Yes** | No |

## 1.8 Generic Skills

a. Apply the principles and theory of aeronautical engineering knowledge to the requirements, design and development of different aviation systems with appropriate understanding.
b. Define and use appropriate research methods and modern tools to conduct a specific project.
c. Learn independently, be self- aware and self- manage their time and workload.
d. Apply critical thinking to solve complex engineering problems
e. Analyse real time problems and justify the appropriate use of technology
f. Work effectively with others and exhibit social responsibility

## CHAPTER 2

# 2 PROGRAMME OUTLINE OF AERONAUTICAL ENGINERING (AEROSPACE)

## 2.1 Introduction

The list of courses offered to the Undergraduate students of Aeronautical Engineering (Aerospace) is categorized into Core courses and Elective courses. Some of the core courses are offered by the Department of ASE and some of those are offered by other departments. Students have the flexibility to choose from Elective courses offered by the department.

## 2.2 Programme Compulsory Courses

The students must complete all the courses enlisted below.

### 2.2.1 List of Core Aerospace Engineering Courses

A total of 41 courses on aerospace engineering topic are included in the programme.

| Course Code | Course Name | Type of Course | Contact hours | Credit Hours | Semester | Page No |
|---|---|---|---|---|---|---|
| ASE 4101 | Introduction to Aeronautical Engineering | Theory | 3.00 | 3.00 | 1 | 23 |
| ASE 4102 | Aeronautical Engineering Drawing-I | Sessional | 3.00 | 1.50 | 1 | 24 |
| ASE 4202 | Workshop Technology Sessional | Sessional | 3.00 | 1.50 | 2 | 25 |
| ASE 4341 | Thermodynamics | Theory | 3.00 | 3.00 | 3 | 26 |
| ASE 4342 | Thermodynamics Sessional | Sessional | 1.50 | 0.75 | 3 | 27 |
| ASE 4351 | Statics | Theory | 3.00 | 3.00 | 3 | 28 |
| ASE 4453 | Dynamics | Theory | 3.00 | 3.00 | 3 | 30 |
| ASE 4304 | Aeronautical Engineering Drawing II | Sessional | 3.00 | 1.50 | 3 | 30 |
| ASE 4405 | Numerical Methods in Engineering | Theory | 3.00 | 3.00 | 4 | 31 |
| ASE 4406 | Numerical Methods in Engineering Sessional | Sessional | 3.00 | 1.50 | 4 | 32 |
| ASE 4411 | Fundamentals of Fluid Mechanics | Theory | 3.00 | 3.00 | 4 | 33 |
| ASE 4412 | Fundamentals of Fluid Mechanics Sessional | Sessional | 1.50 | 0.75 | 4 | 34 |
| ASE 4421 | Mechanics of Materials | Theory | 3.00 | 3.00 | 4 | 35 |
| ASE 4422 | Mechanics of Materials Sessional | Sessional | 3.00 | 1.50 | 4 | 36 |
| ASE 4455 | Aerospace Materials | Theory | 3.00 | 3.00 | 4 | 37 |
| ASE 4456 | Aerospace Materials Sessional | Sessional | 1.50 | 0.75 | 4 | 38 |
| ASE 4513 | Aerodynamics | Theory | 3.00 | 3.00 | 5 | 39 |
| ASE 4514 | Aerodynamics Sessional | Sessional | 3.00 | 1.50 | 5 | 41 |
| ASE 4557 | Aerospace Vehicle Dynamics and Control | Theory | 3.00 | 3.00 | 5 | 42 |
| ASE 4531 | Aerospace Structural System Analysis | Theory | 3.00 | 3.00 | 5 | 43 |
| ASE 4532 | Aerospace Structural System Analysis Sessional | Sessional | 3.00 | 1.50 | 5 | 44 |

| Course Code | Course Name | Type of Course | Contact hours | Credit Hours | Semester | Page No |
|---|---|---|---|---|---|---|
| ASE 4543 | Heat Transfer | Theory | 3.00 | 3.00 | 5 | 44 |
| ASE 4544 | Heat Transfer Sessional | Sessional | 3.00 | 1.50 | 5 | 45 |
| ASE 4561 | Orbital Mechanics | Theory | 3.00 | 3.00 | 5 | 46 |
| ASE 4629 | Machine Design | Theory | 3.00 | 3.00 | 6 | 47 |
| ASE 4630 | Machine Design Sessional | Sessional | 1.50 | 0.75 | 6 | 48 |
| ASE 4633 | Structural Vibration and Aeroelasticity | Theory | 3.00 | 3.00 | 6 | 49 |
| ASE 4645 | Aerospace Propulsion | Theory | 4.00 | 4.00 | 6 | 50 |
| ASE 4646 | Aerospace Propulsion Sessional | Sessional | 3.00 | 1.50 | 6 | 51 |
| ASE 4659 | Aerospace Vehicle Performance | Theory | 3.00 | 3.00 | 6 | 52 |
| ASE 4715 | Computational Fluid Dynamics (CFD) | Theory | 3.00 | 3.00 | 7 | 53 |
| ASE 4773 | Aircraft Design | Theory | 3.00 | 3.00 | 7 | 54 |
| ASE 4774 | Aircraft Design Sessional | Sessional | 3.00 | 1.50 | 7 | 55 |
| ASE 4615 | High Speed Aerodynamics | Theory | 3.00 | 3.00 | 8 | 56 |
| ASE 4807 | Industrial and Business Management | Theory | 3.00 | 3.00 | 8 | 57 |
| ASE 4875 | Space System and Launch Vehicle Design | Theory | 3.00 | 3.00 | 8 | 59 |
| ASE 4876 | Space System and Launch Vehicle Design Sessional | Sessional | 3.00 | 1.50 | 8 | 60 |
| ASE 4600 | Industrial Training | Training | 4 weeks | 1.00 | 6 | 60 |
| ASE 4700 | Final Year Design Project (FYDP) and Thesis | Sessional | 9.00 + 9.00 | 4.50 + 4.50 | 7 & 8 | 61 |

### 2.2.2 List of Humanities and Social Sciences (HASS) Courses for Aerospace Major

A total of 5 courses from HASS are included in the programme.

| Course Code | Course Name | Type of Course | Contact hours | Credit Hours | Semester | Page No |
|---|---|---|---|---|---|---|
| HUM 4201 | Communicative English | Theory | 3.00 | 3.00 | 2 | 62 |
| HUM 4202 | Communicative English Sessional (Technical Report Writing and Sessional) | Sessional | 1.50 | 0.75 | 2 | 63 |
| HUM 4203 | Bangladesh Studies and Society | Theory | 3.00 | 3.00 | 2 | 64 |
| HUM 4611 | Engineering Ethics and Professionalism | Theory | 3.00 | 3.00 | 6 | 65 |
| HUM 4713 | Engineering Economics | Theory | 3.00 | 3.00 | 7 | 66 |

### 2.2.3 List of Basic Sciences and Mathematics Courses for Aerospace Major

A total of 4 math courses and 5 basic sciences courses including 2 sessional are included in the programme.

| Course Code | Course Name | Type of Course | Contact hours | Credit Hours | Semester | Page No |
|---|---|---|---|---|---|---|
| MAT 4101 | Differential Calculus and Integral Calculus | Theory | 3.00 | 3.00 | 1 | 67 |
| MAT 4203 | Ordinary and Partial Differential | Theory | 3.00 | 3.00 | 2 | 68 |

| Course Code | Course Name | Type of Course | Contact hours | Credit Hours | Semester | Page No |
|---|---|---|---|---|---|---|
| | Equations | | | | | |
| MAT 4305 | Linear Algebra and Coordinate Geometry | Theory | 3.00 | 3.00 | 3 | 69 |
| MAT 4407 | Complex Variables, Fourier and Laplace Transform | Theory | 3.00 | 3.00 | 4 | 70 |
| PHY 4101 | Physics-I (Waves, Oscillation, Optics and Thermal Physics) | Theory | 3.00 | 3.00 | 1 | 71 |
| PHY 4201 | Physics-II (Electricity, Magnetism, Modern Physics and Mechanics) | Theory | 3.00 | 3.00 | 2 | 72 |
| PHY 4202 | Physics Sessional | Sessional | 3.00 | 1.50 | 2 | 73 |
| CHM 4101 | Chemistry (Atomic Structure, Thermo-Chemistry, Chemistry of Engineering Materials) | Theory | 3.00 | 3.00 | 1 | 74 |
| CHM 4102 | Chemistry Sessional | Sessional | 3.00 | 1.50 | 1 | 75 |

### 2.2.4 List of Allied Engineering Courses for Aerospace Major

A total of 10 courses are included in the programme.

| Course Code | Course Name | Type of Course | Contact hours | Credit Hours | Semester | Page No |
|---|---|---|---|---|---|---|
| EEE 4191 | Electrical Circuit Analysis | Theory | 3.00 | 3.00 | 1 | 76 |
| EEE 4192 | Electrical Circuit Analysis Sessional | Sessional | 1.50 | 0.75 | 1 | 77 |
| CSE 4291 | Computer Programming and Application | Theory | 3.00 | 3.00 | 2 | 77 |
| CSE 4292 | Computer Programming and Application Sessional | Sessional | 3.00 | 1.50 | 2 | 78 |
| EEE 4391 | Electrical and Electronics Technology | Theory | 3.00 | 3.00 | 3 | 78 |
| EEE 4392 | Electrical and Electronics Technology Sessional | Sessional | 1.50 | 0.75 | 3 | 79 |
| AVE 4791 | Avionics Systems | Theory | 3.00 | 3.00 | 7 | 79 |
| AVE 4839 | Control System Engineering | Theory | 3.00 | 3.00 | 8 | 80 |
| AVE 4803 | Aircraft Instruments and Measurement Systems | Theory | 3.00 | 3.00 | 7 or 8 | 81 |
| AVE 4804 | Aircraft Instruments and Measurement Systems Sessional | Sessional | 1.50 | 0.75 | 7 or 8 | 82 |

## 2.3 Elective Courses

Students of B.Sc. in Aeronautical Engineering (Aerospace) can choose 2 elective courses covering 6 credit hours. Availability of elective courses is subject to availability of faculty and related laboratory facilities. Elective courses may be chosen from Allied Engineering courses also (if require).

### 2.3.1 List of Elective Courses from Aerospace Engineering Department

Elective courses from the department of Aerospace engineering are as follows:

| Course No | Course Name | Semester | Contact Hours | Credit Hours | Page No |
|---|---|---|---|---|---|
| ASE 4717 | Hypersonic Aerodynamics | 7 or 8 | 3.00 | 3.00 | 83 |
| ASE 4725 | Advanced Aerospace Materials Processing Technology | 7 or 8 | 3.00 | 3.00 | 84 |
| ASE 4749 | Rockets and Missiles | 7 or 8 | 3.00 | 3.00 | 85 |
| ASE 4763 | Spacecraft Attitude Determination and Control | 7 or 8 | 3.00 | 3.00 | 86 |
| ASE 4765 | Guidance, Navigation and Control | 7 or 8 | 3.00 | 3.00 | 87 |
| ASE 4767 | Rotorcraft Performance | 7 or 8 | 3.00 | 3.00 | 88 |
| ASE 4785 | Maintenance Management and Repair of Aircraft | 7 or 8 | 3.00 | 3.00 | 89 |
| ASE 4787 | Aircraft Pressurization System | 7 or 8 | 3.00 | 3.00 | 90 |
| ASE 4789 | Aircraft Structural Design | 7 or 8 | 3.00 | 3.00 | 91 |
| ASE 4745 | Feedback Control System | 7 or 8 | 3.00 | 3.00 | 93 |
| ASE 4746 | Feedback Control System Sessional | 7 or 8 | 1.50 | 0.75 | 94 |
| ASE 4771 | Aerospace Systems Engineering | 7 or 8 | 3.00 | 3.00 | 94 |
| ASE 4751 | Aircraft Aerospace Systems | 7 or 8 | 3.00 | 3.00 | 95 |

### 2.3.2 List of Elective Courses from Mechanical Engineering Department

Elective courses from the department of Mechanical engineering are as follows:

| Course No | Course Name | Semester | Contact Hours | Credit Hours | Page No |
|---|---|---|---|---|---|
| MCE 4743 | Advanced Programming with MATLAB | 7 or 8 | 3.00 | 3.00 | 97 |
| MCE 4761 | Finite Element Analysis of Solids and Fluids | 7 or 8 | 3.00 | 3.00 | 97 |
| MCE 4763 | Fundamentals of Nanoengineering | 7 or 8 | 3.00 | 3.00 | 98 |
| MCE 4765 | Introduction to Robotics | 7 or 8 | 3.00 | 3.00 | 98 |
| MCE 4767 | Mechatronics | 7 or 8 | 3.00 | 3.00 | 98 |
| MCE 4769 | Product Design | 7 or 8 | 3.00 | 3.00 | 99 |
| MCE 4771 | Renewable Energy | 7 or 8 | 3.00 | 3.00 | 99 |
| MCE 4773 | Combustion and Pollution | 7 or 8 | 3.00 | 3.00 | 100 |
| MCE 4775 | Energy and Environment | 7 or 8 | 3.00 | 3.00 | 101 |

## 2.4 Final Year Design Project (FYDP) and Undergraduate Research

Final Year Design Project (FYDP) and undergraduate research will have to be undertaken by students under a supervisor in partial fulfilment of the requirement of his degree. Credit hours allotted to the Final Year Design Project (FYDP) and undergraduate research will be 9 having 18 contact hours.

## CHAPTER 3

# 3 DETAILED COURSE PLAN OF AERONAUTICAL ENGINEERING (AEROSPACE)

## 3.1 Introduction

The detailed course plan for Bachelor of Science in Aeronautical Engineering (Aerospace) is presented in this chapter. The programme includes 40 theory courses, 23 sessional courses {including industrial training, Final Year Design Project (FYDP) and Thesis} covering 121 and 37 credit hours for theory and sessional respectively. Total credit hours for the programme is 158 in 8 semesters.

## 3.2 Term Wise Distribution of Courses for B.Sc. in Aeronautical Engineering (Aerospace) Degree

Undergraduate students of the Department of Aerospace Engineering (ASE) must undertake the following course schedule. The term-wise distribution of which is given below:

### 3.2.1 Semester 1

| Course No | Course Name | Type of Course | Contact hours | Credit Hours | Page No |
|---|---|---|---|---|---|
| ASE 4101 | Introduction to Aeronautical Engineering | Theory | 3.00 | 3.00 | 23 |
| MAT 4101 | Differential Calculus and Integral Calculus | Theory | 3.00 | 3.00 | 67 |
| PHY 4101 | Physics-I (Waves, Oscillation, Optics and Thermal Physics) | Theory | 3.00 | 3.00 | 71 |
| CHM 4101 | Chemistry (Atomic Structure, Thermo-Chemistry, Chemistry of Engineering Materials) | Theory | 3.00 | 3.00 | 74 |
| EEE 4191 | Electrical Circuit Analysis | Theory | 3.00 | 3.00 | 76 |
| | | | **15.00** | **15.00** | |
| ASE 4102 | Aeronautical Engineering Drawing-I | Sessional | 3.00 | 1.50 | 24 |
| CHM 4102 | Chemistry Sessional | Sessional | 3.00 | 1.50 | 75 |
| EEE 4192 | Electrical Circuit Analysis Sessional | Sessional | 3.00 | 1.50 | 77 |
| | | | **9.00** | **4.50** | |
| **Total** | | | **24** | **19.5** | |

### 3.2.2 Semester 2

| Course No | Course Name | Type of Course | Contact hours | Credit Hours | Page No |
|---|---|---|---|---|---|
| HUM 4201 | Communicative English | Theory | 3.00 | 3.00 | 62 |
| HUM 4203 | Bangladesh Studies and Society | Theory | 3.00 | 3.00 | 64 |
| MAT 4203 | Ordinary and Partial Differential Equations | Theory | 3.00 | 3.00 | 68 |
| PHY 4203 | Physics II (Electricity, Magnetism, Modern Physics and Mechanics) | Theory | 3.00 | 3.00 | 72 |
| CSE 4291 | Computer Programming and Application | Theory | 3.00 | 3.00 | 77 |
| | | | **15.00** | **15** | |
| ASE 4202 | Workshop Technology Sessional | Sessional | 3.00 | 1.50 | 25 |
| HUM 4202 | Communicative English Sessional (Technical Report Writing and Sessional) | Sessional | 1.50 | 0.75 | 63 |
| PHY 4204 | Physics Sessional | Sessional | 3.00 | 1.50 | 73 |

| Course No | Course Name | Type of Course | Contact hours | Credit Hours | Page No |
|---|---|---|---|---|---|
| CSE 4292 | Computer Programming and Application Sessional | Sessional | 3.00 | 1.50 | 78 |
| | | | **10.50** | **5.25** | |
| **Total** | | | **25.50** | **20.25** | |

### 3.2.3 Semester 3

| Course No | Course Name | Type of course | Contact hours | Credit hours | Page No |
|---|---|---|---|---|---|
| ASE 4341 | Thermodynamics | Theory | 3.00 | 3.00 | 26 |
| ASE 4351 | Statics | Theory | 3.00 | 3.00 | 28 |
| ASE 4353 | Dynamics | Theory | 3.00 | 3.00 | 30 |
| MAT 4305 | Linear Algebra and Coordinate Geometry | Theory | 3.00 | 3.00 | 69 |
| EEE 4391 | Electrical and Electronics Technology | Theory | 3.00 | 3.00 | 78 |
| | | | **15.00** | **15** | |
| ASE 4342 | Thermodynamics Sessional | Sessional | 1.50 | 0.75 | 27 |
| ASE 4304 | Aeronautical Engineering Drawing II | Sessional | 3.00 | 1.50 | 30 |
| EEE 4392 | Electrical and Electronics Technology Sessional | Sessional | 1.50 | 0.75 | 79 |
| | | | **6.00** | **3.00** | |
| **Total** | | | **21.00** | **18.00** | |

### 3.2.4 Semester 4

| Course No | Course Name | Type of course | Contact hours | Credit hours | Page No |
|---|---|---|---|---|---|
| ASE 4405 | Numerical Methods in Engineering | Theory | 3.00 | 3.00 | 31 |
| ASE 4411 | Fundamentals of Fluid Mechanics | Theory | 3.00 | 3.00 | 33 |
| ASE 4421 | Mechanics of Materials | Theory | 3.00 | 3.00 | 35 |
| ASE 4455 | Aerospace Materials | Theory | 3.00 | 3.00 | 37 |
| MAT 4407 | Complex Variables, Fourier and Laplace Transform | Theory | 3.00 | 3.00 | 70 |
| | | | **15.00** | **15.00** | |
| ASE 4406 | Numerical Methods in Engineering Sessional | Sessional | 3.00 | 1.50 | 32 |
| ASE 4412 | Fundamentals of Fluid Mechanics Sessional | Sessional | 1.50 | 0.75 | 34 |
| ASE 4422 | Mechanics of Materials Sessional | Sessional | 3.00 | 1.50 | 36 |
| ASE 4456 | Aerospace Materials Sessional | Sessional | 1.50 | 0.75 | 38 |
| | | | **9.00** | **4.50** | |
| Total | | | **24.00** | **19.50** | |

### 3.2.5 Semester 5

| Course No | Course Name | Type of course | Contact hours | Credit hours | Page No |
|---|---|---|---|---|---|
| ASE 4513 | Aerodynamics | Theory | 3.00 | 3.00 | 39 |
| ASE 4557 | Aerospace Vehicle Dynamics and Control | Theory | 3.00 | 3.00 | 42 |
| ASE 4531 | Aerospace Structural System Analysis | Theory | 3.00 | 3.00 | 43 |
| ASE 4543 | Heat Transfer | Theory | 3.00 | 3.00 | 44 |
| ASE 4561 | Orbital Mechanics | Theory | 3.00 | 3.00 | 46 |
| | | | **15.00** | **15.00** | |

| Course No | Course Name | Type of course | Contact hours | Credit hours | Page No |
|---|---|---|---|---|---|
| ASE 4514 | Aerodynamics Sessional | Sessional | 3.00 | 1.50 | 41 |
| ASE 4532 | Aerospace Structural System Analysis Sessional | Sessional | 3.00 | 1.50 | 44 |
| ASE 4544 | Heat Transfer Sessional | Sessional | 3.00 | 1.50 | 45 |
| | | | **9.00** | **4.50** | |
| Total | | | **24.00** | **19.50** | |

### 3.2.6 Semester 6

| Course No | Course Name | Type of course | Contact hours | Credit hours | Page No |
|---|---|---|---|---|---|
| ASE 4629 | Machine Design | Theory | 3.00 | 3.00 | 47 |
| ASE 4633 | Structural Vibration and Aeroelasticity | Theory | 3.00 | 3.00 | 49 |
| ASE 4645 | Aerospace Propulsion | Theory | 4.00 | 4.00 | 50 |
| ASE 4659 | Aerospace Vehicle Performance | Theory | 3.00 | 3.00 | 52 |
| HUM 4611 | Engineering Ethics and Professionalism | Theory | 3.00 | 3.00 | 65 |
| | | | **16.00** | **16.00** | |
| ASE 4630 | Machine Design Sessional | Sessional | 1.50 | 0.75 | 48 |
| ASE 4646 | Aerospace Propulsion Sessional | Sessional | 3.00 | 1.50 | 51 |
| | | | **4.50** | **2.25** | |
| ASE 4600 | Industrial Training* | Training | 4 weeks | 1.00 | 60 |
| | | | | **3.25** | |
| Total | | | **20.50** | **19.25** | |

**Note:**

1. ASE 4600 will be conducted after the completion of semester 6, at any convenient time as can be arranged by the Department.

### 3.2.7 Semester 7

| Course No | Course Name | Type of course | Contact hours | Credit hours | Page No |
|---|---|---|---|---|---|
| ASE 4715 | Computational Fluid Dynamics | Theory | 3.00 | 3.00 | 53 |
| ASE 4773 | Aircraft Design | Theory | 3.00 | 3.00 | 54 |
| HUM 4713 | Engineering Economics | Theory | 3.00 | 3.00 | 66 |
| AVE 4791 | Avionics Systems | Theory | 3.00 | 3.00 | 79 |
| Optional I | Selected from prescribed optional subjects | Theory | 3.00 | 3.00 | 81-101 |
| | | | **15.00** | **15.00** | |
| ASE 4774 | Aircraft Design Sessional | Sessional | 3.00 | 1.50 | 55 |
| ASE 4700 | Final Year Design Project (FYDP) and Thesis | Sessional | 6.00+3.00 | 3.00+1.50 | 61 |
| | | | **12.00** | **6.00** | |
| **Total** | | | **27.00** | **21.00** | |

### 3.2.8 Semester 8

| Course No | Course Name | Type of course | Contact hours | Credit hours | Page No |
|---|---|---|---|---|---|
| ASE 4815 | High Speed Aerodynamics | Theory | 3.00 | 3.00 | 56 |
| ASE 4807 | Industrial and Business Management | Theory | 3.00 | 3.00 | 57 |
| ASE 4875 | Space System and Launch Vehicle Design | Theory | 3.00 | 3.00 | 59 |
| AVE 4839 | Control System Engineering | Theory | 3.00 | 3.00 | 80 |
| Optional II | Selected from prescribed optional subjects | Theory | 3.00 | 3.00 | 81-101 |
| | | | **15.00** | **15.00** | |
| ASE 4876 | Space System and Launch Vehicle Design Sessional | Sessional | 3.00 | 1.50 | 60 |
| ASE 4700 | Final Year Design Project (FYDP) and Thesis | Sessional | 3.00+6.00 | 1.50+3.00 | 61 |
| | | | **12.00** | **6.00** | |
| **Total** | | | **27.00** | **21.00** | |

## 3.3 Summary of Departmental, Non-departmental, Basic Science and Humanities Courses for Aerospace Major

| Semester | Hours/Week | | Total Cont. Hours | Credits | | Total Credits | No of Courses | |
|---|---|---|---|---|---|---|---|---|
| | Theory | Sessional | | Theory | Sessional | | Theory | Sessional |
| Semester 1 | 15.00 | 9.00 | 24.00 | 15.00 | 4.50 | 19.50 | 5 | 3 |
| Semester 2 | 15.00 | 10.50 | 25.50 | 15.00 | 5.25 | 20.25 | 5 | 4 |
| Semester 3 | 15.00 | 6.00 | 21.00 | 15.00 | 3.00 | 18.00 | 5 | 3 |
| Semester 4 | 15.00 | 9.00 | 24.00 | 15.00 | 4.50 | 19.50 | 5 | 4 |
| Semester 5 | 15.00 | 9.00 | 24.00 | 15.00 | 4.50 | 19.50 | 5 | 3 |
| Semester 6 | 16.00 | 4.50 | 20.50 | 16.00 | 3.25 | 19.25 | 5 | 3 |
| Semester 7 | 15.00 | 12.00 | 27.00 | 15.00 | 6.00 | 21.00 | 5 | 3 |
| Semester 8 | 15.00 | 12.00 | 27.00 | 15.00 | 6.00 | 21.00 | 5 | 2 |
| **Grand Total** | **121.00** | **72.00** | **193.00** | **121.00** | **37.00** | **158.00** | **40** | **25** |

## 3.4 Distribution of Credit Hours for Different Categories of Courses for Aerospace Major

| Semester | Humanities | | Math | | Basic | | Dept | | Allied | | Optional | | Total Credit / Semester |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Theory | Sessional | Theory | Sessional | Theory | Sessional | Theory | Sessional | Theory | Sessional | Theory | Sessional | |
| Semester 1 | - | - | 3.00 | - | 6.00 | 1.50 | 3.00 | 1.50 | 3.00 | 1.50 | - | - | 19.50 |
| Semester 2 | 6.00 | 0.75 | 3.00 | - | 3.00 | 1.50 | - | 1.50 | 3.00 | 1.50 | - | - | 20.25 |
| Semester 3 | - | - | 3.00 | - | - | - | 9.00 | 2.25 | 3.00 | 0.75 | - | - | 18.00 |
| Semester 4 | - | - | 3.00 | - | - | - | 12.00 | 4.50 | - | - | - | - | 19.50 |
| Semester 5 | - | - | - | - | - | - | 15.00 | 4.50 | - | - | - | - | 19.50 |
| Semester 6 | - | - | - | - | - | - | 16.00 | 3.25 | - | - | - | - | 19.25 |
| Semester 7 | 3.00 | - | - | - | - | - | 6.00 | 6.00 | 3.00 | - | 3.00 | - | 21.00 |
| Semester 8 | - | - | - | - | - | - | 9.00 | 6.00 | 0 | - | 6.00 | - | 21.00 |
| Total | 9.00 | 0.75 | 12.00 | - | 9.00 | 3.00 | 70.00 | 29.50 | 12.00 | 3.75 | 9.00 | - | **158.00** |
| Total Credit Hour | 9.75 | | 12.00 | | 12.00 | | 99.50 | | 15.75 | | 9.00 | | **158.00** |
| % of total course | 6.17% | | 7.59% | | 7.59% | | 62.97% | | 9.97% | | 5.70% | | - |

## CHAPTER 4

# 4 DESCRIPTION OF COURSES OF AERONAUTICAL ENGINEERING (AEROSPACE)

## 4.1 Core Courses for Aerospace Major

**ASE 4101: Introduction to Aeronautical Engineering**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Pre-requisite:** None.

**Rationale:**

The purpose of this course is to serve as an introduction into the basics of aircraft aerodynamic-characteristics, components, structures and avionics systems.

**Objective:**

1. To provide the knowledge about basic Aeronautical Engineering and the aerodynamic characteristics of aircraft.
2. To identify the forces acting on aircraft and learn how to analyse them.
3. To interpret the aircraft basic Structure, different aircraft component configurations.
4. To explain about the Mechanics of flight and fight performance.
5. To analyse aircraft avionics systems regarding Instrumentation, Communication and Navigation System.

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Explain basics of Aeronautical Engineering.
2. Identify the forces acting on aircraft.
3. Interpret the aircraft Structure and basic configurations.
4. Explain about Mechanics of flight.
5. Analyse aircraft Instrumentation, Communication and Navigation System.

**Course Contents:**

Introduction to Aeronautical Engineering: Classification of aircraft, Different parts of aircraft (airframe, engine, avionics systems, communication systems, instrumentation and navigation systems) and their function.

Introduction to Aerodynamics: Standard atmosphere, Dimensional analysis, Bernoulli's theorem for incompressible flows and its applications in aeronautical engineering. Local and free stream characteristics.

Aerofoil Classification and Characteristics: Pressure distribution over aerofoil and its variation with angle of attack. Centre of pressure and its movement, Forces and moments acting on aerofoil, centre of gravity, centre of pressure and aerodynamic centre concepts. Characteristics of Lift drag and pitching moment curves. Stall and its effects.

Flight Mechanics: Aircraft manoeuvres- Take off, climb, cruise, glide, descend and landing. Aircraft performance parameters such as endurance, aircraft ceiling and range. Aircraft control surfaces and High lift devices.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Text and Ref Books:**


1. Airframe and Power Plant – C A Zweng; Galotia Publications.
2. Spacecraft Systems Engineering –Peter Fortescue and John Stark; John Wiley and Sons.
3. Introduction to Flight -John D Anderson Jr; Tata McGraw-Hill.
4. Introduction to Aerospace structural Analysis –David H Allen, Publisher; Wiley and Sons.
5. Avionics Navigation Systems, 2nd Ed – Myron Kayton
6. Aerodynamics – L J Clancy
7. Flight without Formulae – Kermode
8. Fundamentals of Aerodynamics- John D. Anderson; McGraw-Hill
9. Principles of Avionics – 6th Ed.– Albert Helfrick.


**ASE 4102: Aeronautical Engineering Drawing-I**
3.00 Contact Hour; 1.50 Credit Hour;

**Pre-requisite:** None

**Rationale:**

It will be useful for designing and drawing accurate schematics for simple blocks, orthographic and isometric representations, dimensioning, etc., which will be helpful during project, work in later semesters, as well as professionally.

**Objective:**

1. To introduce the principles and perspectives of geometric drawing that includes the standardization, drafting, dimensions etc.
2. To introduce the technique of engineering graphics as a basis of engineering communication and expression of idea and thought
3. To use proper and standard technique in lettering, basic geometric constructions, sketching, dimensioning methods to describe size, shape and position accurately on an engineering drawing.
4. To create orthographic projection auxiliary, sectional views, and apply 3Dpictorials to choose the best view to present the drawings.
5. To produce final drawings during the design process including assembly, machine and working drawings.

**Course Outcomes (CO):**

Upon completion of all sessional, the students will be able to:

1. Demonstrate use of appropriate standards and conventions in drawing sheet preparation and layout
2. Apply the correct methods of referencing relevant specifications in the interpretation of aeronautical engineering drawings.
3. Apply the correct conventions and techniques in drawing sectional, auxiliary views.

4. Develop isometric and oblique pictorial form from third angle orthogonal drawings

**Course Contents:**

Class 1: Introduction, Familiarization with drawing tools and types of projections.
Class 2: Drawing orthographic views of simple blocks
Class 3: Drawing orthographic views of objects with round features.
Class 4: Drawing orthographic views of objects with fillets, rounds.
Class 5: Class test on orthographic views.
Class 6: Drawing sectional views.
Class 7: Class test on sectional views.
Class 8: Drawing auxiliary views.
Class 9: Drawing oblique views.
Class 10: Class test on auxiliary and oblique views.
Class 11: Drawing isometric views of simple blocks
Class 12: Drawing orthographic views of objects with round features, fillets and rounds.
Class 13: Class test on isometric views
Class 14: Final Quiz.

**Teaching-learning and Assessment Strategy:**

Class Assessment, Class Participation/ Observation, Class Attendance, Lab Exam, Quiz, Viva

**ASE 4202 Workshop Technology Sessional**
*3.00 Contact Hour; 1.50 Credit Hour;*

**Rationale:**

To provide instructions and practical experience in basic mechanical workshop methods, manufacturing process, tools and machines.

**Course Objective:**

1. To introduce to the basic operations of bench fitting tools.
2. To familiarize with the various types of manual machines and introduce them to different operation of machining.
3. To learn about different types of moulding.
4. To know about various types of Welding and introduce them to different type of welding joints.
5. To provide knowledge on different tools of wood shop and make them familiar with different type of wood joints.

**Course Outcomes (CO):**

1. Identify how to work in workshop environments.
2. Organize practical work in the engineering workshop in various environments.
3. Demonstrate practical knowledge to produce engineering works like- foundry, carpentry, welding etc.

**Course Content:**

Foundry: Introduction to foundry, tools and equipment; Patterns: function, pattern making; Moulding: moulding materials sand preparation, types of mould, procedure; Cores: types, core making materials; Metal melting and casting; Inspection of casting and casting defects. Welding: Metal joints, riveting, grooving, soldering, welding; Welding practice: electric arc steel, aluminium; Types of electrode; Welding defects: visual, destructive and non-destructive tests of welding. Gas welding and equipment; Types of flame; Welding of different types of material; Gas welding defects; Test of gas welding. Carpentry: Wood working tools, Wood working machine, Band Saw, Scroll Saw, Circular Saw, Jointer, Thickness Planner, Disc Sander, Wood Lathe, Types of Sawing, Common Cuts I Wood Works, Types of Joint, Defects of Timber, Natural Defects and Artificial Defects, Seasoning, Preservation, Substitute of Timber, Commercial Forms of Timber, Characteristics of Good Timber, Use of Fastening, Shop Practice, Practical Job, Planning and Estimating of a given Job. Machine: Kinds of tools, Common bench and hand tools, Marking and layout tools, measuring tools, cutting tools, Bench work with job, Drilling, Sharper, Lathe and Milling Machines: Introduction, Type, size and capacity, uses and applications.

**Teaching-learning and Assessment Strategy:**

Lab performances, Lab Report/Assignment/Presentation, Lab Test/ Quiz.

**Reading Material:**


1. Building Materials- Gurcharan Singh, Standard Publishes-Distributors-Del (2008).
2. Engineering Materials- M. A. Aziz.
3. Machine Shop Practice- James Anderson, W. A. Chapman.
4. Shop Theory (6th ed)- Anderson and Tatro, McGraw-Hill Education (1976).


**ASE 4341: Thermodynamics**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Pre-requisite:** Physics I (Waves and Oscillation, Optics and Thermal Physics)

**Rationale:**

To introduce the fundamental concepts of energy, work and heat, as well as to provide understanding on the thermodynamic concepts, first and second thermodynamic laws.

**Course Objective:**

1. To define and explain the basic concepts including the First Law of Thermodynamic and to derive the corollaries of the First Law.
2. To solve problems for each thermodynamic process using steam or air.
3. To explain the Second Law of Thermodynamics and its corollaries, entropy and explain thermodynamic processes based on T-s diagram.
4. To determine the performance of various steam and air thermodynamics cycle.
5. Equations of state for ideal gases, Properties of gases and vapours; Properties of atmospheric air; Non- flow and flow processes.

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to

1. Develop the basic concepts of Thermodynamics.
2. Describe Thermodynamics Laws.
3. Apply basic of thermodynamics to thermal equipment.

**Course Contents:**

**Fundamental concepts and first law**: Concept of continuum, macroscopic approach, thermodynamic systems; closed, open and isolated. Property, state, path and process, quasi-static process, work, modes of work, Zeroth law of thermodynamics- concept of temperature and heat, internal energy, specific heat capacities, enthalpy - concept of ideal and real gases. First law of thermodynamics - applications to closed and open systems - steady flow processes.

**Second law and entropy**: Second law of thermodynamics; kelvin Planck and Clausius statements of second law. Reversibility and irreversibility - Carnot theorem, Carnot cycle using steam, reversed Carnot cycle, efficiency, COP - thermodynamic temperature scale - Clausius inequality, concept of entropy, entropy of ideal gas, principle of increase of entropy.

**Thermodynamic availability**: Basics; energy in non- flow processes: expressions for the energy of a closed system – equivalence between mechanical energy forms and energy – flow of energy associated with heat flow – exergy, consumption and entropy generation - exergy in steady flow processes: expressions for exergy in steady flow processes – exergy dissipation and entropy generation.

**Properties of pure substance**: Properties of pure substances; thermodynamic properties of pure substances in solid, liquid and vapor phases, Use of property tables, phase rule, PVT surfaces, standard Rankine cycle.

**Air standard and Refrigeration cycles**: Equations of state for ideal gases, Properties of gases and vapours; Properties of atmospheric air; Non-flow and flow processes; air standard cycles; Brayton, Otto and Diesel cycles. Refrigeration cycles; phase change of working substance. Thermodynamic

relations and equations of state; Mass and energy balance for a combustion reaction; Mixtures of gases and vapours; Fuels and combustion.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, class tests, assignments, final exam.

**Textbook:**

1. Thermodynamics, Yunus A. Cengel, Michael A. Boles
2. Fundamentals of Thermodynamics, R E Sonntag, C. Borgnakke, G J. Van Wylen; John Wiley & Sons, Inc, 5th edition, 2000.

**ASE 4342: Thermodynamics Sessional**
*1.50 Contact Hour; 0.75 Credit Hour;*

**Pre-requisite:** Thermodynamics

**Rationale**

To describe the concepts of heat, work, and energy and correctly use thermodynamic terminology.

**Objective:**

1. To determine the identity of an unknown metal.
2. To prove the whether the laws of thermodynamics hold when determining this identity.
3. To calculate the approximate specific heat of unknown metal.
4. To evaluate the relationship between the heat that is transferred and change in temperature.

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Describe and correctly use thermodynamic terminology.
2. Define the concepts of heat, work, and energy.
3. Explain fundamental thermodynamic properties.
4. Analyse basic thermodynamic cycles.

**Course Contents:**

These are the experiments name:

1. Determination of Flash Point of Liquid Fluid
2. Study of Sling Psychrometer
3. Viscosity Test of Liquid Substance.
4. Determination of Carbon Residue of a given fuel.
5. Proximate Analysis of Coal
6. Study of Different Speed Measuring Devices
7. Study of a Refrigeration and Air Conditioning Unit.
8. Study and Calibration of pressure gauge by Dead Weight Tester.
9. Determination of the Calorific value of Fuel.
10. Determination of Calorific value of Gaseous by Gas Calorimeter.
11. Concept of pressure and pressure sensor behaviour.

**Teaching-learning and Assessment Strategy:**

Class Assessment, Class Participation/ Observation, Class Attendance, Lab Exam, Quiz, Viva

**Text and Ref Books:**

1. Thermodynamics, Yunus A. Cengel, Michael A. Boles
2. Fundamentals of Thermodynamics, R E Sonntag, C. Borgnakke, G J. Van Wylen; John Wiley & Sons, Inc, 5th edition, 2000.
3. Thermodynamics, Kenneth Wark, 6th Ed; McGraw-Hill, Singapore, 1999.

**ASE 4351: Statics**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Pre-requisite:** None.

**Rationale:**

To provide the students with the basic knowledge in the mechanics of rigid body which will be helpful while studying strength of materials, aircraft structures etc.

**Course Objective:**

1. To be able to express and resolve the position and force into vector unit components.
2. To determine the forces in the members of trusses and frames using the method of joints and sections.
3. To draw and describe the free-body diagram and to solve the problems using the equations of equilibrium.
4. To determine to the location of centre of gravity and centric for a system and to determine the moment of inertia for an area.
5. To apply Newton's laws of motion and conservation principles to solve real life.
6. To understand the principles and methods used in analysing motion of a particle.

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Students will understand the basic principles underlying the equilibrium of rigid bodies in planar and 3D spaces. Students will demonstrate an ability to apply fundamental rigid-body mechanics concepts to set up and solve engineering mechanics problems such as equilibrium and force-balance problems for single and assemblies of rigid bodies.

2. Students will learn to identify, formulate, and solve engineering problems in rigid-body statics.
    a. Students will demonstrate the ability to isolate rigid bodies and to draw clear and appropriate free body diagrams.
    b. Students will demonstrate an ability to apply skills in mathematics and physics to solve engineering mechanics problems.
    c. Students will demonstrate an ability to identify appropriate supports and static knowns and unknowns, in both 2D and 3D structures.

**Course Contents:**

Force and particle equilibrium, moments and resultants; moments and couples and moments about a line, equilibrium of rigid bodies; free-body diagrams and equilibrium in 2D and 3D, centroids and distributed forces; centroids of composite parts - distributed loads, 2D structural applications; plane trusses and frames, internal forces in beams and friction.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Text and Ref Books:**


1. Vector Mechanics for Engineers: Statics and Dynamics, Ferdinand P. Beer, E Russell Jr. Johnstone; McGraw-Hill Companies, 5th edition 1988.
2. Engineering Mechanics, Timoshenko, D H Young, J V Rao
3. Engineering Mechanics, Andrew Pytel, Jaon Kiusaloas
4. Engineering Mechanics, Statics and Dynamics, Joseph F Shelley; McGraw-Hill, 1980.
5. James L. Meriam, L.G. Kraige, and J.N. Bolton, Engineering Mechanics: Statics, 8th Edition, Wiley, 2014.

**ASE 4453: Dynamics**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Prerequisit**e: Statics

**Rationale:**

To make the students to understand the basic physical principles involved in the field of engineering.

**Objective:**

1. To familiarize the concept of equilibrium of particles and rigid bodies.
2. To familiarize the concept of finding centroid of planar figures and moment of inertia about different axes.
3. To familiarize with the dynamics of particles.
4. To familiarize with the dynamics of rigid bodies.
5. To apply the concepts of mechanics to solve problems related to space mechanics

**Course Outcome (CO):**

Upon completion of the course, the students will be able to:

a. Explain basic kinematics concepts – displacement, velocity and acceleration (and their angular counterparts).
b. Demonstrate use of basic dynamics concepts- Work-Energy principle, Impulse-Momentum principle to solve dynamics problems
c. Evaluate equilibrium of particles and bodies in real world problems.

**Course Contents:**

Fundamental principles of dynamics including kinematics and kinetics of particles, kinematics and kinetics of rigid bodies, mass moments of inertia, three-dimensional dynamics of rigid bodies, and simple harmonic motion.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Text and Ref Books:**

1. Vector Mechanics for Engineers: Statics and Dynamics, Ferdinand P. Beer, E Russell Jr. Johnstone; McGraw-Hill Companies, 5th edition 1988.
2. Engineering Mechanics, Timoshenko, D H Young, J V Rao
3. Engineering Mechanics, Andrew Pytel, JaonKiusaloas
4. Engineering Mechanics, Statics and Dynamics, Joseph F Shelley; McGraw-Hill, 1980.
5. James L. Meriam, L.G. Kraige, and J.N. Bolton, Engineering Mechanics: Dynamics, 8th Edition, Wiley, 2014

**ASE 4304: Aeronautical Engineering Drawing-II**
*3.00 Contact Hour; 1.50 Credit Hour;*

**Pre-requisite:** Aeronautical Engineering Drawing I Sessional

**Rationale:**

To introduce the technique of engineering graphics as a basis of engineering communication and expression of idea and thought.

**Objective:**

1. To create orthographic projection auxiliary, sectional views, and apply 3Dpictorials to choose the best view to present the drawings.
2. To able to use proper and standard technique in lettering, basic geometric constructions, sketching, dimensioning methods.
3. To understand various features, sketch tools and sketch relations used in Solid Works.
4. To describe size, shape and position accurately on an engineering drawing.
5. To apply the knowledge for drawing various components of an RC aircraft and assemble them.

**Course outcome:**

1. Gain necessary knowledge to make part, assembly and drawing using Solid Works.
2. Understand various features, sketch tools and sketch relations used in Solid Works.
3. Create drawing of complex mechanical objects.
4. Apply the knowledge (point 1) to draw various components of an RC aircraft and assemble them.
5. Evaluate the performance of an aerofoil using Solid Works Simulation.

**Course Contents:**

1. Lesson 1: Using the Interface
2. Lesson 2: Design Intent, 2D Sketching and Sketch entities
3. Lesson 3: Creating aerofoil from co-ordinates.
4. Lesson 4: Drawing different shapes of 3D wings
5. Lesson 5: 3D Sketching and Reference Planes
6. Lesson 6: Assembly Basics
7. Lesson 7: Drawings Basics

**Teaching-learning and Assessment Strategy:**

Class Assessment, Class Participation/ Observation, Class Attendance, Lab Exam, Quiz, Viva

**Text and Ref Books:**

1. Introductory Circuit Analysis - R.L. Boylestad; Prentice Hall of India Private Ltd.
2. Introductory Circuits for Electrical & Computer Engineering - James. W. Nilson; Prentice Hall of India Private Ltd.

**ASE 4405: Numerical Methods in Engineering**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Pre-requisite:** Mathematics I, II, III and IV and Computer Programming and Application
**Rationale:**

Computers are playing an increasingly important role in any science and engineering curriculum. At the same time there has certainly been a dramatic increase in computer literacy among the undergraduate population during the last decade. Therefore, this course will provide the students with the basic

knowledge in the numerical methods which will be helpful for applying numerical methods and computer programming in solving aerospace engineering problems.

**Objective:**

1. To solve mathematical and engineering problems by numerical methods
2. To improve students' programming skills

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Create computer programmes using logical programming structures.
2. Apply calculus methods for root finding and optimization problems.
3. Use numerical methods to solve for roots of equations.
4. Solve one and multi-dimensional unconstrained engineering optimization problems.
5. Perform linear and nonlinear regressions with one and multi-dimensional data.
6. Perform polynomial and spline interpolations.
7. Perform numerical integration and differentiation.

**Course Contents:**

Taylor series and approximation errors, solving systems of linear and nonlinear equations, curve fitting and interpolation, numerical differentiation and integration, applications to systems of ordinary differential equations.

This course offers students an in-depth exposure to the use of numerical methods and programming to solve engineering problems. It covers the following topics: basic programming (including data structures, if-then-else statements, loops, etc.), numerical solution of equations and system of equations, optimization, curve fitting, and numerical calculus. The course content assumes only an introductory previous exposure to engineering concepts and focuses on exposing students to computational skills commonly used in later engineering courses. The course uses a broad range of examples from different subjects for the purpose of demonstration and preparation of students for future needs.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Text and Ref Books:**

1. Numerical Methods for Engineers, S.C. Chapra and R.P. Canale, 7th edition / 2014, McGraw Hill
2. Chapra, S.C., Applied Numerical Methods with MATLAB for Engineers and Scientists, 3rd Ed., McGraw-Hill, 2011. [ISBN: 9780073401102]

**ASE 4406: Numerical Methods in Engineering Sessional**
*3.00 Contact Hour; 1.50 Credit Hour;*

Sessional for ASE 4405.

**ASE 4411: Fundamentals of Fluid Mechanics**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Pre-requisite:** None.

**Rationale:**

By completing this course, the students will learn the concept of a fluid and hence to provide knowledge on the fundamentals of static and dynamic flows.

**Objective:**

1. To introduce the properties of fluid mechanics, hydrostatic pressure, fluid static forces.
2. Able to determine hydrostatic pressure, centre of pressure, forces, stability of immersed or floating bodies.
3. Able to calculate the flow field for in viscid fluid flow.
4. To apply the Bernoulli equation and continuity equation for flow measurements.
5. Able to calculate the losses in piping system and use the dimensional analysis.

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Describe the basic laws of (i) Hydrostatic forces, (ii) Buoyancy forces, (iii) Stability of floating body, (iv) Losses in pipes and Fittings etc.
2. Analyse fluid in motion using continuity, momentum and energy equation.
3. Explain the design of different types of pipe flow measuring devices and their measurement system.
4. Apply basic similitude analysis in fluid flow.

**Course Contents:**

Fundamental concept of fluid, Properties of fluid, Fluid statics; manometers, hydrostatic forces on submerged surfaces, buoyancy and stability, Fluids in rigid body motion.

Fluid kinematics, Lagrangian and Eulerian descriptions of fluid flow, Reynolds transport theorem, Continuity, Momentum, Energy and Bernoulli ‘s equations and their applications.

Dimensional analysis and similitude, dimensional homogeneity, Experimental testing and modelling.

Introduction to two dimensional incompressible flows, boundary layer, laminar and turbulent flows, losses in pipes, minor losses in pipe fittings, pressure, velocity and flow measurements.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Text and Ref Books:**

1. Mechanics of Fluids - Irving H. Shames
2. Fluid Mechanics - Frank M. White
3. Fluid Mechanics - Yunus A. Cengel& John M. Cimbala

4. Fluid Mechanics - E. John Finnemore& Joseph B. Franzini

**ASE 4412: Fundamentals of Fluid Mechanics Sessional**
*1.50 Contact Hour; 0.75 Credit Hour;*

**Pre-requisite:** Fundamentals of Fluid Mechanics

**Rationale:**

To enhance student knowledge on the basic principles of fluid mechanics and design problem solution.

**Objective**:

1. To introduce and explain fundamentals of Fluid Mechanics, which is used in the applications of Aerodynamics, Hydraulics, Marine Engineering, Gas dynamics etc.
2. To give fundamental knowledge of fluid, its properties and behaviour under various conditions of internal and external flows.
3. To develop understanding about hydrostatic law, principle of buoyancy and stability of a floating body and application of mass, momentum and energy equation in fluid flow.
4. To imbibe basic laws and equations used for analysis of static and dynamic fluids.
5. To inculcate the importance of fluid flow measurement and its applications in Industries.
6. To determine the losses in a flow system, flow through pipes, boundary layer flow and flow past immersed bodies.

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Apply some concept of fluid mechanics.
2. Analyse how to measure flow nature precisely through venture meter and orifice.
3. Analyse coefficient of velocity by coordinate method.
4. Explain about flow through mouthpiece, flow over V –notch, flow over sharp crested weir.
5. Analyse performances of different fluids subject to friction in pipe.

**Course Contents:**

Centre of pressure; proof of Bernoulli's theorem; flow through venturi meter; flow through orifice; coefficient of velocity by coordinate method; flow through mouthpiece; flow over V –notch; flow over sharp crested weir; fluid friction in pipe.

**Teaching-learning and Assessment Strategy:**

Class Assessment, Class Participation/ Observation, Class Attendance, Lab Exam, Quiz, Viva

**Text and Ref Books:**

1. Mechanics of Fluids - Irving H. Shames
2. Fluid Mechanics - Frank M. White
3. Fluid Mechanics - Yunus A. Cengel& John M. Cimbala
4. Fluid Mechanics - E. John Finnemore& Joseph B. Franzini

**ASE 4421: Mechanics of Materials**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Pre-requisite:** None

**Rationale:**

To enhance student knowledge on the basic principles of solid mechanics and design problem solution.

**Course Objective:**

1. To evaluate stress and deformation of simple deformable structural under shear, flexure and torsional loadings.
2. To analyse statically indeterminate structure.
3. To analyse deflection of beam and shaft.
4. To establish the stress transformation equations and determine the absolute maximum normal and shear stress.
5. To analyse various situations involving structural members subjected to combined stresses by application of Mohr's circle of stress.

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Explain the concepts and principles, and perform calculations, relative to the strength and stability of structures and mechanical components.
2. Evaluate the characteristics and calculate the magnitude of combined stresses in individual members and complete structures.
3. Analyse various situations involving structural members subjected to combined stresses by application of Mohr's circle of stress.
4. Evaluate stresses & strains for structural elements.
5. Evaluate the deflection at any point on a beam subjected to a combination of loads.

**Course Contents:**

Stress analysis: Stress-strain concept and their inter-relationship, axially loaded member, thermal and centrifugal stresses; Stresses in thin and thick-walled cylinders and spheres.

Beams: Forces under different loading conditions and its effect on the resisting member; Shear force and bending moment diagrams; Various types of stresses i.e., bending, torsion, shear etc. in beams; Flexure formula; Deflection analysis of beams: integration and area moment methods; Introduction to reinforced concrete beams and slabs.

Torsion formula; Angle of twist; Modulus of rupture; Helical springs; Combined stresses: principal stress, Mohr 's Circle.

Columns: Euler 's formula, intermediate column formulas, the Secant formula; Flexure formula of curved beams; Problem-based applications in aerospace, mechanical and biomedical engineering.

Introduction to experimental stress analysis techniques: Strain energy; Failure theories.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Text and Ref Books:**

1. Strength of Materials – James M. Gere & Barry Goodno.
2. Strength of Materials (4t h edition) – Andrew Pytel, Ferdinand L. Singer.
3. Strength of materials (4t h edition) -William Nash; McGraw-Hill International Editions, Schaum's Outline Series.
4. Strength of Materials – Beer and John Stone.

**ASE 4422: Mechanics of Materials Sessional**
*3.00 Contact Hour; 1.50 Credit Hour;*

**Pre-requisite**: Mechanics of Solids

**Rationale:**

Apply the concept of Mechanics of Solids to determine the internal forces and deformations in common structural members.

**Objective:**

1. To demonstrate the knowledge of stress, strain and bucking in different experiments.
2. To evaluate the mechanical properties of materials and design of the structural members.
3. To analyse performances of different materials under different loading.
4. To learn the strength, stiffness and stability design and construction requirements.

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Apply some concept of solid mechanics.
2. Analyse how to measure objects precisely and develop skill.
3. Analyse the failure patterns and failure surfaces of testing materials.
4. Explain about different testing methods and machines.
5. Analyse performances of different materials under different loading.

**Course Contents:**

Experiments cover basic concepts of mechanics, structures and materials science; Selected experiments on Kater's Pendulum, equilibrium of forces and moments, tension and torsional test of different materials and deflection of thin- walled members, bending of beams under flexural loads.

**Teaching-learning and Assessment Strategy:**

Class Assessment, Class Participation/ Observation, Class Attendance, Lab Exam, Quiz, Viva

**Text and Ref Books:**

1. Strength of Materials – James M. Gere & Barry Goodno.
2. Strength of Materials (4t h edition) – Andrew Pytel, Ferdinand L. Singer.

3. Strength of materials (4t h edition) -William Nash; McGraw-Hill International Editions, Schaum ‘s Outline Series.
4. Strength of Materials – Beer and John Stone.

**ASE 4455: Aerospace Materials**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Pre-requisite:** None

**Rationale:**

To learn the basic properties of different materials and to familiarize with the methods to produce composite materials with new properties using the basic properties.

**Objective:**

1. To learn the basic scientific facts of Physics/ Chemistry disciplines about different materials and their properties.
2. To use the knowledge of material science to provide solution to related engineering, commercial problems.
3. To be able to evaluate the different materials and their properties and to select them rightly for design and construction.
4. To understand the basic working principle of various methods involving the inspection of materials.
5. To be able to ensure the safety of components with different materials from unwanted decay/corrosion.

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Describe modern materials chemistry, materials physics and energy physics.
2. Apply core concepts in Materials Science to solve engineering problems.
3. Explain how to select materials for design and construction.
4. Analyse the methods required to inspect material components using different approaches.
5. Explain how to protect materials from unwanted/untimely decay.

**Course Contents:**

Elements of aerospace materials; Structure of solid materials, Atomic structure of materials, crystal structure, miller indices, density, packing factor, space lattices, imperfection in crystals, physical metallurgy, Phase diagram including the Fe-FeC3 equilibrium diagram, general requirements of materials for aerospace applications.

Mechanical behaviour of materials; Linear and nonlinear elastic properties, Yielding, strain hardening, fracture, Bauchinger‘s effect –Notch effect testing and flaw detection of materials and components, creep and fatigue -Comparative study of metals, ceramics plastics and composites. Introduction to destructive and non-destructive tests.

Corrosion & heat treatment of metals and alloys; Types of corrosion, effect of corrosion on mechanical properties, stress corrosion cracking, Corrosion resistant materials used for space vehicles, heat treatment of carbon steels, aluminium alloys, magnesium alloys and titanium alloys, effect of alloying treatment, heat resistance alloys, tool and die steels, magnetic alloys.

Introduction to powder metallurgy, modern ceramic materials, cermet, glass ceramic, plastics and rubber, carbon/carbon composites, fabrication processes involved in metal matrix composites, shape memory alloys, applications in aerospace vehicle design, Basic concepts of Nanoscience and Nanotechnology.

High temperature materials: Characterization; classification, production and characteristics, methods and testing, determination of mechanical and thermal properties of materials at elevated temperatures, super alloys, high temperature material applications.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Text and Ref books**:

1. Aircraft Materials and Processes- Titterton.G.; Pitman Publishing Co.
2. Introduction to Physical Metallurgy (2nd edition) -Sidney H Avner; Tata McGraw – Hill Edition.
3. Engineering Materials, Their properties and Applications- Martin, J.W.; Wykedham Publications (London) Ltd.

**ASE 4656: Aerospace Materials Sessional**
*1.50 Contact Hour; 0.75 Credit Hour;*

**Pre-requisite:** Aerospace Materials

**Rationale:**

To learn the necessary knowledge about metallurgy and phase diagram.

**Objectives:**

1. To learn the basic classification of steel based on the percentage of Carbon present in it and their properties.
2. To visualize the phase diagram of different types of steel in the microscope and analyse the different regions.
3. To be able to explain the use of materials of different properties in order to make alloys of a new property.
4. To gain knowledge about the heat treatment method used in making steel of different properties.

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Understanding different types of carbon steel.
2. Know about phase diagram of different steel.
3. Apply the knowledge about different types of material in making of alloys.
4. Evaluate different heat treatment methods.

**Course Contents:**

**Elements of Aerospace materials**; crystal structure, imperfection in crystals, physical metallurgy, Phase diagram including the Fe-FeC3 equilibrium diagram, general requirements of materials for aerospace

applications. Mechanical behaviour of materials; Linear and nonlinear elastic properties, Yielding, strain hardening, fracture, creep and fatigue -Comparative study of metals.

Introduction to destructive and non-destructive tests. Corrosion & heat treatment of metals and alloys; Types of corrosion, effect of corrosion on mechanical properties.

Heat treatment of carbon steels, aluminium alloys, magnesium alloys and titanium alloys.

**High temperature materials**: Characterization; classification, production and characteristics, methods and testing.

**The Experiments are:**

1. Study of Crystal structure of different types of iron.
2. Study of Phase diagram including the Fe-FeC3 equilibrium diagram.
3. Study of Mechanical behaviour of materials.
4. Study of destructive and non-destructive tests.
5. Heat treatment of carbon steels, aluminium alloys, magnesium alloys and titanium alloys.

**Teaching-learning and Assessment Strategy:**

Daily Evaluation, Class Participation, Class Attendance, Lab report, Final quiz

**Text and Ref Books:**


1. Aircraft Materials and Processes- Titterton.G.; Pitman Publishing Co.
2. Introduction to Physical Metallurgy (2nd edition) -Sidney H Avner; Tata McGraw – Hill Edition.
3. Engineering Materials, Their properties and Applications- Martin, J.W.; Wykedham Publications (London) Ltd.
4. Composite Materials for Aircraft Structures (2nd edition)- Allan Baker, Stuart Dutton, Donald Kelly; AIAA Education Series
5. Engineering Metallurgy (Part I & II) (6th edition) – Raymond A. Huggins; Viva Books Private Ltd.
6. Materials Science and Engineering: An Introduction – W D Callister, Jr.; John Wiley and Sons, Inc (4th edition) 1997
7. A Textbook of Nanoscience and Nanotechnology- T. Pradeep; Tata McGraw Hill.


**ASE 4513: Aerodynamics**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Pre-requisite:** Fundamentals of Aeronautical Engineering, Fundamentals of Fluid Mechanics, Mechanics of Solid

**Rationale:**

This course introduces the students with the fundamental principles of aerodynamics for understanding stability and control, aircraft performance etc.

**Objective:**

1. To understand the fundamental principles of incompressible and compressible fluid mechanics and aerodynamics.
2. To apply these principles to real systems such as pipe flows, automobiles and aircraft.

3. To explain the sources of friction, induced, wave, and pressure drag.
4. To understand aspects of flight characteristics that relates to lift, drag, thrust and power.
5. To be able to perform calculations involving lift, drag in relation to various aspects of flight and aircraft performance.

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Explain the methods of fluid flow analysis i.e. theoretical, experimental and computational.
2. Analyse the concept potential theory and its application to incompressible and inviscid flows.
3. Apply of theoretical techniques to analyse the simple viscous flows.
4. Apply the numerical methods for solution of complex flow situations.
5. Describe implications errors and stability analysis of numerical methods.

**Course Contents:**

**Inviscid flows**
Models of fluid flow, continuity and momentum equations applied to inviscid flows, drag momentum theory, concept of streamlines, stream tubes, streak line, path lines. Angular velocity, strain and vorticity, potential theory applied to Inviscid flows, elementary flows, their combination and applications. Solution of flows past bodies using Panel methods.

**Theory of 2D aerofoils**: Kutta-Joukowski theorem, Kutta condition, Kelvin circulation theorem. Classical thin aerofoil theory. Types of flow separation and inviscid flow characteristics over a 2D aerofoil. Inviscid & incompressible flow over finite wings, Prandtl's lifting line theory, lift distribution over finite wings, effect of aspect ratio; Different types of drags.

**Viscous Flows**

Qualitative aspects of viscous flows, Navier-Stokes equations, modification N-S equation for different flows, Exact solutions of N-S equations, Aerodynamic heating, Prandtl Boundary Layer theory; Boundary Layer equations and their solutions. Skin friction and skin friction drag.

Laminar flow past flat plate. Concept free shear flows viz. jet, wake and mixing streams. Flow past cylinder and spheres and their applications. Boundary layer separation and its effects. Flow control techniques. Methods to reduce different types of drag. Introduction to turbulence, concept of turbulence modelling, Prandtl mixing length theory.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam

**Text and Ref Books:**


1. Mechanics of Fluids - Irving H. Shames
2. Mechanics of Fluids - B. S. Messy
3. Fundamentals of Aerodynamics - John D Anderson; McGraw-Hill.
4. Aerodynamics for Engineering Students –E. L Houghton, P.W. Carpenter, S.H. Collicot and D.T. Valentine; Elsevier.
5. Computational Fluid Mechanics and Heat Transfer – Anderson

**ASE 4514: Aerodynamics Sessional**
*3.00 Contact Hour; 1.50 Credit Hour;*

**Pre-requisite:** Fluid Mechanics

**Rationale:**

This course introduces the students with the fundamental principles of aerodynamics for understanding stability and control, aircraft performance etc.

**Objective:**

1. To understand the fundamental principles of incompressible and compressible fluid mechanics and aerodynamics.
2. To apply these principles to real systems such as pipe flows, automobiles and aircraft.
3. To explain the sources of friction, induced, wave, and pressure drag.
4. To understand aspects of flight characteristics that relate to lift, drag, thrust and power.
5. To be able to perform calculations involving lift, drag in relation to various aspects of flight and aircraft performance.

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Conduct experiments, and then analyse and interpret results successfully.
2. Demonstrate that theoretical characteristics of low speed aerodynamics can be implemented through the wind tunnel operations and flow visualization techniques.
3. Analyse the Pressure and velocity distribution along the radius of a forced vortex and interpret the results
4. Demonstrate coefficient of drag for a right circular cylinder
5. Evaluate the performance of lift and drag characteristics of NACA-0012 aerofoil.

**Course Contents:**

Experiments include topics of theory of flight, low speed aerodynamics, wind tunnel operations and flow visualization techniques; Pressure and velocity distribution along the radius of a forced vortex, coefficient of drag for a right circular cylinder, and lift and drag characteristics of NACA-0012 aerofoil; Experiments in the open circuit subsonic wind tunnel, wind tunnel calibration, model testing and data reduction for obtaining important aerodynamic and stability parameters of an aircraft; Familiarization with the use of supersonic wind tunnel and its flow visualization system.

**Teaching-learning and Assessment Strategy:**

Class Assessment, Class Participation, Class Attendance, Lab Report, Lab Test

**Text and Ref Books:**


1. Mechanics of Fluids - Irving H. Shames
2. Mechanics of Fluids - B. S. Messy
3. Fundamentals of Aerodynamics - John D Anderson; McGraw-Hill.
4. Aerodynamics for Engineering Students –E. L Houghton, P.W. Carpenter, S.H. Collicot and D.T. Valentine; Elsevier.
5. Computational Fluid Mechanics and Heat Transfer – Anderson

**ASE 4557: Aerospace Vehicle Dynamics and Control**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Pre-requisite:** None

**Rationale:**

The main course's objective is to teach students about the stability, the trim and the control characteristics of the aircraft.

**Course Objective:**

1. To define the longitudinal static stability of the aircraft.
2. To determine the longitudinal control of the aircraft.
3. To derive the equation of motion of the aircraft.
4. To solve the longitudinal equations of motion which result in an exact description of the stability and response characteristics of the aircraft.
5. Explain the difference between, and factors affecting, static and dynamic stability

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Describe aircraft dynamic modes.
2. Analyse contribution of various aircraft components to longitudinal, directional and lateral stability.
3. Evaluate aircraft stability and appreciate relevant flight and handling qualities
4. Develop the equations of motion of an aircraft.

**Course Contents:**

Importance and significance of flight stability and control: Static Longitudinal, Directional and Lateral stability with respect to the aircraft axis systems; Effect of various wings design and secondary control surfaces; Origin of symmetric forces and moments; Static and manoeuvring longitudinal stability, equilibrium and control of rigid aircraft; Effects of various major components on Static Stability, Critical flight conditions and controls requirement.

Dynamic Stability: The Axes Systems (Inertial, Body and Stability axes) and their Transformations; Treatment of Aircraft Equations of motion / linearization; Aerodynamic load effects of wings, stabilizers, fuselages and power plants; Trailing edge aerodynamic controls; Trimmed equilibrium condition; Static margin; Effect on static stability of free and reversible controls.

Introduction to automatic flight control: Setup of the flight control system, System performance specification: - Requirements on flying and handling qualities and Parameters.

Stability augmentation systems: - Dampers-Acquiring static stability, Feedback-Acquiring static stability. Basic autopilot systems- Basic Longitudinal and Lateral autopilot systems; Navigational autopilot systems- Longitudinal and Lateral autopilot systems.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Text and Ref Books:**

1. Aircraft Performance Stability and Control, Vol-I, James D; Lang United States Air Force Academy.
2. Automatic Control of Aircraft and Missiles, Col. John H, Blakelock
3. Airplane Performance, Stability and Control, Perkins and Hage
4. Dynamics of Flight, Bernard Etkin

**ASE 4531: Aerospace Structural System Analysis**
3.00 Contact Hour; 3.00 Credit Hour;

**Pre-requisite:** Mechanics of Materials

**Rationale:**

To learn and familiarize the basics of Aircrafts Structure and its components.

**Objective:**

1. Introduction of design philosophies like damage tolerance, safe- life, fail-safe
2. Introduction of the aircraft data requirements and description of the critical air loads used in the design and analysis of aircraft structures
3. Introduction of the aero-elastic stability design constraint
4. Overview of the role and lay-out of main structural members used in aircraft structures
5. Fatigue failure consideration and its relationship with design philosophies, fatigue loads in aircraft operations and fatigue life analysis methods.

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Explain fundamental concepts in the analysis of flight structures.
2. Apply theory of elasticity in solution of engineering problems.
3. Apply energy methods in the analysis of statically indeterminate structures.
4. Evaluate stress distribution in aircraft components.
5. Create an appreciation for the design and sizing of aircraft structural configurations subjected to various load combinations.

**Course Contents:**

Fundamental equations of elasticity and their applications, stress and deformation in elemental structures/components; General equations and solution techniques; Energy methods in structural analysis: Principles of virtual work and total potential and complimentary energies.

Bending of beams with unsymmetrical cross-sections; Basic principles and theory of stressed-skin structural analysis; Determination of direct stresses and shear flows in arbitrary thin-walled beams: unsymmetrical sections, open and closed sections, tapered sections, continuous and idealized sections.

Fundamental theory of plates, including in-plane and bending loads as well as buckling and shear instabilities; Solution techniques for plate problems including Navier Stokes' solutions for rectangular plates; Energy methods for plate bending and plate buckling. Analysis of common aircraft components including fuselages, wings, skin-panels, spar, stringers, ribs, frames and longerons.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Text and Ref Books:**

1. Aircraft Structures for Engineering Students- T.H.G Megson
2. Aircraft Structure –David & Perez; McGraw-Hill.
3. Strength of Materials (4th edition), Andrew Pytel, Ferdinand L. Singer.
4. Strength of Materials, Beer and Johnston.

**ASE 4532: Aerospace Structural System Analysis Sessional**
*3.00 Contact Hour; 1.50 Credit Hour;*

Sessional for ASE 4531.

**ASE 4443: Heat Transfer**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Pre-requisite:** Thermodynamics

**Rationale:**

The course introduces heat transfer and introduces practical application in industry

**Objective:**

1. Apply principles of heat and mass transfer to basic engineering systems
2. Explain heat transfer by conduction, convection
3. Analyse and design heat exchangers
4. Analyse diffusion processes and calculate the flux in a diffusion process
5. Describe the fundamental principles of radioactive emission and absorption

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Explain heat and different heat transfer mechanisms.
2. Evaluate basic heat transfer problems occur in engineering field involving Conduction, Convection and Radiation.
3. Know different types of boiling.
4. Analyse heat exchanger capacity using LMTD and effective NTU relations

**Course Contents:**

Basic modes of heat transfer; General conduction equations; Steady state conduction in different geometrics and composite structures; Effect of variable thermal conductivity; Heat transfer from extended surfaces.

Mechanism of convective heat transfer; General methods for estimation of convective heat transfer coefficient; Heat and momentum transfer associated with laminar and turbulent flow of fluids in forced convection; Free convection from exterior surfaces of common geometrics.

Mechanism and laws of radiation heat transfer; Blackbody and grey body emission; Radioactive properties of surfaces.
Boiling and condensation; pool boiling, forced convection boiling, film condensation, dropwise condensation, condensation number

Heat exchanger: basic types, LMTD, exchanger effectiveness-NTU relations; Techniques of heat transfer augmentation; Heat exchanger devices.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Text and Ref Books:**

1. Heat Transfer, J. P. Holman
2. Heat & Mass Transfer, Yunus A. Cengel&Afshin J. Ghajar
3. Principles of Heat Transfer, F. Kreith, Mark S. Bohn
4. Heat Transfer, Binay K. Dutta
5. Heat Transfer, A basic approach by M. Necati Ozisik

**ASE 4544: Heat Transfer Sessional**
*3.00 Contact Hour; 1.50 Credit Hour*

**Pre-requisite:** Heat Transfer

**Rationale:**

The course introduces heat transfer and introduces practical application in industry

**Course Objective:**

1. Apply principles of heat and mass transfer to basic engineering systems
2. Analyse heat transfer by conduction, convection
3. Analyse and design heat exchangers
4. Analyse diffusional processes and calculate the flux in a diffusion process
5. Understand the fundamental principles of radiative emission and absorption

**Course Outcomes (CO):**

Upon completion of all sessional, the students will be able to:

1. Describe basic calculations involving heat and mass transfer as is typical for an aeronautical engineer.
2. Explain the basic heat transfer phenomena regarding convection, conduction and radiation.
3. Apply empirical correlations to analyse external and internal, forced and free convection problems.
4. Analyse heat transfer through convection and radiation by plotting graph from obtained data.

5. Evaluate the performance characteristics of different types of heat exchangers through practical observation.

**Course Contents:**

Experiment no. 1: Determination of Thermal Conductivity of A Metal By Stead y State Method.
Experiment no. 2: Determination of Thermal Contact Conductance.
Experiment no. 3: (A) Inverse Square Law for Light Radiation. (B) Lamberts Cosine Law for Light.
Experiment no. 4: Study of a Free Convection of Fin/ Flat Plate/ Pipe Bundle.
Experiment no. 5: Force Convection Heat Transfer in a Flat Plate.
Experiment no. 6: Study of Heat Exchanger.
Experiment no. 7: Study of Thermal Radiation Unit.
Experiment no. 8: Study of Heat Transfer by Radiation.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Text and Ref Books:**

1. Principles of Heat Transfer, F. Kreith, Mark S. Bohn
2. Heat Transfer, Binay K. Dutta

**ASE 4561: Orbital Mechanics**
*3.00 Contact hour; 3.00 Credit hour;*

**Prerequisite:** Mathematics, Physics

**Rationale:**

To have introductory understanding of orbits, orbital mechanics and interplanetary missions

**Objectives:**

1. Learn about fundamental laws that govern the orbital dynamics, equations for satellite dynamics, basics of different orbits
2. Learn about fundamental laws that govern the orbital dynamics, equations for satellite dynamics, basics of different orbits
3. Learn the different types of satellite orbit transfer from one orbit to an another, basics of inter-planetary trajectory

**Course Outcomes (CO):**

1. Understand basics of orbital mechanics, orbits, trajectories.
2. Understand the orbital properties in detail.
3. Understand orbital transfer and interplanetary missions

**Course Contents:**

Orbital Mechanics Fundamentals; Laws of orbital dynamics, Solar system, Earth geometry and structure of upper atmosphere, Multi-body problem, Two body problem, Equation of motion, Orbit equation, in circular, elliptical orbits, parabolic, hyperbolic orbits, Interplanetary trajectories.

Orbits in Three Dimensions: Coordinate systems, Time systems, Keplerian Orbital elements, Relations between position and time, Kepler's equation, Effects of the earth's oblateness, Types of satellite orbits, their characteristics and applications, Orbit perturbation due to third body, Orbit decay and lifetime.

Orbital Transfer and Powered Flight: Rocket equation, application to orbit transfer, velocity requirement, different propulsion systems, Propellant, Single and two Impulse transfer, Hohmann transfer, One tangent manoeuvre, Plane change manoeuvre, Bielliptic manoeuvre, Phasing manoeuvre and interplanetary missions.

**Teaching-learning and Assessment Strategy:**

Daily Evaluation, Class Participation, Class Attendance, Lab report, Final quiz

**Text and Ref Books:**


1. Orbital Mechanics for Engineering Students, Howard D. Curtis, Elsevier Butterworth-Heinemann, 2005
2. Rocket Propulsion and Space Dynamic, Cornelisse, J.W, Schoyer H F R, and Wakker K F, Pitman Publishing Co., 1979
3. Fundamentals of Astrodynamics, Bate R. R., Mueller D. D., and White J. E., Dover Publications, New York, 1972
4. Atmospheric and Space Flight Dynamics, Ashish Tewari, Birkhauser Boston, 2007
5. Rocket and Spacecraft Propulsion, Martin J L Turner, Springer Praxis Publishing Co, Chichester, UK, 2001
6. Fundamentals Astrodynamics and applications, David A Vallado, Space Technology Series, McGraw Hill, 1997
7. Orbital Mechanics, Vladimir A Chobotov, AIAA Education Series, 2002


**ASE 4629: Machine Design**

*3.00 Contact Hour; 3.00 Credit Hour;*

**Pre-requisite:** None.

**Rationale:**

To design, analysis and selection of commonly used mechanical components subject to static and dynamic loads.

**Objective:**

6. To calculate various loads as applied to shaft, and specify appropriate design stresses for shaft.
7. To specify suitable keys and couplings for shaft and other type of machine elements
8. To analyze and design spur gear, helical gear and bevel gear
9. To analyze and design of rolling element bearings
10. To analyze and design of lubrication and sliding bearings

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

6. Understand the theories relating to power screws, shaft, keys, springs, bearings, gears, brakes and clutches.
7. Apply the knowledge to design such machines like power screws, shaft, keys, springs, bearings, gears, brakes and clutches.
8. Evaluate the design requirement of various engineering machines.
9. Analyze of design parameters of various engineering machines.

**Course Contents:**

Introduction to machine design. Design of basic machine elements like power screws, shaft and hole systems, keys and couplings, rivets, springs, bearings, gears, brakes and clutches. Design with composite materials.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Text and Ref Books:**

1. A Textbook of Machine Design - R. S. Khurmi, J. K. Gupta
2. Fundamentals of Machine Component Design - Robert C Juvinall.
3. Design of Machine Elements (4th Ed) - Virgil Moring Faires
4. Mechanical Engineering Design (7th Edition) - Joseph E Shigley, Charles R Mischke & Richard G Budynas.

**ASE 4630: Machine Design Sessional**
*1.5 Contact Hour; 0.75 Credit Hour;*

**Pre-requisite:** None.

**Rationale:**

To calculate the stress and strain of the mechanical components subject to static and dynamic loads.

**Objective:**

1. To determine the dimensions of the component by analysing their stress and strain condition.
2. To calculate the bearing types, and sizing and analysis of rolling element bearings
3. To calculate the gear types, sizing, analysis and material selection of gear systems
4. To calculate the rolling element bearing types, sizing, analysis and material selection of gear systems

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. To design, analysis and sizing of shafts
2. To analyze the bearing types, and sizing and analysis of rolling element bearings
3. To calculate the gear types, sizing, analysis and material selection of gear systems
4. To determine the selection, sizing, design, and analysis of other mechanical components/systems

**Course Contents:**

Introduction to machine design based on 4629. Design of basic machine elements like power screws, shaft and hole systems, keys and couplings, rivets, springs, bearings, gears, brakes and clutches. Design with composite materials.

**Teaching-learning and Assessment Strategy:**

Lectures, assignments, final quiz.

**Text and Ref Books:**

1. Mechanical Engineering Design by J.E. Shigley
2. Analysis and Design of Machine Elements by V.K. Jadon
3. Machine Design by R.S. Khurmi

**ASE 4633: Structural Vibration and Aeroelasticity**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Pre-requisite:** Statics, Dynamics

**Rationale:**

To provide with the knowledge of relative motion between the various parts of a machine, forces which act on them and analysis of vibration. The knowledge of this subject is very essential for an engineer in designing the various parts of a machine.

**Course Objective:**

1. To introduce the approaches and mathematical models used in kinematic and dynamic analysis of machinery.
2. To understand techniques for studying motion of machines and their components.
3. To give basic knowledge on kinematic and dynamic design of machinery.
4. To give basic knowledge on different types mechanical vibrations.
5. To be able to construct turning moment diagram.
6. To be able to calculate balancing mass and its position.

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Apply graphical and analytical methods to study the motion of a planar mechanism.
2. Analyse simple mechanisms and gear trains.
3. Evaluate natural frequency and period of simple vibrating mechanical systems and obtain the analytical solution for system's time response.
4. Develop mathematical model of dynamic systems with single and multi-degrees of freedom.
5. Explain the concepts of vibration isolation and rotating imbalance.

**Course Contents:**

Mechanisms; Displacement, velocity and acceleration; Turning moment: inertia and kinetic energy of reciprocating and rotating parts; Study of gears and gears trains; Static and dynamic balancing: reciprocating and rotating parts, multi-cylinder in- line and radial engines, V engines and opposed-piston engines; Balancing machines; Principles and applications to orbital and gyroscopic motion.

Free vibrations with one and two degrees of freedom; Longitudinal, transverse and torsional vibrations; Damped free and forced vibrations with single degrees of freedom; Whirling of shafts and rotors; Vibration

absorption and isolation; Vibration measuring instruments; Methods of determining natural frequencies: matrix methods; Continuous systems: lateral vibrations of beams; Introduction to Lagrangian methods.

Introduction to aero elasticity, load distribution, concepts of divergence, control effectiveness and reversal.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Text and Ref Books:**

1. Theory of Machines (S. I. Units), R. S. Khurmi, J. K. Gupta; Eurasia Publishing House (Pvt.) Ltd.
2. Mechanical Vibration-Theory and Applications (2nd Edition), Frances S Tse, Ivan E Morse and R T Hinkle
3. Theory of Vibration with Application, William T Thomson

**ASE 4645: Aerospace Propulsion**
*4.00 Contact Hour; 4.00 Credit Hour;*

**Pre-requisite:** Fundamentals of thermodynamics.

**Rationale:**

To learn about the fundamentals of air breathing and non-air breathing engines and their different components.

**Objective:**

1. To learn about the contemporary propulsion systems used in both air breathing and non-air breathing aircrafts.
2. To use the knowledge of thermodynamics to assess the thermodynamic process occurring in various components of a gas engine which include inlets, fans, compressors, combustion chambers, turbines, afterburners and nozzles and how they interact with each other.
3. To be able to evaluate the thermodynamic properties involved in each component associated with the Gas Turbine cycle.
4. To understand the how the design variables, affect the performance of each component of a turbine engine.
5. To be able to explain the basic aspects of rocket propulsion, propellants, rocket staging and dynamics.

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Gain knowledge about various types of aircraft &spacecraft propulsion systems.
2. Explain the thermodynamics of each component of a turbine engine which include inlets, fans, compressors, combustion chambers, turbines, afterburners and nozzles and how they interact with each other.
3. Evaluate various thermodynamic properties associated with the Gas Turbine cycle;
4. Gain knowledge about the performance &design variables for each component of a turbine engine.
5. Understand the basic aspects of rocket propulsion, propellants, rocket staging and dynamics.

**Course Contents:**

**Fundamentals of air breathing engines**; Operating principles of piston engines, thermal efficiency calculations, classification of piston engines, illustration of working of gas turbine engine, the thrust equation, factors affecting thrust, effect of pressure, velocity and temperature changes of air entering compressor, Propeller theory.

**Inlets, nozzles and combustion chambers for jet engines** ; Internal flow and Stall in subsonic inlets – relation between minimum area ratio and eternal deceleration ratio, diffuser performance, supersonic inlets, shock swallowing by area variation, real flow in nozzles and nozzle efficiency, losses in nozzles, equilibrium flow and frozen flow in nozzles, two phase flow in nozzles, ejector and variable area nozzles, interaction of nozzle flow with adjacent surfaces, thrust reversal, classification of combustion chambers, combustion chamber performance, flame stabilization.

**Propulsion unit requirements for subsonic and supersonic flight**. Compressors, combustion systems, turbines and after burner. Gas turbine cycles for aircraft propulsion; turbojet, turbofan, turbo shaft engines. Efficiency of components; Off-design considerations; Selection of materials for aero-engine. Aerothermochemistry of Fuels and Propellants. Methods of thrust augmentation, Aero engine control.

**Rocket propulsion and rocket propellants**; liquid and solid rocket propulsion systems, nozzle design, rocket performance; Dynamics of rocket flight, orbital velocity; Staging; Future developments; Minimization of noise and pollution; Sub-orbital propulsion systems; Ram jet; Scramjets; Hybrid engines.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam

**Text and Ref Books:**


1. Mechanics and Thermodynamics of Propulsion, Hill and Peterson, 2nd edition; Addison; Wesley, NY, 1992.
2. Gas Turbine Theory, H Cohen, GFC Rogers, HIH Saravanamuttoo
3. Rocket propulsion elements (6th edition), George P Sutton, Oscar Biblarz, John; Wiley, NY, 1992.
4. Aero thermodynamics of Aircraft Engine Components, Oates, G.C.; AIAA Education Series
5. Aircraft Gas Turbine Engine Technology (3rd edition), Treager.
6. The Jet Engine, Rolls Royce Limited.


**ASE 4646: Aerospace Propulsion Sessional**

*3.00 Contact Hour; 1.50 Credit Hour;*

**Pre-requisite:** Fundamentals of Thermodynamics, Aerospace Propulsion.

**Rationale:**

To get a hands-on experience on the various aspects of reciprocating and gas turbine engine as taught in the Aerospace Propulsion theory course.

**Course Objective:**

1. To compare the structural layout of the Piston & Jet engines.
2. To observe practically the actual operation of a jet engine and match this with the theoretical knowledge.
3. To be able to apply the theoretical knowledge basic formulas in relation to the diesel & jet engine.

4. To analyse how the flow property is changed by tweaking the dimensions of the compressor & turbine section (of a jet engine).
5. To be able to evaluate various parameters of the gas turbine cycle associated with a small-scale jet engine from practical operation.

**Course Outcomes (CO):**

Upon completion of all sessional, the students will be able to:

1. Know about of major structural and working components & their relative layout of Piston & Jet engines.
2. Apply basic formulas and equations regarding diesel & jet engine learned in the theory course.
3. Analyse the dimensional effects of compressor & turbine section (of a jet engine) on flow properties by plotting graphs from obtained data.
4. Evaluate the thrust and cycle efficiency of a small-scale jet engine with the parameters obtained from practical operation.

**Course Contents:**

1. Experiment no. 1: Construction of a Typical Jet Engine (WP7C Jet Engine) of a Fighter Aircraft.
2. Experiment no. 2: Dimensional Change of Compression Sections and Effects.
3. Experiment no. 3: Dimensional Change of Turbine Sections and Effects.
4. Experiment no. 4: Ground Operation of a CM-14 Jet Engine.
5. Experiment no. 5: Construction of a Typical Radial Piston Engine (HUO SAI-7A Engine) of a Trainer Aircraft.
6. Experiment no. 6: Performance Test of a High-Speed Diesel Engine.

**Teaching-learning and Assessment Strategy:**

Class Assessment, Class Participation, Class Attendance, Lab Test, Lab Report

**Text and Ref Books:**

1. Aircraft Gas Turbine Engine Technology (3rd edition), Treager.
2. The Jet Engine, Rolls Royce Limited.
3. Wiley, 2014.

**ASE 4659: Aerospace Vehicle Performance**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Pre-requisite:**

High Speed Aerodynamics, Aerospace Vehicle Stability and Control, Applied Aerodynamics

**Rationale:**

To learn the details of Performance of Fixed-Wing and rotary Aircraft:

**Objective:**

1. To understand flight mechanisms of Rotary Wing Aircraft.

2. To develop the basic concepts momentum theory and blade elementary theory as applied to Rotor Dynamics.
3. To understand different performance parameters and factors influencing these performance parameters a helicopter.
4. To analyse performance of a fixed wing aircraft.

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. To understand flight mechanisms of Rotary Wing Aircraft.
2. To develop the basic concepts momentum theory and blade elementary theory as applied to Rotor Dynamics.
3. To understand different performance parameters and factors influencing these performance parameters a helicopter.
4. To analyse performance of a fixed wing aircraft.

**Course Content:**

Performance of Fixed-Wing Aircraft: Introduction, the aircraft and its environment, weight performance, Aerodynamic performance, Engine performance. Flight envelopes, take-off and landing, climb and gliding, cruise performance; Manoeuvre performance.

Rotary-Wing Aircraft Performance: Introduction to rotor dynamics, momentum theory, Vertical climb and descent, Autorotation, Ground effect, Rotor mechanisms, Introduction to rotor aerodynamics and aerodynamic design, Rotorcraft performance, rotorcraft in vertical and forward flight, rotorcraft manoeuvre, Rotorcraft mission analysis, V/STOL performance; Noise performance.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Textbooks:**

1. Performance of Fixed and Rotary Wing Aircraft, Antonio Filippone
2. Aerodynamics of the helicopter, Alfred Gessow/ Garry C. Myers Jr.
3. Basic Helicopter Aerodynamics, John Seddon/Simon Newman.
4. The Art of the Helicopter, John Watkinson.
5. Aircraft Performance and Design, John D. Anderson; WCB McGraw-Hill.

**ASE 4715: Computational Fluid Dynamics**
*3.00 Credit Hour 3.00 Contact Hour;*

**Course Objective:**

1. To understand mathematical characteristics of partial differential equations.
2. To understand basic properties of computational methods – accuracy, stability, consistency
3. To learn computational solution techniques for time integration of ordinary differential equations
4. To learn computational solution techniques for various types of partial differential equations
5. To learn how to computationally solve Euler and Navier-Stokes equations
6. To acquire basic programming and graphic skills to conduct the flow field calculations and data analysis.

**Course Content:**

Introduction: Computational Fluid Dynamics (CFD)- a research, modelling and design tool, historical perspective, commercial CFD packages, mathematical description of physical phenomena, a brief discussion of discretization methods-finite difference, finite element. Introduction to control volume method.

Numerical solution of diffusion type equations: Steady one-dimensional conduction, unsteady one dimensional conduction, two and three- dimensional situations.

Numerical solution of convection-diffusion-type equations: Steady one-dimensional convection-diffusion, discretization equation in two and three-dimensions.

Numerical solution of fluid flow equations: Discretization of continuity and momentum equations for fluid flow, pressure-based algorithms- SIMPLE & SIMPLER

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Reading Material:**


1. Tannehill, J.E., Anderson, D.A., and Pletcher, R.H., Computational Fluid Mechanics and Heat Transfer, 2nd ed., Taylor & Francis, 1997.
2. Hoffmann, K.A. and Chiang, S.T., Computational Fluid Dynamics for Engineers, Engineering Education Systems, 2000.
3. Anderson J.D., Computational Fluid Dynamics – The basics with applications, Mc Graw Hill, 1995.
4. Versteeg, H.K. and Malalasekera, W., An Introduction to Computational Fluid Dynamics – The finite volume method, Longman Scientific & Technical, 1995.
5. Patankar, S.V., Numerical Heat Transfer & Fluid Flow, Hemisphere, 1980.


**ASE 4773: Aircraft Design**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Pre-requisite:** Aeronautical Engineering Drawing-I, Aeronautical Engineering Drawing II, Aerodynamics, Aerospace Propulsion, Aircraft Loading and Structure Analysis, Aerospace Vehicle Stability and Control.

**Rationale:**

The main course's objective is to teach students the methodology and decision making involved in the process of designing aircraft.

**Objective:**

1. To describe an aircraft design phase like conceptual, preliminary and detail
2. To generate a first estimation of the new aircraft weight
3. To analyse the critical performance parameters for the new aircraft
4. To generate the configuration layout for the new aircraft
5. To understand the detail design phase and analysing the wing design, tail design, fuselage design, propulsion system design.

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Understand and experience of design of an aerospace system, mission, or vehicle.
2. Apply the knowledge of fundamentals of aeronautics with different disciplines.
3. Understand the conceptual design phase, design layout and design analysis - various types and categories of aircraft, requirement of teamwork for complex engineering projects.
4. Understand the preliminary design phase and evaluating Max take-of weight (MTOW), wing area & engine sizing.
5. Understand the detail design phase and analysing the wing design, tail design, fuselage design, propulsion system design.

**Course Content:**

Introduction to conceptual design; Design layout and design analysis - various types and categories of aircraft, requirement of teamwork for complex engineering projects.

Aircraft design methods; Techniques for selecting, sizing and stressing components; Regulatory requirements for certification; Off-design requirements; Construction tolerances.

Aircraft preliminary design; Configuration design - performance, propulsion, weight and balance; Aerodynamics design – lift, drag, stability and control, structures and loads; Structural design -payload considerations, centre of gravity requirements and materials; Philosophies of design and analysis.

Aircraft detailed design; System design –System design procedures; Systems integration; Test procedures; Fatigue and damage tolerance; the art of design and trade studies. Investigation of a typical aircraft configuration; Component layout; Alternate configurations; weight penalties or gains; requirements for ancillary equipment. Engine and propeller selection.

Launch vehicle design; liquid rocket launch vehicle design, solid motor launch vehicle design.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Text and Ref Books:**


1. Aircraft Design: A systems of Engineering Approach, Mohammad H. Saddaey
2. Aircraft Design: A Conceptual Approach, Raymer, 3rd Ed; AIAA Virginia, 1999.
3. Airplane Design, John Roskam
4. Launch Vehicle Design, He Linshu, BUAA


**ASE 4774: Aircraft Design Sessional**
*6.00 Contact Hour; 3.00 Credit Hour;*

**Prerequisite:** Aircraft Design

To apply all the design phases & structural layout for aircraft design.

**Course Objective:**

1. To learn the system engineering approach.
2. To solve Numerical problems on maximum take-off weight estimation, wing area &engine sizing.
3. To Analyze the influence of design for manufacture and maintainability.
4. To analyze the fuselage structure.
5. To evaluate requirements, selection & sizing method for the design of an aerospace vehicle

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Explain design of an aerospace system, mission, or vehicle.
2. Apply all design phases & structural layout through participation on design project.
3. Analyze the requirements, selection & sizing method for the design of an aerospace vehicle.
4. Evaluate of different structural parameters.
5. Analyze the influence of design for manufacture and maintainability.

**Course Content:**

1. Aircraft Conceptual Design:
    a. Development of system operational requirement,
    b. Selection of configuration from different alternative using Figure of Merit.
2. Preliminary Design:
    a. Numerical problems on maximum take-off weight estimation, wing area &engine sizing.
3. Detail design:
    a. Wing design: Selection of aero foil, Numerical on determination of wing parameters using Geometric and Trigonometric method.
    b. Tail design: Numerical on determination of tail parameters.
    c. Fuselage Design: Numerical on determination of fuselage parameters
    d. Propulsion System Design: Numerical on determination of propulsion system parameters
    e. Landing Gear Design: Numerical on determination of landing gear parameters
    f. Weight of Components & Weight Distribution: Estimation of component's weight and distribution.
4. Individual project on specified Aircraft Design / Spacecraft System Design / Launch Vehicle design.

**Teaching-learning and Assessment Strategy:**

Lab performances, Lab Report/Assignment/Presentation, Lab Test/ Quiz

**Text and Ref Books:**


1. Aircraft Design: A systems of Engineering Approach, Mohammad H. Saddaey
2. Aircraft Design: A Conceptual Approach, Raymer, 3rd Ed; AIAA Virginia, 1999.
3. Airplane Design, John Roskam, Parts 1-8
4. Launch Vehicle Design, He Linshu, BUAA


**ASE 4615: High Speed Aerodynamics**
*3.0 Contact Hour; 3.0 Credit Hour;*

**Pre-requisite:** Fundamentals of Aeronautical Engineering, Engineering Mechanics (Statics and Dynamics)

**Rationale:**

To introduce the theories of compressible flow involving subsonic and supersonic cases.

**Objective:**

1. To define the fundamental aspects of compressible flow.
2. To solve simple problems related to shock and expansion (Prandtl-Meyer) waves phenomena.
3. To solve simple problems related to adiabatic flow
4. To design and perform the experimental work related to water table experiments.
5. To evaluate and perform the CFD simulations works related to compressible

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Explain the concept of compressible flow involving subsonic and supersonic cases.
2. Explain the mechanism of formation of sound wave and shock wave and their effect on the compressible flow involving change of pressure, temperature, velocity, entropy etc.
3. Analyse the influence of normal shock, oblique shock and expansion wave on compressible flow.
4. Evaluate the change of properties of compressible flow due to stationary and moving shock waves.

**Course Contents:**

Basic equations of compressible flow, wave propagation in compressible media; velocity of sound, subsonic and supersonic flows, Mach number, isentropic flow, stagnation properties, flow through convergent-divergent nozzle,

Normal shock waves, oblique shock and expansion waves, Prandtl-Mayer expansion fans, shock expansion theory, linearized flow theory,

Flow with friction and heat transfer, moving shock wave, shock tube flow, transonic flow, and measurements in compressible flow.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Text and Ref Books:**

1. Fundamentals of Aerodynamics- John D. Anderson; McGraw Hill.
2. Aerodynamics for Engineering Students, 5th Edition-E. L. Houghton & P. W. Carpenter
3. Gas Dynamics, 3rd Edition-James E. A. John and Theo G. Keith
4. Gas Dynamics- E. Rathakrishna

**ASE 4807: Industrial and Business Management**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Pre-requisite:** None

**Rationale:**

To learn the principles and techniques of industrial management which is essential for doing job in industry

**Objective:**

1. To be able to describe central theories within the field of industrial management, such as costing
2. To be able to describe the transactions of a company.
3. To be able to analyse the cash flow and the financial tools for a company.
4. To be able to describe how the accounting system of a company is constructed.
5. To be able to describe the most well-known theories and perspectives on management
6. To have a basic understanding of contemporary organizational forms

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Gain knowledge about financial concepts used in making business decisions.
2. Apply quantitative measurements to solve business problems related to depreciation, percentages, future value of money and to be able to make better business decisions.
3. Understand the roles of Manager and how to use motivation in workplace.
4. Gain knowledge about the methods and processes of plant layout & production planning and control.
5. Understand project scheduling selection and operations management.

**Course Content:**

Organization and management: system approach to organization, organization theory and organizing practices, basics of organizing.

Personnel and human resource management in business human factors and motivation, leadership, group decision making and communication, Job gradation, process of performance appraisal and reward systems

Emergence of management thought and the patterns of management analysis scientific management and Taylorism, Modern operational-management theory, emergence of the behavioural sciences, recent contributors to management thought.

Cost management elements of cost of products, cost centres and allocation of overhead costs; Management accounting: marginal costing, standard costing, cost planning and control, budget and budgetary control; Development and planning process; Annual development plan; National budget.

Financial management: objectives, strategy, financing, performance analysis of enterprises, investment appraisal, criteria of investment.

Marketing management: marketing concept, marketing organization; Industrial and consumer selling; Channel decisions; Advertising decisions; new product strategy.

Elements of production planning and control; plat location and layout; Types of production system; Functions of production, planning and control with an overview of different types of manufacturing systems; Factors affiliated with different fields of production including product characteristics and economic analysis.

Forecasting methods and their application; Aggregate planning; Master production scheduling; MRP; Coding and standardization; Capacity planning; Inventory management - ABC analysis; Production scheduling techniques - CPM and PERT; Line balancing; Capacity planning.

Types of information systems and it‘s benefits at different management levels; Computers in production planning and control; MRPII and JIT.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Text and Ref Books:**

1. Management - Jams A. F. Stoner, R. Edward Freeman, Daniel R. Gilbert,
2. Management - Stephen P. Rubbins, Mar Conlter, Robin Stuart kotze.
3. Operation Management - Chase & Jacob.
4. Managerial Accounting - Garrison, Noreen.
5. Product Design & Development - Ulrich &Eppinger
6. Product Design Methods & Practices - Henry W Stoll
7. Developing New Products with TQM - Charles Gevirtz

**ASE 4875: Space System and Launch Vehicle Design**
*3.00 Contact Hour; 3.0 Credit Hour;*

**Prerequisites:**

Machine Design and Aircraft Design

**Rationale:**

To learn the principles and techniques of launch vehicle and space system design.

**Course Objectives:**

1. To understand the methods of launch vehicle and space system design
2. To be able to apply techniques of Launch Vehicle and Space System design

**Course Outcomes (CO):**

Upon completion of the course the students will be able to:

1. To learn how to design space system and launch vehicles
2. To be able to analyse different components of space system and launch vehicle

**Course Contents:**

Introduction to the engineering design process for space systems. Includes a lecture phase that covers mission planning, launch vehicle integration, propulsion, power systems, communications, budgeting, and reliability.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Textbooks:**

1. Space Vehicle Design, Michael D Griffin, James R. French, AIAA Education Series, 2004
2. Introduction to Space Systems Design and Synthesis, Miguel R Aguirre, Springer, 2012
3. Fundamentals of Space Systems, 2nd edition, Vincent L. Pisacane, Oxford University Press, 2005
4. Space Mission Analysis and Design, Wiley J Larson, A.V. Wertz, Springer Netherlands, 2013

**ASE 4876: Space System and Launch Vehicle Design Sessional**
*3.00 Contact Hour; 1.5 Credit Hour;*

**Prerequisites:**

Workshop Technology, Machine Design, Aircraft Design and Computational Fluid Dynamics (CFD)

**Rationale:**

To learn the principles and techniques of designing launch vehicle and space system and design/manufacture an object.

**Course Objectives:**

1. To understand the methods of launch vehicle and space system design
2. To be able to apply techniques by designing/manufacture a Launching Vehicle.

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. To learn the design/manufacture of space system and launch vehicle
2. Students will design/manufacture a launching vehicle either numerically or experimentally basing on previous experience/studies. At the end, they will give a presentation on their design/manufacture in front of teachers.

**Course Contents:**

Practical orientation basing on ASE 4875.

**Teaching-learning and Assessment Strategy:**

Lectures, assignments and presentation.

**Reference Books:**

1. Space Vehicle Design, Michael D Griffin, James R. French, AIAA Education Series, 2004
2. Introduction to Space Systems Design and Synthesis, Miguel R Aguirre, Springer, 2012
3. Fundamentals of Space Systems, 2nd edition, Vincent L. Pisacane, Oxford University Press, 2005
4. Space Mission Analysis and Design, Wiley J Larson, A.V. Wertz, Springer Netherlands, 2013

**ASE 4600: Industrial Training**
*8 weeks Contact Hour; 1.0 Credit Hour;*

**Pre-requisite:** Student should complete all courses up to 3rd Year, 2nd Semester

**Rationale:**

To provide the experience for the students of the industrial environment and organization as well as the functionality of the engineers in industries.

**Course Objective:**

1. To be able to practice the responsibility of becoming an engineer in the profession of engineering.
2. To be able to Able to instil communication skill in engineering which include daily interaction with working environment and technical writing.
3. To be able to involve and experience the true working environment of the engineer.
4. To be able to work in a team.
5. To be able to manage a project within a given time frame.
6. To be able to effectively communicate solution to problems (oral, visual, written).

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Explain about the structure and management of an industry/organization to apply this knowledge in the individual's professional life.
2. Devise the industrial works like maintenance, planning, engineering service and aircraft inspection with practical experience.
3. Apply the industrial training knowledge further in project or research work.
4. Describe various engineering aspects of different industries/organizations through group presentation.
5. Develop the responsibility of safety, legal and cultural issues in engineering practices**.**

**Teaching-learning and Assessment Strategy:**

Internship for 04 weeks, assessment and presentation, observation and evaluation by officers of that industry.

**ASE 4700: Final Year Design Project (FYDP) and Thesis**
*9.00 + 9.00 Contact Hour; 4.50 + 4.50 Credit Hours;*

**Rationale:**

This course motivates to go neck-deep in research, synthesize it, and make a point or look at something in a different way after going through all of it.

**Course objective:**

The objective is to provide an opportunity to develop initiative, self-reliance, creative ability and engineering judgment.

**Course Content:**

In this course, students are required to undertake a major project in engineering analysis, design, and development of research. The project / research will either be open to student's choice subject to approval of supervisor or to be chosen from the list of options provided to the students. The results must be submitted in a comprehensive report with appropriate drawings, charts, bibliography, etc. along with products if any.

**Course Outcome:**

1. Students are exposed to research methodology.
2. Students can analyse problems and apply engineering knowledge in finding solution to those problems.
3. Students gain insight into latest trend in the field of research / project.

## 4.2 Humanities and Social Sciences (HASS) Courses

**HUM 4201: Communicative English**
*3.00 Contact Hour, 3.00 Credit Hour; Pre-requisite: None*

**Rationale:**

To provide fundamental knowledge on how to improve spoken English skills and to enable to write more effectively in English.

**Course Objective:**

1. To learn to improve skills as writer, critical readers and thinker.
2. To learn to write for various audiences and purposes and to adapt the essay form to various writing situations.
3. To learn the structure and style of effective sentences, paragraphs, and essays.
4. To help to focus on diction and spelling, punctuation and mechanics, and functional grammar in direct relation to their own writing.

**Course Outcomes (CO):**

1. Recognize and get a clear idea about how to speak understand and speak English quickly and smartly.
2. Organize them within the shortest possible time to present their ideas and opinions.
3. Find out the main points of any long article within a very limited time.
4. Interpret the techniques of any effective writing.
5. Overcome language barrier.

**Course Content:**

Language: Introduction to Language, Methodologies/Approaches of English Teaching-Learning Process, Introduction to Phonetics, IPA Transcription and variation of accents. Grammar: Types of Sentences, Introduction to Tense, Use of Main Verbs, Auxiliaries, Modals & Semi modals, Causatives, Conditionals, Active / Passive Sentences, Forming Questions, Problems with Adverbs and Adverb related structures, Adjectives, Conjunction, Prepositions. Reading: Skimming, and Scanning, Reading Comprehension, Selected short Stories. Writing: Writing Strategies. General Correspondence & Communication/Tech Writing: Introduction to General Correspondence, Formal Communication, Report Writing; How to write a curriculum vitae.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Reading Material:**

1. English Grammar in Use (4th ed), Raymond & Murphy, Cambridge University Press (2012).
2. Introduction to Linguistics, Prof Dr. Maniruzzaman.
3. A Guide to Correct Speech (5th ed), S M Amanullah, Albatross Publication (2007).
4. Oxford Advanced Learners' Dictionary (7th ed), Oxford University Press (2007).
5. Prose of Our Time, Ahsanul Hoque (2nd ed), Serajul Islam Chowdhury and M Shamsuddoha.
6. From Paragraph to Essay, Maurice Imhoof and Herman Hudson, Longman, London (1976).
7. Headway Series Advanced Level (2 parts with CDs) (4thed), Oxford University Press Ltd.
8. Business correspondence and report writing, R. C. Sharma & Krishna Mohan.
9. Advance learners Degree general English, Chowdhury and Hossain.
10. The most common mistakes in English usage, Thomas Elliott Berry.

**HUM 4202: Communicative English Sessional (Technical Report Writing and Sessional)**
*1.50 Contact Hour 0.75 Credit Hour; Pre-requisite: None*

**Rationale:**

To help to improve spoken English skills and to enable to communicate more effectively in English.

**Course Objective:**

1. To develop confidence among students.
2. To learn how to think logically and how to give group presentation.
3. To develop the English language skills (listening, speaking, reading and writing) that are necessary to be successful on the IELTS test.

**Course Outcomes (CO):**

1. Determine and get a clear idea about how to speak understand and speak English quickly and smartly.
2. Organize them within the shortest possible time to present their ideas and opinions.
3. Find out the main points of any long article within a very limited time.
4. Recognize the techniques of any effective writing.
5. Overcome language barrier.

**Course Content:**

Introduction to Language: Introducing basic skills of language; Phonetics, English Vowel and consonant sounds, Difference between different accents, Self-Introduction, how a speaker should introduce himself; Situational talks / dialogues; Speaking: IELTS speaking - Part 1, 2 & 3; Group discussion, taking participation in any discussion and drawing conclusion and giving recommendation; Brain storming: Principles of brain storming. How to think logically; Facing any problem, trying to find out possible solutions, drawing conclusion and giving recommendation; Individual / Group presentation, good presentation skills; Skimming, Scanning & Analytical Ability, techniques of skimming, scanning and generating ideas through purpose reading. Reading: Introducing IELTS academic reading comprehension, Listening and understanding, note taking and answering questions; Listening: Introducing IELTS / TOEFL listening section Academic Writing: Introducing IELTS academic writing, Public Speaking: Basic elements of good presentation or public speaking, some tips for good speech.

Tutorial Discussion – On a given topic to test the proper use of phonetics, pronunciation grammar, logic and confidence; Public Speaking – Demonstration by teacher for a short specific period, speaking by students

(each student minimum twice) on different but easy given topic, well in advance as per a schedule maximum for 3 to 4 minutes for each student; Extempore – Minimum two presentations by each student for a duration of maximum 3 to 4 minutes; Debriefing on public speaking and extempore presentation ; Presentation – On a given professional topic or on a given research paper using power point followed by question and answer session. Group presentation or different given topics by the students using power point.

**Teaching-learning and Assessment Strategy:**

Speaking, Presentation, Report Writing, Group Discussion, Lab Test/ Quiz.

**Reading Material:**


1. Introduction to Linguistics, Prof Dr. Maniruzzaman.
2. A Guide to Correct Speech (5th ed), S M Amanullah, Albatross Publication (2007).
3. Oxford Advanced Learners' Dictionary (7th ed), Oxford University Press (2007).
4. English Grammar in Use (4th ed), Raymond & Murphy, Cambridge University Press (2012).
5. From Paragraph to Essay, Maurice Imhoof and Herman Hudson, Longman, London (1976).
6. Headway Series, Advanced Level (2 parts with CDs) (4thed), Oxford University Press Ltd.
7. IELTS and TOEFL Practice Book, Cambridge University Press.
8. English for Technical Students, David Bonamy, Longman Publisher.
9. Business Correspondence and Report Writing, R. C. Sharma & Krishna Mohan.


**HUM 4203: Bangladesh Studies and Society**
*3.00 Contact Hour, 3.00 Credit Hour; Pre-requisite: None*

**Rationale:**

This course has been designed to help the students in obtaining comprehensive idea about the history, culture and heritage of Bangladesh. It will introduce students with economy, society, politics, diplomacy and foreign policy of Bangladesh. Students will learn about the challenges and potentials of Bangladesh in shaping its peaceful and sustainable future. It will also assist the students in assessing roles and contribution of Bangladesh in the regional and international bodies which are dedicated to establishing world peace.

Systematic study of social behaviour and human groups. It focuses on the influence of social relationships upon people's attitudes and behaviour and on how societies are established and changed. This course provides students with both methodologies and knowledge of the study of critical social issues ranging in scope from family to global.

**Course Objective:**

1. Introduce students with rich history, culture and heritage of Bangladesh.
2. Providing them in-depth knowledge on the major political events that shaped Bangladesh as an independent sovereign state.
3. Improve their understanding on political, economic and social development of Bangladesh.
4. Help them think critically and comprehensively about foreign policy of Bangladesh, its relationship with other countries and its important roles in the international organizations like UN, Commonwealth and SAARC etc.
5. To correctly identify critical social issues through a systematic study of social behaviour and social change.
6. To demonstrate comprehension of roles and functions of various social institutions, relationships, several sociological theories and apply them to explain social phenomena or situations.

7. To demonstrate interest in taking part in social activities and use sociological imagination to explain their life experience in a broader social context.

**Course Outcomes (CO):**

1. To enrich knowledge with brief history, culture and heritage of Bangladesh.
2. To provide in-depth knowledge on the major political events that shaped Bangladesh as an independent sovereign state.
3. To improve understanding on political, economic and social development of Bangladesh.
4. To think critically and comprehensively about foreign policy of Bangladesh, its relationship with other countries and its important roles in the international organizations like UN, Commonwealth and SAARC etc.
5. Correctly identify causes of critical social issues through a systematic study of social behaviour and social change.
6. Demonstrate comprehension of roles and functions of various social institutions and relationships among them.
7. Demonstrate understanding of several sociological theories and apply them to explain social phenomena or situations.
8. Demonstrate interest in taking part in social activities.

**Course Content:**

Ancient period and Muslim period of Bengal, British period, Pakistan period: an overview (1952-1971), The problem of national integration under Ayyub regime, Elite in crisis during Pakistan rule, nation-building in the new state, The ideals and philosophy of constitution making of Bangladesh, Study on the coup and assassination of Bangabandhu Sheikh Mujibur Rahman, Philosophy and fundamental changes of Zia regime, Constitutional amendments of Bangladesh, Corruption and good governance in Bangladesh, Issues of governance of Bangladesh, Bangladesh's economy, Ideas on political and ethnic conflict in Bangladesh, Geographical setting of Bangladesh, environmental challenges of Bangladesh, Bangladesh foreign policy: realities and challenges, Foreign policy-decision-making process in Bangladesh, Bangladesh-soviet union relations.

Nature, scope and perspectives of sociology; stages of social research and research methods; culture and civilization; socialization and personality development; globalization; media and individual; social organization and social problem; social stratification; industrial revolution, capitalism and socialism; work and economic life; environment and human activities; climate change and global risk; population and human society; urbanization and city development; social change and technology.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**HUM 4611: Engineering Ethics and Professionalism**
*3.00 Contact Hour; 3.00 Credit Hour; Pre-requisite: None*

**Course Content:**

Scope of sociology, Industrial revolution, Society and population, Social pathology, Nature of social change, Sociology of development, Urban ecology.

Definition and scopes of Ethics. Different branches of ethics. Social change and the emergence of new technologies. History and development of engineering ethics. Science and technology- necessity and application. Study of ethics in engineering. Applied ethics in engineering.

Human qualities of an engineer. Obligation of an engineer to the clients. Attitude of an engineer to other engineers. Measures to be taken in order to improve the quality of engineering profession.

Ethical expectation: Employers and employees, inter-professional relationship, Professional Organization - maintaining a commitment of ethical standards. Desired characteristics of a professional code. Institutionalization of ethical conduct. Socialization; Poverty social exclusion and welfare; Women and Development; Crime, deviance and social control; Environment and risk; Sustainable development; Rural sociology; Family urbanization and industrialization; Urban ecology; Collective behaviour and social movements;

Organization and management: system approach to organization, organization theory and organizing practices, basics of organizing. Personnel and human resource management in business human factors and motivation, leadership, group decision making and communication, Job gradation, process of performance appraisal and reward systems.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Reading Material:**

1. Sociology (4th edition), Anthony Gidders, Excel Media, India.
2. Sociology: Primary Principles, C. N. Shankar Raw, S. Chand Co Ltd.
3. Sociology (Rev. ed.), T. B. Bottomore.
4. Engineering Ethics(4t h edition), Charles B. Fleddermann, 2012, New Jersey, NJ: Pearson Education
5. Engineering Ethics, 1st Edition, Gail Baura
6. Sociology in Modules (2nd edition), Richard T. Schaefer, 2013, New York, NY: McGraw-Hill

**HUM 4713: Engineering Economics**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Course Content:**

Microeconomics: Definition of economics; Fundamentals of economics; Market and government in a modern economy; Basic elements of supply and demand; Choice and utility; indifference curve technique; Analysis of cost; Short run long run theory of production; Analysis of Market; Optimization; Theory of distribution.

Macroeconomics: key concept of macroeconomics; Saving, consumption, investment; National income analysis; Inflation, Unemployment; Fiscal and monetary policy.

Development: Theories of developments; Economic problem of developing countries; Planning in Bangladesh

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Reading Material:**

1. Economics by Samuelson
2. Economics by John Sloman
3. Economic Development by Michael Todaro

## 4.3 Basic Sciences & Mathematics Courses for Aerospace Major

**MAT 4101: Differential Calculus and Integral Calculus**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Rationale:**

To provide an understanding of the basic concepts of differential and integral calculus.

**Course Objective:**

1. To develop fundamental ideas on limits, continuity and derivative.
2. To gain knowledge on various techniques of finding derivative.
3. To familiar students 'how integration is associated with differentiation.'
4. To learn several techniques of finding integrals.
5. To prepare students to apply derivatives and integrals in engineering problems.

**Course Outcomes (CO):**

1. Demonstrate basic concepts of calculus.
2. Derive derivatives and integrals of polynomials, trigonometric functions, logarithmic function, exponential function, hyperbolic function etc.
3. Use derivatives and integrals to expand a function into a series and to find relationship of Gamma and Beta function.
4. Evaluate motion of moving objects, area of a region and volume of space.
5. Apply derivatives and integrals when modelling engineering problems.

**Course Content:**

Differential Calculus: Introduction to Differential Calculus: Concepts of Set, Interval and absolute value, Cartesian product set, Relation, Functions, Domain, Co-domain and Range of a function, Types of functions, Graph of functions, Limit, continuity and differentiability, successive differentiation of various types of functions, Leibnitz's theorem, Rolle's theorem, Mean value theorem, expansion in finite and infinite forms, Lagrange's form of remainder, Cauchy's form of remainder, indeterminate form, Partial differentiation, Euler's theorem, tangent and normal, sub tangent and subnormal in Cartesian and polar coordinates, maxima and minima of functions of single variables, curvature, asymptotes.

Integral Calculus: Introduction to integral calculus, Indefinite integral, Methods of integration: integration by substitution, integration by parts, standard integrals, integration by successive reduction, Integration by partial fraction, integration of hyperbolic functions, Definite integrals: Evaluation of definite integrals, properties of definite integral and its use, summing series, Walli's product formula, improper integrals, Beta function and Gamma function, double integral and multiple integral, Application of integration: area under a plane curve, area of the region enclosed by two curves, volume of solid of revolution, arc length, area of surfaces.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Reading Material:**

1. Integral Calculus & Differential equation, (5th ed), Matin & Chakraborty, Standard Publication (2016).
2. Differential Calculus (5th ed), Matin Chakraborty, Dhaka Standard Publication (2015).
3. Calculus - Haward Anton (9th ed), Stephen Davis, Wiley (2012).
4. A Textbook on Integral Calculus (4th ed), Mohammad, Bhattacharjee & Latif, Dhaka (2010).

**MAT 4203: Ordinary and Partial Differential Equations**
*3.00 Contact Hour; 3.00 Credit Hour; Pre-requisite: MAT 4101*

**Rationale:**

To provide knowledge of formation, classification, order and application of Ordinary Differential Equation and Partially Differential Equation.

**Course Objectives:**

1. To introduce students with Ordinary Differential Equation and Partial Differential Equation.
2. To Increase understanding on two-dimensional as well as three dimensional measurements.
3. To teach solving techniques of ordinary differential equation.
4. To teach solving techniques of partial differential equation.
5. To prepare students so that they can create and analyse mathematical models for engineering problems such as harmonic oscillator, heat transfer and circuits using differential equations.

**Course Outcomes (CO):**

1. Demonstrate fundamental concepts of Ordinary Differential Equation and Partial Differential Equation.
2. Solve first and higher order ordinary differential equations by various methods.
3. Solve partial differential equations by various techniques.
4. Select and apply appropriate geometric formula to measure angles, perimeters, surface area and volume.
5. Formulate scientific problems into Differential Equation problems then analyse engineering problems using of solving methods of differential equations.

**Course Content:**

Ordinary Differential Equations: Introduction to Differential Equations, Formulation of Differential Equations; Degree and order of differential equations, Solution of first order differential equations by various methods, solution of first order higher degree ordinary differential equations, Solution of general linear equations of second and higher orders with constant co-efficient, Solution of homogeneous linear differential equations, solution of differential equations of higher order when dependent and independent variables are absent, solution of differential equations by the method of factorization of operators. Application of ODE.

Partial Differential Equations: Formation of differential equation eliminating constants and functions, four rules for solving simultaneous equations, Lagrange's method of solving PDE of order one. Integral surfaces passing through a given curve, non-linear PDE of order one (complete singular and general integrals), Standard forms, Charpit's method, second order PDE, its nomenclature and classification to canonical, parabolic, elliptic, hyperbolic, solution by separation of variables, linear PDE with constant coefficients. Application of PDE.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Reading Material:**

1. Ordinary and Partial Differential Equations, Raisinghania.
2. A Textbook on Co-ordinate Geometry with Vector Analysis, Rahman & Bhattacharjee.

**MAT 4305: Linear Algebra and Coordinate Geometry**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Rationale:**

To provide knowledge of matrices and linear algebra which ultimately increase knowledge to formulate and solve engineering problems. It also provides knowledge of problem-solving regarding geometry.

**Course Objectives:**

1. Familiar students with basic ideas on Linear Algebra and coordinate geometry.
2. Demonstrate solving systems of linear equations using various methods.
3. Explain vector in vector spaces.
4. Display linear transformation and inner product spaces.
5. Clarify eigenvalues and eigenvectors with example.
6. Show application of linear algebra in engineering problems.

**Course Outcomes (CO):**

1. Demonstrate basic idea of matrix, linear algebra and coordinate geometry.
2. Select and apply appropriate method to solve system of linear equations.
3. Demonstrate and apply linear transformation
4. Evaluate eigenvalues and eigenvectors and recognize characteristic matrix, characteristic polynomial, characteristic equation and Diagonalization.
5. Apply knowledge of linear algebra to formulate and solve engineering problems.

**Course Content:**

Linear Algebra: Matrices and Determinants: Definition of matrices, order of a matrix, Row matrix, Column matrix, Square matrix, Operations of matrices, determinant of square matrix, Minors and cofactors, Transpose of a matrix, Symmetric and skew-symmetric matrix, Cofactor and adjoint of a matrix, inverse of a matrix, Echelon Matrix, Canonical matrix. System of linear equations: Linear equations, Solution of a system of linear equations (Cramer's rule, Gauss elimination method, Gauss-Jordan elimination method, inverse matrix method), Application of system of linear equations. Vectors in Euclidean n-space, Basic properties of the vectors, Basic properties of dot product, Orthogonal vectors, Norm or length, Angle between two vectors, Mathematical problems. Vector spaces: Introduction, Definition and examples of vector spaces and subspaces, Linear combination, linear dependence and independence, Basis and Dimension, Rank of matrix. Linear transformation: Definition of linear transformation, properties of linear transformation, Kernel and image of linear transformation, Singular and non-singular linear transformation, Matrix representation of a linear transformation, Rank and Nullity of a linear transformation. Inner product spaces: Euclidean and Unitary spaces, orthogonality, Gram-Schmidt process and QR-Decomposition. Eigen values and Eigen vectors: Matrix polynomials, Polynomial of a linear operator, Eigenvalues and

eigenvectors of a square matrix, Eigenvalues and eigenvectors of a linear operator, Eigenvalues and eigenvectors of linear transformation, Characteristic matrix, Characteristic polynomial and Characteristic equation, Diagonalization, Cayley-Hamilton theorem, Application of linear algebra in engineering problems.

Coordinate Geometry: Two-dimensional coordinate geometry: Changes of axes: Transformation of co-ordinates, simplification of equation of curves, Conic section (pair of straight line, system of circle, parabola, Ellipse, Hyperbola). Three-dimensional coordinate geometry: System of coordinate, distance between two points, section formula, projections, direction cosines, equations of planes and lines.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Reading Material:**

1. Elementary Linear Algebra, Anton, H. & Rorres, C.
2. A textbook on Co-ordinate Geometry with Vector Analysis, Rahman & Bhattacharjee
3. Elementary Linear Algebra, Prof. Abdur Rahman

**MAT 4407: Complex Variables, Fourier and Laplace Transform**
*3.00 Contact Hour; 3.00 Credit Hour; Pre-requisite: MAT-4201*

**Course Objectives**:

To discuss the complex number system, different types of complex functions, analytic properties of complex numbers and theorems in complex analysis to carryout various mathematical operations in complex plane, roots of a complex equation.

To discuss limits, continuity, differentiability, contour integrals, analytic functions and harmonic functions.
To learn about Cauchy–Riemann equations in the Cartesian and polar coordinates, Cauchy's integral formula, Cauchy–Goursat theorem, convergence of sequence and series, Taylor series, Laurent's series.
To apply Integral transforms with a special focus on Laplace integral transform and Fourier transform.

**Course Outcomes:**

1. Demonstrate understanding of the basic concepts underlying complex number system.
2. Describe geometrical interpretation of complex inequalities and find the 'n' th root of complex number.
3. Apply the methods of complex analysis to evaluate definite integrals and infinite series.
4. Explain the concept of integral transforms, e.g., Laplace, Fourier transforms and the related inverse transforms by using the following Partial fractions method, Convolution theorems and apply these transformations for engineering problems.

**Course Content:**

Complex Variables: complex number system, general function of a complex variable, limits and continuity of a function of a complex variable and related theorems, complex differentiation, the Cauchy-Riemann equation, mapping by elementary functions, line integral of a complex function, Cauchy's Integral Theorem and formula, Liouville's theorem, Taylor's theorem, Laurent's theorem, Singular points, Residue, Cauchy's Residue Theorem, evaluation of Residues, Contour integration, conformal mapping.

Laplace Transforms: Laplace transforms of some elementary functions, sufficient conditions for existence of Laplace Transforms, inverse Laplace transforms, Laplace transforms of derivatives, the unit step function, periodic function, some special theorems on Laplace transforms, partial fractions, solutions of differential equations.

Fourier Transforms: Real and complex form of Fourier series, finite transforms, Fourier Integral, Fourier transforms and their uses in solving boundary value problems of wave equations.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Reading Material:**

1. Theory and problems of Complex Variables, Murry R. Spiegel
2. Mathematical Methods (volume Two), Professor MD. Abdur Rahman
3. Function of a Complex variable, M. L. Khanna

**PHY 4101: Physics-I (Waves, Oscillations, Optics and Thermal Physics)**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Rationale:**

To perform experiments to verify practically the theories and concepts learned and understand the difference between theory and application.

**Course Objective:**

1. To help learning how to be patient and careful while taking observation.
2. To provide knowledge on how to develop the ability of the students to conduct, observe, analyse and report an experiment.
3. To help to deal with physical models and formulas mathematically.

**Course Content:**

Waves and Oscillation: Differential equation of Simple harmonic oscillator, total energy and average energy, Combination of Simple harmonic oscillations, Lissajous figures; spring mass system, Calculation of time period of torsional pendulum; damped oscillations, determination of damping co-efficient forced oscillation, resonance, two body oscillations, reduced mass , differential equation of a progressive wave, power and intensity of wave motion, stationary wave, phase velocity and group velocity, Architectural acoustics, reverberation and Sabine's formula

Geometrical optics: *Combination of lenses:* equivalent lens and equivalent focal length, cardinal points of a lens, power of a lens. Defects of images: spherical aberration. Astigmatism, coma, distortion, curvature and chromatic aberration. Optical instruments, Compound microscope, polarizing microscope, resolving power microscope, camera and photographic techniques.

Wave mechanics: Principle of statistical physics: Probabilities, classical statistics, quantum statistics: Bose-Einstein statistics, Fermi-Dirac statistics and their applications. Fundamental postulates of wave mechanics, time dependent Schrodinger's equation, steady state Schrodinger's equation for one electron atom and its solution.

Thermal Physics: Heat and work- the first law of thermodynamics and its applications; Kinetic Theory of gases- Kinetic interpretation of temperature, specific heats of ideal gases, equipartition of energy, mean free path, Maxwell's distribution of molecular speeds, reversible and irreversible processes, Carnot‟s cycle, second law thermodynamics, Carnot‟s theorem, entropy, Thermodynamic functions, Maxwell relations, Clausius and Clapeyron equation.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Reading Material:**

1. A Textbook of Optics, Brijlal and Subramannyam
2. A Textbook of Sound, Brijlal and Subramannyam
3. Waves and oscillation, Brijlal and Subramannyam
4. Physics part-I, Resnick and Haliday
5. Physics part-II, Resnick and Haliday
6. Fundamentals of Physics, Haliday, Resnick and Walker
7. Concept of Modern Physics, Arther Beiser; McGraw Hill
8. Perspective of Modern Physics, Arther Beiser; McGraw Hill

**PHY 4203: Physics-II (Electricity, Magnetism, Modern Physics and Mechanics)**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Rationale:**

To perform experiments to verify practically the theories and concepts learned and understand the difference between theory and application.

**Course Objective:**

1. To help learning how to be patient and careful while taking observation.
2. To provide knowledge on how to develop the ability of the students to conduct, observe, analyse and report an experiment.
3. To help to deal with physical models and formulas mathematically.

**Course Outcomes (CO):**

1. Demonstrate an ability to make physical measurements and understand the limits of precision in measurements.
2. Demonstrate the ability to use experimental statistics to determine the precision of a series of measurements.
3. Compare to use various methods of circuit analysis both for DC and AC networks and their solution methods.
4. Appraise the characteristics of different electronic devices.

**Course Content:**

States of matter: solid, liquid, and gas. *Classification of solids:* amorphous, crystalline, ceramic and polymers; Plasticity and Elasticity, *Atomic arrangement in solid;* different types of bonds in solids: metallic and Vander Waal’s, covalent and ionic bond. Packing in solids; Inter atomic distances and forces of equilibrium; X-ray diffraction; Bragg’s law, distinction between metal, insulator and semiconductor.

Electricity: electric charges and Coulomb's law. *The electric field:* calculation of the electric flux and Gauss' law; some application of Gauss' law, electric potential, relation between electric potential and electric-field; capacitors: Capacitance, dielectrics and atomic view, dielectric and Gauss' law; Current and resistances: current density, ohm's law, resistivity-an atomic view, Ampere's law, Faraday's law; Lenz's law, self-inductance and mutual inductance.

Magnetic properties of matter*:* magneto motive force, magnetic field intensity, permeability, susceptibility; classification of magnetic materials, magnetization curves.

Modern physics: Photoelectric effect, Compton effect, de-Broglie wave, Bohr atomic model, radioactive decay, half-life, mean life, isotopes; nuclear binding energy, alpha, beta, gamma decay.

Theory of relativity: Michelson Morley's experiment, Galilean transformation, Special theory of relativity, Lorentz transformation, relative velocity, Length contraction, Time dilation, mass energy relation,

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Reading Material:**


1. Elementary Solid-state Physics, M. Ali Omar, Pearson education.
2. Introduction Solid state Physics, C. Kittle; John Wiley& sons Inc.
3. Concept of Modern Physics, Arther Beiser; McGraw Hill
4. Perspective of Modern Physics, Arther Beiser; McGraw Hill
5. Modern Physics, B. L Theraja.
6. Physics part-II, Resnick and Halliday
7. Crystallography applied to solid state Physics, A.R. Verma


**PHY 4204: Physics Sessional**
*3.00 Contact Hour; 1.50 Credit Hour;*

**Rationale:**

To perform experiments to verify practically the theories and concepts learned and understand the difference between theory and application.

**Course Objective:**

1. To help learning how to be patient and careful while taking observation.
2. To provide knowledge on how to develop the ability of the students to conduct, observe, analyse and report an experiment.
3. To help to deal with physical models and formulas mathematically.

**Course Outcomes (CO):**

1. Demonstrate an ability to make physical measurements and understand the limits of precision in measurements.
2. Demonstrate the ability to use experimental statistics to determine the precision of a series of measurements.

3. Compare to use various methods of circuit analysis both for DC and AC networks and their solution methods.
4. Appraise the characteristics of different electronic devices.

**Course Content:**

Determination of specific resistance of a wire using a meter bridge, determination of the resistance per unit length of meter bridge wire, determination of mechanical equivalent (J) of heat by the electrical method, determination of electrochemical equivalent (ECE) of copper by the cooper Voltammeter, determination of resistance of a galvanometer by half deflection method, determination of high resistance by the method of deflection, determination of focal length of a concave lens by auxiliary lens method, determination of radius of a curvature of a Plano convex lens by Newton's ring method, determination of the refractive index of the material of a prism by spectrometer, determination of the specific rotation of sugar solution by Polarimeter, determination of frequency of a tuning fork by the Melda's experiment, determination of the spring constant and the effective mass of a loaded spring and hence to calculate the rigidity modulus of the spring, determination of the value of g acceleration due to gravity by means of a compound pendulum, determination of Young's modulus of a bar by bending method, determination of the modulus of rigidity of a wire by statistical method.

**Teaching-learning and Assessment Strategy:**

Lab performances, Lab Report/Assignment/Presentation, Lab Test/ Quiz.

**Reading Material:**


1. Fundamentals of Physics (10th ed), Halliday, Resnick and Walker, Wiley (2013).
2. A Textbook of Optics, Brijlal and N. Subrahmanyam, S. Chand (2006).
3. Physics for Engineers, Part-1 & Part-2 (4th ed), Dr. Giasuddin Ahmad, Hafiz Book Centre (2000).
4. Waves and oscillations (2nd ed), Brijlal and Subramannyam, Vikas Publishing House Pvt Ltd (1994).
5. Physics part-I & II ($2^{nd}$ ed), Resnick and Halliday, John Wiley & Sons, Inc. (1968).
6. Fundamental of Optics ($3^{rd}$ ed), Jenkine and White, McGraw Hill (1957).


**CHM 4101: Chemistry (Atomic Structure, Thermo-Chemistry, Chemistry of Engineering Materials)**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Rationale:**

To provide a broad foundation in chemistry that stresses scientific reasoning and analytical problem solving with a molecular perspective.

**Course Objective:**

1. To learn laboratory skills to design, conduct and interpret chemical research.
2. To expose the students to a breadth of experimental techniques using modern instrumentation.

**Course Outcomes (CO):**

1. Identify the basic knowledge of different areas of chemistry.
2. Interpret the application of computer science in chemistry.
3. Apply the knowledge of chemistry for studying wide range of subjects such as medical science.

**Course Content:**

Concepts of atomic structure, Different atom models, Quantum numbers, Electronic configuration, Periodic classification of elements, Periodic properties of elements, Properties and uses of noble gases, Chemical bonding (types, properties, Lewis theory, VBT, MOT), Hybridization and shapes of molecules, Selective organic reactions such as- addition, substitution, oxidation- reduction, alkylation and polymerization, Phase rule, Phase diagram of mono component system.

Solutions and their classification, Unit expressing concentration, Colligative properties of dilute solutions, Thermo chemistry, Chemical kinetics, Chemical equilibrium, pH and buffer solutions, and Electrical properties of solution.

Glass: raw materials, classification, manufacturing processes and application of glasses in chemical industries. Ceramics: fundamental of ceramic industry, raw materials, property, manufacture and classification of ceramic products. Refractory materials: raw materials, properties, manufacture and classification of refractory. Corrosion: nature, form and types of corrosion, electrochemical mechanism and prevention of corrosion. Corrosion in boiler and boiler feed water treatment, Paints, varnishes and metallic coating: composition and application of paints, varnishes and metallic coatings, methods used in applying coatings on metal surface.

Plastics: fundamental characteristics, classification, raw materials, and manufacture of plastics, some typical examples of plastics and their uses. Fibres: types of fibres, raw materials, applications and manufacturing processes of synthetic fibres. Rubber: source of natural rubber, chemical treatment of latex, raw materials, synthetic reactions and properties of synthetic rubber. Lubricants: principle of lubrication, sources, properties and refining of lubricants, mechanical and industrial importance of lubrication, Carbon: properties and application of carbon and graphite, manufacturing and applications of non- fabricated industrial carbon.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Reading Material:**


1. Chemical Process Industries ($5^{th}$ edition), Norris Shreve & Joseph A. Brink, Jr.
2. Industrial Chemistry, B. K. Sharma.
3. A textbook of Engineering Chemistry, M. M. Uppal.
4. Industrial Chemistry, B. N. Chakrabarty.
5. Corrosion Engineering, Mars G. Fontana & Norbert D. Greene.
6. Design and Corrosion Control, V. R. Pludek.
7. An Introduction to Metallic Corrosion and its Prevention, Raj Narayan.


**CHM 4102: Chemistry Sessional**
*1.50 Credit Hour; 3.00 Contract Hour;*

**Rationale:**

To learn the basic concepts of inorganic, organic and physical chemistry.

**Course Outcomes (CO):**

1. Upon completion of all sessional, the students will be able to:

2. Define the different parameters regarding acid and base neutralization, titration and quantitative analysis of metals etc. and others key words like primary standard substances, secondary standard substances, molarity, normality, indicator, equivalent weights and so on.
3. Explain the different phenomena regarding iodometric and iodometric method, complexometric titration etc.
4. Estimate zinc, ferrous content in water sample by using various titrimetric methods.
5. Summarize a report of any project work and apply in real life.

**Course Contents:**

Volumetric analysis: Acid-base titration, Oxidation-reduction titration: Determination of Cu, Fe and Ca content volumetrically.

**Teaching-learning and Assessment Strategy:**

Daily lab performance, Lab Attendance, Lab reports, Lab test, Lab quiz, Lab viva.

**Reading Material:**


1. Principles of Physical Chemistry, Haque & Nawab; Students' Publications.
2. Fundamentals of Physical Chemistry, Samuel H. Maron& Jerome B. Lando; MacMillan
3. Publishing Co., Inc., New York.
4. Physical Chemistry, P. W. Atkins; Oxford University Press.
5. Essentials of Physical Chemistry, B.S. Bahl & G.D. Tuli; S., Chand and Company Ltd.
6. General Chemistry, Ebbing; Houghton Mifflin Company.
7. Organic Chemistry, M. Ahmed &Jabbar Mian; Mrs. Sufia Ahmed and Mrs. Jahan-Ara Begum.
8. Organic Chemistry, I. L Finar; ELBS Longman Group Ltd.
9. Organic Chemistry, Morison & Boyd; Prentice Hall of India.
10. Introduction to Modern Inorganic Chemistry, S.Z. Haider; Friend's International.
11. Modern Inorganic Chemistry, R. D. Madan; S. Chand and Company Ltd.
12. Advanced Inorganic Chemistry, F. Albert Cotton & Geoffrey Wilkinson; John Wiley & Sons.


## 4.4 Allied Engineering Courses for Aerospace Major

**EEE 4191: Electrical Circuit Analysis**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Course Content:**

Laws of electric circuit: Ohm's Law, Kirchhoff's voltage and current laws, delta-wye transformation. Electrical networks: network analysis methods of branch and loop currents, method of node pair voltages, Thevenin's and Norton's theorems, Magnetic concepts and units: magnetic field, right hand rule, magnetic flux density, Biot Savart law, magnetic field intensity, measurement of magnetic flux, energy of magnetic field, characteristic of ferromagnetic materials, theory of ferromagnetism, B-H curve, hysteresis loss, eddy current and eddy current loss, total core loss. Introduction to magnetic circuits. Electromagnetic forces: forces upon a current carrying conductor and charged particles moving in a magnetic field. Electromagnetic torque; electric motor. Electromagnetic induction and emf; Lenz's law, Blv rule, elementary a.c. generator.

General concepts and definitions. Instantaneous current, voltage and power, R-, L-, C-, RL-, RC- and RLC-branches, Effective current and voltage: average values, form factor, crest factor, power real and reactive. Introduction to vector algebra. Impedance in polar and Cartesian forms. Sinusoidal single-phase circuit

analysis. Impedance in series, parallel branches, series-parallel circuits. Network analysis – Thevenin's theorem. Balanced poly phase circuits: three phase, four wire system of generated emfs, three phase, three wire systems, balanced wye loads, balanced delta loads, power in balanced systems, power factor. Balanced three phase circuit analysis and power measurement.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Reading Material:**

1. Introductory Circuit Analysis, R. L. Boylestad.
2. Introductory Circuit for Electrical & Computer Engineering, James W. Nilson.
3. Alternating Current Circuits, Russel M Kerchner and George F Corcoran.

**EEE 4192: Electrical Circuit Analysis Sessional**
*3/2 Contact Hour; 0.75 Credit Hour;*

Sessional for EEE 4191.

**CSE 4291: Computer Programming and Application**
*3.00 Contact Hour; 3.00 Credit Hour; Pre-requisite: None*

**Course Objectives:**

1. The course is designed to provide complete knowledge of C language.
2. Students will be able to develop logics which will help them to create programs, applications in C.
3. Learning the basic programming constructs so that students can easily switch over to any other language in future.

**Course Content:**

Introduction to computer hardware and its working principle; Programming logic, algorithms, and flowcharts. Introduction to structured programming; Overview of C and C++ programming languages; C and C++ fundamentals – data types and expressions; Operators, Libraries and keywords; Statements; Arrays and strings; Functions; Control statements; Pointers; Input and output systems, Objective Oriented programming; Introduction to advanced programming. Introduction and familiarization with MATLAB software.

**Course Outcomes**:

1. Analyse syntax- related concepts including context- free grammars, parse trees, recursive- descent parsing, printing, and interpretation.
2. Interpret semantic issues associated with function implementations, including variable binding, scoping rules, parameter passing, and exception handling.
3. Design issues of object- oriented and functional languages.
4. Inspect language abstraction constructs of classes, interfaces, packages, and procedures.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Reading Material:**

1. Turbo C/C++: The complete reference (2nd edition), Herber Schildt, Osborne Mc Graw-Hill.
2. C Programming using Turbo C++ (2nd edition), Robert Lafore, Tech media.

**CSE 4292: Computer Programming and Application Sessional**
*3.0 Contact Hour; 1.50 Credit Hour; Pre-requisite: CSE 4291*

**Course Objectives**:

1. The course is designed to provide complete knowledge of C language.
2. Students will be able to develop logics which will help them to create programs, applications in C.
3. Learning the basic programming constructs so that students can easily switch over to any other language in future.

**Course Content:**

As a fundamental subject, this course equips the students with theory and practice on problem solving techniques by using the structured approach. Students are required to develop programs using C programming language, in order to solve simple to moderate problems. The course covers the following: pre-processor directives, constants and variables, data types, input and output statements, text files, control structures: sequential, selection and loop. It may also include arrays and basic library functions.

**Course Outcomes:**

1. Solve problems systematically using a structured logic approach.
2. Construct a C program correctly from the analysed problems using structured approach.
3. Construct or develop complete C programs for simple to moderate problems individually.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Reading Material:**

1. Turbo C/C++: The complete reference (2nd edition), Herber Schildt, Osborne Mc Graw-Hill.
2. Heat Engines, D. A. Low
3. C Programming using Turbo C++ (2nd edition), Robert Lafore, Tech media

**EEE 4391: Electrical and Electronic Technology**
*3.00 Contact Hour; 3.00 Credit Hour*

**Course Outline:**

Single phase transformer-equivalent circuit and laboratory testing, introduction to three phase transformers. DC generator: principle, types, performances and characteristics. D C Motor: principles, types of motor, performances, speed control, starters and characteristics. A C Machines: three phase induction motor principles, equivalent circuit. Introduction to synchronous machines and fractional horsepower motors.

Semiconductor diode, transistor characteristics, equivalent circuits, self-biasing circuits, emitter-follower amplifiers, push-pull amplifier. Introduction to silicon-controlled rectifier and its application. Oscilloscope. Transducers: strain, temperature, pressure, speed and torque measurements.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Reading Material:**

1. Electric Machines and Transformers, Irving L. Kosow.
2. Electrical Machines Fundamentals, Stephan J. Chapman.
3. A Textbook of Electrical Technology (AC, DC Machines), B L Theraja, A. K. Theraja.
4. Electronic Devices and Circuit Theories, R. L. Boylsted.

**EEE 4392: Electrical and Electronic Technology Sessional**
*3.00 Contact Hour; 1.50 Credit Hour;*

Laboratory experiments based on EEE 4391.

**AVE 4791: Avionics Systems**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Pre-requisite:** EEE 4191, EEE 4391

**Course Objective:**

1. To learn about basic operating principles of airborne electronic systems used in common aircrafts and helicopters.
2. To learn about basic operating principles of ground-based navigation and control equipment used for guiding air vehicles.
3. To develop an understanding on how real time safety critical electronic systems are different from commercial electronic systems.
4. To learn about fault tolerant systems.
5. To develop analytic knowledge on system integration and sensor network in a real time safety critical environment

**Course Outcomes:**

Upon completion of the course, the students will be able to:

1. Analyse and formulate requirement of specific airborne RF and digital control equipment for a basic air vehicle.
2. Apply techniques of real time system development in safety critical environment.
3. Develop an airborne electronic platform with common control and monitoring systems

**Course Contents:**

Introduction: VHF and UHF radio, methods of navigation, radio direction finding, automation direction finder, radio compass, VHF omni directional range, distance measuring equipment (DME), DME beacon, TACAN.

Hyperbolic system of navigation: Loran-C, Instrument Landing System (ILS), localizer, glide slope indicator and marker beacon. Microwave Landing System (MLS), Doppler Navigation, Inertial Navigation.

Global positioning system (GPS): GPS segment, satellite constellation, navigation technique, GPS signal structure, navigation data, application of GPS, differential GPS and augmentation of GPS.

Traffic Alert Collision Avoidance System: Introduction, basic operating principle, block diagram and system description, controls and display.

Flight Management System: Introduction, basic operating principle, block diagram and system description, controls and display.

**Text and Ref Books:**

1. Electronics Defence Systems, Filippo Neri, Artech House Publishers.
2. Introduction to Electronics Navigation, Nagaraja, McGraw-Hill.
3. Digital Avionics Systems Principles and Practice, R. Spitzer; The Blackburn Press.

**AVE 4839: Control System Engineering**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Pre-requisite:** None.

**Rationale:**

This subject is classified and is introduced with a view that the students will be exposed to various types of control systems. More emphasis is given for understanding the basic concepts of control systems. Students are required to know the various components of a control system, basic concepts of stability, time domain and frequency domain characteristics, when they are working in process industries.

**Objective:**

1. To prepare engineers who can plan, design and construct instrumentation and control systems.
2. To develop and inculcate the engineer with intellectual, imaginative and engineering skills and to be able to respond and adapt to change, anticipate and initiate such a change.
3. To provide the graduate with a basis for continuing postgraduate education and self-reliance/employment skills

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Demonstrate an understanding of the fundamentals of linear control systems.
2. Determine and use of linear models of physical systems in forms suitable for use in the analysis and design of control systems.
3. Express and solve system equations in state-variable form (state variable models).
4. Analyze the time and frequency-domain responses of first and second-order systems to step and sinusoidal (and to some extent, ramp) inputs.
5. Evaluate the (relative and absolute) stability of a closed-loop control system using Routh criterion.
6. Apply root-locus, frequency response and state variable method technique to analyze and design control systems.

**Course Contents:**

Introduction to control systems. Linear system models: Transfer function, block diagram and signal flow graph (SFG). State variables: SFG to state variables, transfer function to state variable and state variable to transfer function. Feedback control system: Closed loop systems, parameter sensitivity, transient characteristics of control systems, effect of additional pole and zero on the system response and system types and steady state error. Routh stability criterion. Analysis of feedback control system: Root locus method and

frequency response method. Design of feedback control system: Controllability and observability, root locus, frequency response and state variable methods. Digital control systems: introduction, sampled data systems, stability analysis in Z-domain.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Text and Ref Books:**

1. Modern Control Systems – Richard C. Dorf and Robort H Bishop; Pearson Education Private Ltd.
2. Control System Engineering- Norman S. Nise; Wiley
3. Linear Control System Analysis and Design. - John J.D. Azzo& Constantine H. Houpis; McGraw-Hill International.
4. Modern Control Engineering - Ktsuhiko Ogata; Prentice Hall

**ASE 4803: Aircraft Instruments and Measurement Systems**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Pre-requisite:** None.

**Rationale:**

The goal of this syllabus is for the student to gain the necessary aeronautical skill, knowledge and experience to meet the requirements of an Instrument Rating with an Airplane category.

**Objective:**

1. To develop the idea of basic fundamental of instruments, working principles, basic structures classifications, mechanisms and comparisons of instruments.
2. Categorize aircraft flight Instruments according to different use and working mechanisms
3. Comparison between various system and rating different instruments
4. To learn about Temperature Indicating Systems, fuel quantity and flow systems and pitot static flight instruments.
5. Describe and explain the operation of flight instruments incorporating gyroscopes, using words and diagrams the operation of gyro-magnetic compass systems and operation of a flight director system (FDS) to block diagram level.

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Analyze the functioning of the flight instruments and power plant instruments in the aircraft system with different types of data displays.
2. Explain the working of airspeed, altitude, vertical speed, Mach, TAS, CAS, and IAS measuring system.
3. Analyze the working principle and usage of gyroscope in the aircraft system
4. Analyze the fuel flow and quantity measurement, signal conditioning system and digital data transmission lines.

**Course Contents:**

Fundamentals: Generalized measurements systems, dimensions and units of measurements, causes and types of experimental errors, error and uncertainty analysis.

Air pollution sampling and measurements; Data acquisition and processing.

Introduction to Basic-6 and Basic-T aircraft instruments, applications of instruments in aircraft, functional elements of a measurement system and classification of instruments.

Instrument display and layout: Qualitative, quantitative display, scale range, operating range, type of scales- linear, non-linear, circular, straight, dual displays and digital display; instrument grouping in cockpit.

Transducers: Primary, secondary, mechanical, electrical and optical.

Measurement of non-electrical quantities: Temperature, pressure, flow, level, force and torque.

Pitot-static group of Instruments: ASI, Altimeter, VSI, Mach meter: Construction, operating principle, square law compensation, introduction to Air Data Computer, TAS, CAS, IAS

Aircraft Attitude & Indication system: Gyroscope & properties- Precession & rigidity, Gyro Horizon Indicator, Turn & Bank Indicator, construction and operating principle.

Measurement of Engine RPM: Torque measurement, Tacho probe.

Temperature Measurement: Thermocouple, Radiation pyrometer, PRTD, air temperature sensors' principle application in aviation.

Fuel flow and quantity measurement: Resistive & Capacitive transducer, aircraft fuel measurement system, compensation for aircraft attitude and non-uniform tank contour.

Basic elements of signal conditioning: Instrumentation amplifier, noise and source of noise, noise elimination compensation, A/D and D/A converters, sample and hold circuits. Data acquisition system.

Digital Data Transmission Lines: Data buses, MIL STD 1553, ARINC 429, Optical data buses.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Text and Ref Books:**


1. Aircraft Instruments and integrated Systems- EHJ Pallet; Pearson Education Publishers.
2. Aircraft Electricity and Electronics- Thomas Eismin; Glencoe.
3. Modern Electronic Instrumentation and Measurement Techniques - Albert D Helfrick; Prentice, Hall of India private Ltd.
4. Federal Aviation Agency (FAA) Hand Book of Flying: Flight Instruments.
5. Electrical Electronics Measurement and Instrumentation - A.K. Sawheney; Dhanpat Rai and Company Private Ltd.


**ASE 4804: Aircraft Instruments and Measurement Systems Sessional**
*1.50 Contact Hour; 0.75 Credit Hour;*

**Pre-requisite:** Aircraft Instruments and Measurements.

**Rationale:**

The student must demonstrate to aeronautical knowledge and skills necessary to obtain an Instrument Rating of any Airplane.

**Objective:**

1. To learn about different mechanism system and how they works in practical environment
2. Understanding different flight instruments working category

3. Experimenting errors in system and deduce the errors to get better values
4. Prepare and plan any project related to aircraft instrument and demonstrate its working principle

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Conduct experiments, and then analyze and interpret results successfully.
2. Demonstrate that water level and flow rate can be controlled by using feedback transducer.
3. Analyze the principle of operations of the pitot static system.
4. Demonstrate that the functions of various aircraft instruments are based on the pitot static system
5. Analyze the properties, operation and construction of directional gyro.
6. Know the basic working principle of instruments using in aircraft's operation and maintenance.

**Course Contents:**

Familiarization with Pressure Transducer (Strain Gauge), Flow Rate Control of Water by Feedback Transducer, Study of negative temperature coefficient transducer (NTC) and its linearity by feedback method, Errors in measurement and basic statistical sampling, Study of an 8 bit analog to digital converter.

**Teaching-learning and Assessment Strategy:**

Daily lab performance, Lab Attendance, Lab reports, Lab test, Lab quiz, Lab viva.

**Text and Ref Books:**


1. Modern Electronic Instrumentation and Measurement Techniques - Albert D Helfrick; Prentice, Hall of India private Ltd.
2. Federal Aviation Agency (FAA) Hand Book of Flying: Flight Instruments.
3. Electrical Electronics Measurement and Instrumentation - A.K. Sawheney; Dhanpat Rai and Company Private Ltd.


## 4.5 Elective Courses from Aerospace Engineering Department

**ASE 4717: Hypersonic Aerodynamics**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Pre-requisite:** High Speed Aerodynamics

**Rationale:**

To learn about aerodynamics of hypersonic flows.

**Course Outcomes (CO):**

1. Understand the fundamentals of hypersonic flows and understanding the shock wave nature in hypersonic flow regime and quantitatively analyse the property variation.
2. Solve the inviscid and viscous flows in the hypersonic regime using specific methods.
3. Evaluate the Boundary layer interaction in hypersonic flow. Understand and analyse the heat-transfer related issues in the hypersonic regime.
4. Prepare themselves for the futuristic design of the vehicles including high speed heat transfer problems in aerospace.

**Course Contents:**

The course covers: fundamentals of hypersonic aerodynamics, simple solution methods for hypersonic inviscid flows, viscous hypersonic flow theory, viscous interaction in hypersonic flows, heat transfer problems in aerosapce engineering.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Reading Materials:**


1. John D. Anderson Jr., "Hypersonic and High Temperature Gas Dynamics," McGraw Hill Series, New York, 1996
2. William, H. D., "Viscous Hypersonic Flow – Theory of Reacting and Hypersonic Boundary Layers,"Dover Publications Inc. Mineola, New York, 2017.
3. Murthy, T. K. S., "Computational Methods in Hypersonic Aerodynamics," Springer, New Delhi, 1992 edition.
4. Dr. Mukarram Hussain, "Hypersonic Aerodynamic Performances of Asymmetric Re-Entry Vehicles," LAP Lambert Academic Publishing, Saarbrücken, Germany, 2011.
5. John D. Anderson Jr., "Modern Compressible Flow with Historical Perspective". McGraw Hill Publishing Company, New York, 1996.
6. John T. Bertin, "Hypersonic Aerothermodynamics", published by AIAA Inc.,


**ASE 4725: Advanced Aerospace Materials Processing Technology**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Pre-requisite:** None

**Rationale:**

To learn about Advanced Materials Processing Technologies.

**Course Objectives:**

1. To Explain the common mechanisms by which engineering materials fail
1. 2.To Explain the general internal structure of each major class of engineering material
2. To Identify the principal concerns of common materials processing techniques;

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Explain the common mechanisms by which engineering materials fail
2. Explain the general internal structure of each major class of engineering material
3. Identify the principal concerns of common materials processing techniques;

**Course Content:**

Overview of Advanced Materials Processing Technologies: Outline of advanced materials processing techniques: Precision Materials Removal Processes; Precision Forming; Microwave Technology; Advanced Surface Engineering Processes; Joining Technologies.

Precision Removal Processes: Ultra-precision machining, theories, principles and applications. Micro Electro-discharge machining. Physio-chemical machining, Surface Metrology of machined components.

Laser Materials Processing: Fundamentals of industrial lasers. Laser materials interaction theories. Laser processing for various industries such as metals, non-metals, photovoltaic, bio-medical applications.

Nontraditional Machining: Principles, equipment, process variables and applications – surface engineering – concept of CIM and FMS – additive manufacturing – advanced manufacturing techniques.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Text and Ref books**:

1. Aerospace Materials Handbook- Editors: Sam Zhang, Dongliang Zhao
2. Manufacturing Technology for Aerospace Structural Materials- F.C. Campbell; Elsevier

**ASE 4749: Rockets and Missiles**
*3.0 Contact Hour; 3.0 Credit Hour;*

**Pre-requisite:** High Speed Aerodynamics, Aerospace Vehicle Stability and Control, Applied Aerodynamics

**Rationale:**

To provide theoretical background for research, development weapons and other artillery associated with it.

**Course Objective:**

1. To be familiarized with different aspects of explosives.
2. To understand fundamental concepts of missiles.
3. To learn missile aerodynamics, missile guidance.
4. To have a proper understanding of phenomena related to blast.
5. To understand basics of designing explosives, missile

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to

1. To differentiate between energetic materials and non-energetic materials.
2. To explain the explosion process and its effects
3. To explain working principle of warheads, propulsion systems.
4. To apply the theoretical knowledge for designing of explosive storage areas.

**Course Content:**

History of explosives; Types and properties of explosives; Initiation systems, quantity distance procedures; Effect of blast, fragmentation and shaped charge warheads; Quarry blasting and explosive demolition; Blast waves and interactions, blast loads on structures, blast analysis and structural design; Survivability of structures.

Kinetic energy of penetrations; Propellant charges; Fuses, initiators, detonators and safe / arm devices; Dynamics of unguided weapons: fin and spin stabilization.

Principles of missile flight and propulsion; Aerodynamics and dynamics of slender bodies and wings; Spin and fin stabilization of projectiles, trajectories and manoeuvre capabilities; Layout, control, propulsion and their integration with other systems; Storage, maintenance, transport and launch considerations. Missile guidance techniques; Physics and accuracy of missile sensors and effect on guidance; Advanced guidance and sensor systems; Prediction techniques for missile aerodynamics; Introduction to Electronic warfare.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Textbook:**

1. Brassey's Series Book on Explosives, Propellants and Pyrotechnics, A Bailey, S.G. Murray
2. Explosive Engineering, P.W Cooper.
3. Conventional Warhead Systems Physics and Engineering Design, R. M. Lloyd
4. Guided Missiles, T.V. Karthikeyan and A.K. Kapoor
5. Missile Guidance and Control systems, George M Siouris.
6. Recommendations on Transport of Dangerous Goods, United Nations Orange Book

**ASE 4763: Spacecraft Attitude Determination and Control**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Prerequisites:**

Mathematics, Aerosapce Vehicle Dynamics and Control, Feedback Control System

**Rationale:**

To introduce students to the dynamics and control problems of pointing spacecraft.

**Course Objectives:**

1. To provide students a solid understanding of spacecraft and missile attitude dynamics.
2. To present applications of classical and modern control theory to design of guidance, navigation and control systems for spacecraft and missiles.
3. To provide students with the simulation and analysis tools required to perform graduate level research in spacecraft and missile control systems.

**Course Outcomes (CO):**

1. Students can identify attitude control concepts. Students can apply rotational kinematics to the pointing motion of spacecraft.
2. Students can apply attitude determination methods.
3. Students can apply rigid body mechanics to the pointing motion of spacecraft.

**Course Contents:**

Space missions and how pointing requirements affect attitude control systems. Rotational kinematics and attitude determination algorithms. Modelling and analysis of the attitude dynamics of space vehicles. Rigid body dynamics, effects of energy dissipation. Gravity gradient, spin, and dual spin stabilization. Rotational manoeuvres. Environmental torques. Impacts of attitude stabilization techniques on mission performance.

**Reading Materials:**

1. Markley, F. Landis, and John L. Crassidis. Fundamentals of Spacecraft Attitude Determination and Control. Vol. 33. New York: Springer, 2014.
2. Schaub, Hanspeter, and John L. Junkins. Analytical mechanics of space systems. AIAA, 2003.
3. Kabamba, Pierre T., and Anouck R. Girard. Fundamentals of Aerospace Navigation and Guidance. Cambridge University Press, 2014.

**ASE 4765: Guidance, Navigation and Control**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Rationale:**

GNC (Guidance, Navigation and Control) is one of the most important field for aerosapce vehicle, it is therefore very important that aerosapce engineers are made aware of these systems.

**Course Objective:**

To familiarize students on guidance, navigation and control systems of aerospace vehicle.

**Course Outcomes (CO):**

1. Develop mathematical models that characterize aerospace vehicle dynamics, navigation errors, guidance laws, and control laws.
2. Use linear/nonlinear techniques to synthesize navigation, guidance, and control algorithms for aerospace vehicles.
3. Learn to use computer aided design and analysis tools for navigation, guidance, & control design (MATLAB/SIMULINK).

**Course Contents:**

The topics to be covered are listed below.

1. Aerospace Vehicle Dynamics (a) Review of governing equations of motion for aerospace vehicles (b) Linear systems analysis of aerospace systems (c) Applications - aircraft, spacecraft, missiles, launch vehicles.
2. Navigation (a) Navigation computation and error modelling (b) Inertial navigation systems (c) External navigation aids - GPS, Doppler radar, Star trackers (d) Multi-sensor fusion

3. Guidance (a) Guidance mission and performance (b) Guidance algorithm - guidance laws, single-dual-multi-mode guidance (c) Advanced guidance system design
4. Control (a) Basic linear control laws for aerospace applications (b) Nonlinear control laws - Gain scheduling
5. Practical navigation and guidance filter design
6. Integrated inertial navigation system - Integrated sensing/flight control, Integrated missile guidance systems Robust navigation and guidance laws

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Reading Materials:**

1. Aircraft Control and Simulation: Dynamics, Controls Design, and Autonomous Systems, 3rd Edition, Brian L. Stevens, Frank L. Lewis, Eric N. Johnson, ISBN: 978-1-118-870983, November 2015, Wiley-Blackwell.
2. Modern Navigation, Guidance and Control Processing Volume-II, Ching-Fang Lin, Prentice Hall Series in Advanced Navigation, Guidance and Control and Their Applications.
3. Tactical and Strategic Missile Guidance, Paul Zarchan, AIAA Progress in Astronautics and Aeronautics

**ASE 4767: Rotorcraft Performance**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Pre-requisite:** None

**Rationale:**

To learn about the performance of rotorcraft.

**Course Objectives:**

1. To Gain knowledge about various types rotorcraft flight conditions.
2. To Understand the performance of rotors and engines in the presence of a helicopter fuselage and other rotors.
3. To Evaluate various control settings and actuator forces for trim in hover, forward and climbing flight.
4. To Gain knowledge about various types of flight tests in relation to rotorcrafts.

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Gain knowledge about various types rotorcraft flight conditions.
2. Understand the performance of rotors and engines in the presence of a helicopter fuselage and other rotors.
3. Evaluate various control settings and actuator forces for trim in hover, forward and climbing flight.
4. Gain knowledge about various types of flight tests in relation to rotorcrafts.
5. Gain knowledge about and design components of rotorcrafts considering fail safe and safe life concepts.

**Course Content:**

Examine the performance of rotorcraft in hover, forward and climbing flight; Methods for estimating the performance of rotors and engines in the presence of a helicopter fuselage and other rotors; Calculate the control settings and actuator forces for trim in hover, forward and climbing flight at various centre of gravity locations for a real helicopter.

Helicopter dynamics and proceeds to derive stability augmentation and flight control system design; Rotorcraft flight test engineering including the use of dimensional analysis; Design regulations and considerations relating to rotor induced vibration, ground resonance and fatigue; Emphasis on design for crash worthiness; Fail safe and safe life concepts.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Text and Ref Books:**

1. Rotary Wing aerodynamics, W.Z. Stepniewski and C.N. Keys; Dover Publications.
2. Theory of Flight (AP 3456A), Royal Air Force Manual.
3. Helicopter Flight Dynamics, Gareth D. Padfield.

**ASE 4785: Maintenance Management and Repair of Aircraft**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Pre-requisite:** None

**Rationale:**

To learn the vocabulary, practice and technologies of aircraft maintenance management, the areas of concern for maintenance professionals.

**Course Objective:**

1. To be familiarized with aviation regulatory framework in which continuing airworthiness and aircraft maintenance is managed
2. To learn about tools used in the planning and control of maintenance.
3. To understand aircraft maintenance principles and procedures.
4. To have knowledge about the personnel issues of training and safety.
5. To understand the processes of maintenance programme development.

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Understand the basic function of an organization/industry and associated role of an aircraft maintenance engineer to ensure compliance to industry standards to accomplish its objective.
2. Study the concept, benefits, policies, performance indicators, methods and techniques of different maintenance programmes for proactive and cost-effective approaches of aircraft maintenance.

3. Apply systematic approaches in a variety of different ways to describe, investigate and analyze complex engineering systems and associated issues as well as conduct any type of management in engineering projects.
4. Develop decision-making methodologies for components, systems and/ or processes to meet specified requirements, including innovative approaches to synthesis alternative solutions, concepts and procedures.
5. Apply aircraft maintenance principles, procedures and airworthiness regulations to aircraft maintenance management.

**Course Content:**

Maintenance management principles and techniques – maintenance strategies, repair/replacement decision making, condition monitoring, maintenance management information systems; damage assessment techniques; Types of aircraft maintenance; Maintenance requirements for various aircraft components; Aero-engine maintenance; Engine overhaul, component life, lubrication, patches and repairs, serviceability of components.

Logistics concepts, statistics of reliability, availability, maintainability, reparability, life-cycle costing, logistic support analysis and supply support factors.

Practical issues in maintenance and repair of structures and systems and details of maintenance scheduling activities; Advanced methods of maintenance and repair; Application of NDI for manufacture and maintenance of structural components in aircraft industry.

Different structural failure modes and analysis the causes of failure; Aircraft accident investigation and prevention.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Text and Ref Books:**

1. Aircraft Production Technology and Management, S C Keshu and KK Ganapathi; Interline Publishing.
2. Aircraft Maintenance and Repair, Kroes; Watkins Delp, McGraw Hill.
3. Aircraft Construction, Repair and Inspection, JOE Christy; Sterling Book House.

**ASE 4787: Aircraft Pressurization System**
3.00 Contact Hour; 3.00 Credit Hour;

**Pre-requisite:** None

**Rationale:**

To learn about the pressurization and air conditioning system in an aircraft.

**Course Objectives:**

1. To learn the basic knowledge about the Concept of pressurization and its applications in the cockpit
2. To analyse the various components related to cockpit pressurization

3. To be able to ensure the flight safety by actively considering the effect of Air conditioning equipment.
4. To analyse the associated risk and reliability in relation to Pressurization and Air Conditioning Systems
5. To be able to incorporate emergency procedure in handling Fire hazard and firefighting equipment.

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Gain knowledge about pressurization system and different components related to cockpit pressurization;
2. Analysis of vapor compression refrigeration, absorption refrigeration and air-cycle refrigeration systems;
3. Evaluate various Air conditioning systems;
4. Gain knowledge about Refrigeration equipment: compressors, condensers, evaporators, expansion devices, other control and safety devices;
5. Analysis of Fire hazard and firefighting equipment

**Course Content:**

Concept of pressurization and its applications in the cockpit; Study of pressurization system and different components related to cockpit pressurization.

Concept of refrigeration and its applications; Different refrigeration methods; Analysis of vapor compression refrigeration, absorption refrigeration and air-cycle refrigeration systems; Refrigerants; Refrigeration equipment: compressors, condensers, evaporators, expansion devices, other control and safety devices; Multi-evaporator, multi-compressor systems; Low temperature refrigeration.

Concept of air conditioning and its uses; Cooling load calculation; Psychometric analysis; Air conditioning systems; Air distribution systems; Duct design methods; Air conditioning equipment; Application criteria; Control systems.

Fire hazard and firefighting equipment.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Text and Ref Books:**

1. Modern Refrigeration and Air-conditioning, A D. Althause, C. H. Turnquist, A.F. Bracciano; The Goodheant Wilcox Company, Inc. 1982.
2. Heating cooling of Building, Design for Efficiency, J. F. Kreidev, A. Raldl; McGraw-Hill International Edition, 1994.

**ASE 4789: Aircraft Structural Design**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Pre-requisite:** None

**Rationale:**

To learn the various factors in designing the different components of the aircraft.

**Course Objective:**

1. To learn what an engineer should consider as a responsibility during the design phase of an aircraft.
2. To be able to explain the contemporary requirements and trends for designing various components of an aircraft.
3. To be able to evaluate the different types of loads acting on the aircraft and their possible effect in its structural integrity.
4. To evaluate the advantages and disadvantages of basic contemporary configurations of different aircraft components.
5. To be able to ensure the safety of designed components based on structural integrity.

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Gain knowledge about an engineer's responsibility in relation to designing various components of an aircraft.
2. Understand the basic contemporary factors for designing various components of an aircraft.
3. Evaluate various types of loads acting on the aircraft.
4. Gain knowledge about various contemporary configurations of different aircraft components.

**Course Content:**

Introduction to Aircraft Structural Design; Design for Manufacturing: Engineer's Responsibility, Producibility, Maintainability, Tooling, Other Considerations.

Aircraft Loads: Review of Aero-elasticity, Flight Manoeuvres, Wing Design Loads, Empennage Loads, Fuselage Loads, Propulsion Loads, Landing Gear Loads, Miscellaneous Loads, and Example of an Airplane Load Calculation

Buckling and Stability of Structures: Columns and Beam Columns, Crippling Stress, Buckling of Thin Sheets, Thin Skin-Stringer Panel – Compression, Skin-Stringer Panel – General, Integrally Stiffened Panel, Wing Design: Wing Box Structure, Wing Box Design, Wing Covers, Spars, Ribs and Bulkheads, Wing Root Joints, Variable Swept Wings, Wing Fuel Tank Design, Wing Leading and Trailing Edges, Wing Control Surfaces, Fixed Leading and Trailing Edges, Design Considerations.

Empennage Design: Horizontal Stabilizer, Vertical Stabilizer (Fin), Elevator and Rudder Fuselage Design: Introduction, Fuselage Configuration, Fuselage Detail Design, Forward Fuselage, Wing and Fuselage Intersection, Stabilizer and Aft Fuselage Intersection, Fuselage Opening.

Landing Gear: Introduction, Development and Arrangements, Stowage and Retraction, Selection of Shock Absorbers, Wheels and Brakes.

Engine Mounts: Propeller-Driven Engine Mounts, Inlet of Jet Engine (Fighter), Wing-Pod (Pylon) Mounts, Rear Fuselage Mount and Tail Mount, Fuselage Mount (for Fighters)

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Text and Ref Books:**

1. Design of Aircraft, Thomas C. Corke; Pearson Education.
2. Synthesis of Subsonic Airplane Design (Delft UP), Torenbeek.
3. Airframe Structural Design: Practical Design Information and Data on Aircraft Structures, Michael Chun-Yung Niu

**ASE 4745: Feedback Control System**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Prerequisites:**

Mathematics and Computer Programming Language and Application

**Rationale:**

Feedback controls are ubiquitous and fundamental to modern engineering. Whether it is a component in a simple water tank or the sophisticated control systems in aeronautics and robotics, feedback controls make technology safer, faster, more reliable, if not possible in the first place. Feedback systems can also be found in unexpected areas, for example in biology or economics. Therefore, it is important that engineering students understand feedback control system and its application.

**Course Objective:**

1. Learn how to describe and characterize the process to be controlled
2. Learn how to determine the performance of feedback systems in terms of stability and dynamic response
3. Learn how to design feedback controls to meet desired performance criteria.

**Course Outcome (CO):**

By the end of this course, students should have:

1. Obtained an understanding of the eff ect of feedback in linear systems
2. Gained the ability to quantitatively describe a given system (e.g., equations, block diagram)
3. Gained the ability to predict the stability behaviour, and the dynamic and steady-state response of feedback control systems
4. Acquired the ability to apply various feedback control analysis and design methods
5. Learned how to simulate a feedback control system in software
6. Learned how to design a closed-loop system to meet a required behaviour

**Course Contents:**

The course covers the following topics:

1. Introduction to feedback control systems with examples
2. System description with diff erential equations
3. Mathematical treatment of feedback systems in the Laplace domain

4. State-variable description of feedback systems
5. Time-discrete systems, finite-diff erence equations, z-transform
6. Formal description with block diagrams and signal flow graphs
7. Linearization of nonlinear elements
8. Numerical simulation of control systems with MATLAB
9. Disturbances and steady-state response of feedback systems
10. Dynamic performance and transient response of feedback systems
11. Stability criteria for continuous and time-discrete systems
12. Controller and compensator design
13. The root locus design method
14. Frequency-domain design methods, Bode diagrams and Nyquist design
15. The PID controller

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Text and Ref Books:**

1. Modern Control Systems, Dorf RC, Bishop RH. Pearson/Prentice Hall, ISBN 0-13-600152-1
2. Linear Feedback Controls, The Essentials, by M.A. Haidekker. Elsevier 2013, ISBN 978-0-124-05875-0
3. Feedback and Control Systems, DiStefano JJ, Stubberud AR, Williams IJ. Schaum's Outlines, ISBN 0-07-017052

**ASE 4746: Feedback Control System Sessional**
*1.50 Contact Hour; 0.75 Credit Hour;*

Sessional of ASE 4745 through MATLAB work in the Computer Lab.

**ASE 4771: Aerospace Systems Engineering**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Prerequisite:**

All courses taught up to $6^{th}$ semester.

**Rationale:**

Systems Engineering is an interdisciplinary approach and means to enable the realization of successful systems. It focuses on defining customer needs and required functionality early in the development cycle, documenting requirements, then proceeding with design synthesis and system validation while considering the complete problem including operations, performance, test, manufacturing, cost, and schedule. As such, it is important that engineering students are aware of the overall system engineering approach.

**Course Objectives:**

1. To understand system design methodology
2. To understand system engineers' role and responsibilities
3. To be able to apply systems engineering tools to realistic problems

4. To learn how to design for and manage system lifecycle targets

**Course Outcomes (CO):**

1. Develop a system engineering plan for a realistic project.
2. Judge the applicability of any proposed process, strategy, or methodology for systems engineering using the fundamental concepts from disciplines such as probability, economics, and cognitive science.
3. Understand system engineers' role and responsibilities. Understand the role of organizations.
4. Apply systems engineering tools (e.g., requirements development and management, robust design, Design Structure Matrix) to realistic problems.
5. Recognize the value and limitations of modelling and simulation.
6. Formulate an effective plan for gathering and using data.
7. Know how to proactively design for and manage system lifecycle targets.

**Course Contents:**

The course has been designed to introduce students to the elements of systems engineering and its application in aerospace engineering practice. Emphasis is placed on developing skills in problem formulation, system synthesis, use of analytical tools, and group dynamics. Some of the topics that will be presented include the structural analysis of systems, sequential-modular and equation-oriented process simulation software, mathematical systems and control theory, optimization theory and algorithms, and modelling from data and experimental design. Applications of these tools will be illustrated with a series of case studies involving steady-state and dynamic process simulation, control system synthesis, new product and process design, plant-wide diagnostics and planning, and formulation and decomposition of large-scale problems. Some of these case studies will be undertaken as group projects.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, group assignments, class tests, final exam.

**Text and Ref Books:**


1. Systems Engineering Fundamentals, Defence Acquisition University Press fort Belvoir, Virginia
2. Miller, John. QBQ! The Question Behind the Question: Practicing Personal Accountability at Work and in Life. East Rutherford, NJ: Putnam Publishing Group, 2004. ISBN: 9780399152337.
3. Altshuller, Genrich, Dana W. Clarke, Uri Fedozeev, and Steve Rodman. 40 Principles: TRIZ Keys to Innovation. Worcester, MA: Technical Innovation Centre, Inc., 2005. ISBN: 9780964074057.


**ASE 4751 : Aircraft Aerospace Systems**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Pre-requisite:** None.

**Rationale:**

To introduce the students with various systems associated with aircraft operations and safety issues.

**Objective:**

1. To create an idea about the operation of different systems of aircraft.

2. To be able to visualize the importance of different systems for aircraft safe operations.
3. To understand various features of the systems and subsystems.
4. To describe avionics systems associated with aircraft control and navigation

**Course Outcomes (CO):**

Upon completion of the course, the students will be able to:

1. Demonstrate an understanding of hydraulic system,
2. Understand the principles of safe operation to aircraft cabin atmospheric control systems, ice protection systems, position and warning systems,
3. Understand modern aircraft electrical system power generation and distribution principles
4. Knowledge about Flight Data Recorders, Cockpit Voice Recorders.
5. Determine the fuel system of an aircraft

**Course Contents:**

**Hydraulic Systems:** Fundamentals of hydraulic systems: components, hydraulic systems controllers, fluid reservoirs, oil coolers, valves and actuators;
**Landing Gear System:** Anti-skid system, shock absorbers, maximum braking performance;
**Airplane Control System:** Push pull rod system, Power assisted and fully powered flight controls, digital fly by wire systems;
**Engine Systems**: Starting and ignition systems, Fuel systems of piston and jet engine, multi-engine fuel systems, Fuel system operating modes;
**Air Conditioning and Pressurization System**: Basic air cycle systems, Oxygen systems, Deicing and anti-icing system;
**Electrical Systems**: AC and DC power generations and supply in aircraft, aircraft batteries, external power supplies, Auxiliary Power Unit (APU), Components of power distribution, safety requirements, aircraft electrical wiring and lighting system;
**Avionics Systems**: Flight Data Recording System, Cockpit Voice Recording System, Cockpit Display System, Glass Cockpit, HUD, HDD, HMD, Warning Systems, Fire detection and suppression, Emergency power sources, Emergency landing, Full Authority Digital Engine Control (FADEC) System.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Text and Ref Books:**

1. Aircraft Power Plants- Mekinley, J.L. and R.D. Bent; McGraw Hill 1993.
2. Aircraft Fuel Systems -Roy Langton, Chuck Clark, Martin Hewitt, Lonnie Richards; WILEY Publications.
3. Aircraft Maintenance & Repair- Mckinley, J.L. and Bent R.D; McGraw Hill.
4. Aircraft Instruments & Principles- Pallet, E.H.J; Pitman & Co 1993.
5. Advanced Aircraft Systems – David A. Lombardo; Mc-Grew Hill.
6. Aircraft Landing Gear Design: Principles and Practices (AIAA Education Series) - Norman S. Currey; American Institute of Aeronautics and Astronautics.
7. Aircraft Hydraulic Systems: An Introduction to the Analysis of Systems and Components – W.L Green, Wiley Publication.

## 4.6 Elective Courses from Mechanical Engineering Department

**MCE 4743: Advanced Programming with MATLAB**
*3.00 Contact Hour; 3.00 Credit Hours;*

**Course Objectives:**

1. To review of basic MATLAB features, class organization and functionality.
2. To study about advanced graphical features of MATLAB. Effective use of programs written in C, FORTRAN and use of SIMULINK.

**Course Content:**

Advanced MATLAB syntax; Object Oriented Programming, Handle Graphics/Graphical User Interface. Project brainstorming, Building, ODE solver suite in MATLAB, Simulink architecture and programming, Intro to C, CMEX interface, Java and Java classes in MATLAB, XML in MATLAB.

**Course Outcomes:**

1. Students will be able use advanced programming features of the Matlab language, including multidimensional arrays.
2. They are also able to create user defined classes and graphical user interfaces. Students can interface C-language programs into Matlab and/or use Java and Java classes within Matlab environment.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Reading Material:**

1. Introduction to Optimum Design, Jasbir Singh Arora
2. Numerical Methods for Engineers and Scientists Using MATLAB, Ramin S. Esfandiari
3. MATLAB Programming for Engineers, Stephen J Chapman

**MCE 4761: Finite Element Analysis of Solids and Fluids**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Course Content:**

Finite element methods for analysis of steady-state and transient problems in solid, structural, fluid mechanics, and heat transfer. Presents finite element methods and solution procedures for linear and nonlinear analyses using largely physical arguments. Demonstrates finite element analyses. Homework involves use of an existing general-purpose finite element analysis program. Includes modelling of problems and interpretation of numerical results. Students taking graduate version complete additional assignments.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Reading Material:**

1. Textbook of Finite Element Analysis, Seshu, P., Prentice-Hall, India, 2003.

2. Applied Finite Element Analysis, Segerlind, L. J., John Wiley, 1987.

**MCE 4763: Fundamentals of Nanoengineering**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Course Content:**

Presents the fundamentals of molecular modelling in engineering in the context of nanoscale mechanical engineering applications. Statistical mechanics and its connection to engineering thermodynamics. Molecular origin and limitations of macroscopic descriptions and constitutive relations for equilibrium and non-equilibrium behaviour. Introduction to molecular simulation, solid-state physics and electro kinetic phenomena. Discusses molecular approaches to modern nanoscale engineering problems. Graduate students are required to complete additional assignments with stronger analytical content.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Reading Material:**

1. Introduction to Nanotechnology, Frank J. Ovens

**MCE 4765: Introduction to Robotics**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Course Content:**

Presents the fundamentals of robot mechanisms, dynamics, and controls. Planar and spatial kinematics, differential motion, energy method for robot mechanics; mechanism design for manipulation and locomotion; multi-rigid-body dynamics; force and compliance control, balancing control, visual feedback, human-machine interface; actuators, sensors, wireless networking, and embedded software.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Reading Material:**

1. Introduction to Robotics Analysis System Application, S. B. Niku.
2. Robotics Engineering, R. D. Klefter & Others.
3. Robotics, J. J. Craig.

**MCE 4767: Mechatronics**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Course Content:**

Introduction; Organization structure; System concept; Mechanical, electrical, electronic and software components; Process; Software based tools; Virtual instrumentation; CAD; CAM; Computer integrated systems; Computer interfacing; Manipulators; Actuator types; Sensors and vision systems; Smart robots; Artificial intelligence; Factory, office, and home automation; Future trend.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Reading Material:**

1. Mechatronics: Electronic Control Systems in Mechanical Engineering, W. Bolton, William Bolton, Prentice Hall, 2nd edition, 1998,
2. Mechatronics: Mechanical System Interfacing, David M. Auslander, Carl J. Kempf, Prentice Hall, 1st edition, 1995.
3. Mechatronics, D Necsulescu.
4. Mechatronics, N. P. Mahalik.

**MCE 4769: Product Design**
*3.00 Contact Hour; 3.00 Credit Hour;*

**Course Content:**

Project-centred subject addressing transformation of ideas into successful products which are properly matched to the user and the market. Students are asked to take a more complete view of a new product and to gain experience with designs judged on their aesthetics, ease of use, and sensitivities to the realities of the marketplace. Lectures on modern design process, industrial design, visual communication, form-giving, mass production, marketing, and environmentally conscious design.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Reading Material:**

1. Product Design, Mike Baxter
2. Product Design Methods and Practices, Henry W. Stoll

**MCE 4771: Renewable Energy**
*3.00 Contact Hour; 3.00 Credit Hours; Pre-requisite: None*

**Course Objectives:**

1. To introduce renewable energy technologies and emphasize exploration of principles and concepts as well as the application of renewable energy technologies (RET).
2. To Explores topics such as energy consumption, the pros and cons of renewable energy, energy production and cons, energy conversion, environmental issues and concerns, electrical grid, biomass and biofuels, geothermal, wind, power, solar power, nuclear power, and hydropower systems.

**Course Content:**

Reserves of non-renewable fuels; Prospects of renewable energy, and its sources and pattern of usage: Characteristics of renewable sources: intermittent, low power density etc.; use of renewable in small-scale systems.

Current technology: wind wave, tidal, passive and active solar, biological and examples of devices; Energy management, interaction of non-technical requirements (social, economic, political, environment) in engineering design and innovation; Case-study.

**Course Outcomes:**

1. Identify issues facing the renewable energy industry and understanding of specialist bodies of knowledge within the engineering discipline.
2. Understand contextual factors impacting the engineering discipline and an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice
3. Investigate basic social, political, economic and ecological factors impacting renewable energy resources and systems regionally, nationally and abroad.
4. Evaluate the financial costs and benefits of a renewable energy project.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Reading Material:**

1. Energy Resources and Policy, R. C. Dorf
2. Alternative Energy Sources: A Strategy Planning Guide, R. T. Sheahan

**MCE 4773: Combustion and Pollution**
*3.00 Contact Hour; 3.00 Credit Hours; Pre-requisite: None*

**Course Objectives:**

1. To introduce to combustion; Heat of reaction, adiabatic flame temperature, heating values, chemical composition of products of combustion; Chemistry and kinetics of reactions; Reaction rate and flame propagation; Structure of laminar premixed flames; Explosions and fuel oxidation; Detonation; Combustion in internal and external combustion engines.
2. To analyse the production of pollutants in combustion systems; Emissions of greenhouse gases, carbon monoxide, oxides of nitrogen and Sulphur, and other pollutants.

**Course Content:**

Introduction to combustion; Heat of reaction, adiabatic flame temperature, heating values, chemical composition of products of combustion; Chemistry and kinetics of reactions; Reaction rate and flame propagation; Structure of laminar premixed flames; Explosions and fuel oxidation; Detonation; Combustion in internal and external combustion engines. Production of pollutants in combustion systems; Emissions of greenhouse gases, carbon monoxide, oxides of nitrogen and sulphur, and other pollutants. Pollution control: post-engine exhaust treatment for emission control - thermal reactors, exhaust gas recirculation, catalysis; Pollution control by modification of combustion parameters; other pollution control strategies.

**Course Outcomes:**

1. Recognize the ongoing role of combustion, both of fossil and biofuels, in providing a more sustainable energy source for society, and the environmental challenges to be met to achieve this.
2. Explain the responsibility of engineers to the community in terms of providing a safe healthy environment.

3. Identify the formation mechanisms and reduction strategies of pollutant species in combustion systems and design the technology and the logic behind after-treatment of pollutants
4. Identify design trade-offs between increasing engine performance and maintaining low emission characteristics and explain the technology and the logic behind after-treatment of pollutants.

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Reading Material:**

1. Industrial Combustion Pollution and Control, Charles E. Baukal, Jr.
2. Combustion Engineering, G L Borman, K. W Ragland, McGraw-Hill International

**MCE 4775: Energy and Environment**
*3.00 Contact Hour; 3.00 Credit Hours; Pre-requisite: None*

**Course Objectives**:

1. To provide a deep understanding of the issues of energy production, transmission and usage.
2. To discuss qualitatively and quantitatively, informed by a working knowledge of the physical principles governing the transformation of energy from one form to another

**Course Content:**

Energy sources and utilization; Principles of energy conversion and storage. Building thermal energy-principles and optimization; Energy economy tools and techniques; Environmental impacts of energy conversion; Environmental economics and management; Case studies.

**Course Outcomes:**

1. Understand of the underpinning natural and physical sciences and the engineering fundamentals applicable to the engineering discipline and explain the physical principles governing energy transformations using correct terminology
2. Specify suitable units for, and state the relationships between basic physical quantities such as force, work, energy, temperature (developing the knowledge capability dimension)
3. Identify how environmental science has interdisciplinary connections with other sciences.
4. Analyse and solve problems in environmental science by selecting and applying practical and/or theoretical techniques with technical competence in conducting field, laboratory-based, or virtual experiments

**Teaching-learning and Assessment Strategy:**

Lectures, class performances, assignments, class tests, final exam.

**Reading Material:**

1. Principles of Energy Conversion, A W Culp
2. Energy, Environment and Development, José Goldemberg, Oswaldo

# CHAPTER 5

# 5 RULES AND REGULATIONS FOR UNDERGRADUATE PROGRAM

## 5.1 Overview

BSMRAAU has introduced Course Curriculum for undergraduate studies from the academic session 2019-2020. Therefore, the rules and regulations mentioned in this paper will be applicable to students for administering undergraduate curriculum through the Course Curriculum. This will aim at creating a continuous, even and consistent workload throughout the term for the students.

## 5.2 The Course Curriculum

The salient features of the Course Curriculum are as follows:

a. The number of theory courses will be generally limited to 5 for each term. However, with the recommendation of the Course Coordinator and the Head of the Department, honourable Vice Chancellor of BSMRAAU may allow relaxation in this regard. This relaxation is to be duly reported to the Academic Council of BSMRAAU.

b. Students will not face any level repeat for failing.

c. Students might get the opportunities to improve their grades.

d. Availability of numerous electives to enable the students to select courses according to their individual needs and preferences.

e. Continuous evaluation of students' performance and achievements.

f. Promotion of effective Lecturer-Content and Lecturer-Student interactions and contact.

Beside the professional courses pertaining to each discipline, the undergraduate curriculum gives a strong emphasis on acquiring thorough knowledge in the basic sciences of mathematics, physics and chemistry. Due importance is also given on the study of several subjects in language, humanities and social studies. The first two years of bachelor's degree programs generally consist of courses on basic and engineering sciences, and language, humanities and social studies; while the third and subsequent years focus on specific disciplines with the respective core and elective courses.

## 5.3 Course Terms

BSMRAAU follows Semester System for the purpose of conducting lectures and assessments. An academic year consists of two semesters each of which having fourteen weeks of instruction. The undergraduate program will have a total of 8 semesters in 4 years. Semesters are named as Spring (Odd Semester) and Fall (Even Semester) with a provision of a concise Summer Semester (Short Term) where limited number of courses can be offered as required.

### 5.3.1 Duration of Terms

The duration of each semester can be extended up to a maximum of 21 working weeks. Following table has the breakdown of a typical term.

| Events | Durations |
|---|---|
| Classes before Mid Term | 7 weeks |
| Mid Term Vacation | 1 week |
| Classes after Mid Term | 7 weeks |
| Makeup Classes and Preparatory leave | 2 to 3 weeks |
| Term Final Assessment and Evaluation | 2 to 3 weeks |
| Term End Vacation | 4 to 7 weeks |

## 5.4 Course Pattern and Credit Structure

The undergraduate program is covered by a set of theoretical courses along with a set of sessional/laboratory courses to support them.

### 5.4.1 Course Designation System

Each course is designated by a maximum of three letter code identifying the department offering the course followed by a four-digit number. All courses offered by the Department of Aerospace Engineering will be prefixed by the department code 'ASE'. The course code contains four numeric digits WXYZ. The interpretation of WXYZ is as follows:

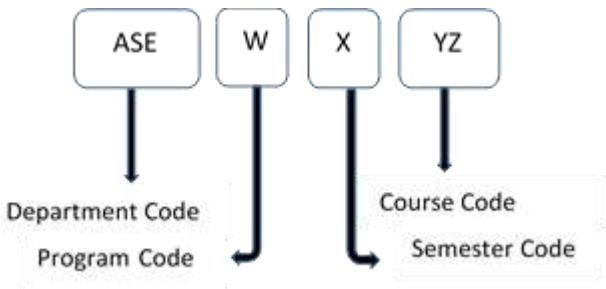
a. The first digit corresponds to the program. For 4-year program such as B.Sc. Engineering, the first digit is 4, e.g., course code is ASE 4XYZ. Courses offered by other departments will be prefixed by the department codes; AVE for Avionics Engineering, EEE for Electrical & Electronic Engineering, CSE for Computer Science and Engineering and MCE for Mechanical Engineering.

b. The second digit X represents semester (1 to 8). For example, a course in third semester of a four-year program will be ASE 43YZ.

c. Third and fourth digits YZ represent type of course as follows:

| Course Code Designation System | | |
|---|---|---|
| **3rd and 4th Digit** | **Meaning** | **3rd Digit** |
| 01 to 19 | Compulsory Core Courses | 0 or 1 |
| 20 to 79 | Departmental Elective Courses | 2, 3, 4, 5, 6, 7 |
| 80 to 99 | Non-Departmental Elective courses | 8 or 9 |

Odd fourth numeric digit Z represents theory course and even fourth numeric digit Z represents sessional course. The numbering policy can be summarized in the following figure:



For general courses like Mathematics, Physics, Chemistry, Humanities, the prefixes will be as follows; MAT for Mathematics, PHY for Physics, CHM for Chemistry and HUM for Language, Humanities and Social Studies.

### 5.4.2 Assignment of Credits

The assignment of credits to a theoretical course follows a different rule from that of a sessional course.

a. Theoretical Courses. A 'One contact-hour' per week per semester is equivalent to one credit hour.

b. Sessional Courses. A 'Two contact-hours' per week per semester is equivalent to one credit hour.

Credits are also assigned to project and thesis work taken by the students. The amount of credits assigned to such work varies from discipline to discipline.

### 5.4.3 Types of Courses

The types of courses included in the undergraduate curriculum are divided into the following groups/categories:

a. Core Courses. In each discipline, several courses are identified as core courses, which form the nucleus of the respective bachelor's degree program. A student must complete all the designated core courses belonging to his/her discipline.

b. Co- and/or Pre-requisite Courses. Some of the core courses are identified as Co-requisite and/or Pre-requisite to a specific course.

c. Elective Courses: Apart from the core courses, the students can choose from a set of Elective Courses. A required number of Elective Courses from a specified group must be undertaken.

## 5.5 Course Offering and Instruction

The courses to be offered in a term are announced and published in the Course Catalogue along with the tentative Term Schedule before the end of the previous term. The courses to be offered in any term will be decided by the respective department.

Each course is conducted by a course teacher who is responsible for maintaining the expected standard of the course and for the assessment of students' performance. Depending on the class size (i.e. on the number of students) enrolled for the course, the concerned teacher might have course coordinators and Teaching Assistants (TA) to aid in teaching and assessments.

## 5.6 Lecturer-Student Interaction

The course curriculum encourages students to come in close contact with the teachers. To promote a high level of Lecturer-Student Interaction, each student is assigned to an adviser and the student is free to discuss all academic matters with his/her adviser throughout the duration of his/her program. Students are also encouraged to meet with other teachers for assistance and guidance in academic matters at any time through prior arrangement. However, students are not allowed to interact with their teachers during and after the moderation process of the questions.

## 5.7 Student Adviser

One adviser is normally assigned for a group of students by the concerned department. The adviser advises each student about the courses to be taken in each term by discussing the academic program of that particular term with the student.

However, it is also the student's responsibility to keep regular contact with his/her adviser who will review and eventually approve the student's specific plan of study (Academic Progression Form) and monitor subsequent progress of the student.

For a student from the second and subsequent terms, the number and nature of courses for which he/she can register is decided based on his/her academic performance/standing during the previous term. The adviser may allow the student to drop one or more courses based on his/her previous academic performance/standing. Students' academic performance/standing can be expressed in three ways, namely, Good Standing, Academic Probation and Academic Warning.

## 5.8 Course Registration

Any student making use of classroom, laboratory facilities and/or faculty-time is required to register through proper channel. Upon admission to BSMRAAU, each student is assigned to an adviser. Advisers provide necessary guidance to the students in choosing and registering courses.

### 5.8.1 Registration Procedure

At the commencement of each term, each student must consult with his/her adviser for guidance and assistance before he/she gets registered for the courses. An academic Progression Form could be handy for a student to register for the selection of his/her proposed or projected courses. The date, time and venue of registration are announced in advance by the Registrar's Office. Counselling and advising are done at the same time. It is essential that all students be present for registration within the specified time frame.

### 5.8.2 Pre-conditions for Registration

a. For the first-year students, department-wise enrolment/admission is mandatory prior to registration. At the beginning of the first term, an orientation program will be conducted where students are handed in with the registration package on submission of the enrolment slip.

b. Any student, other than the new batch, with outstanding dues to the BSMRAAU or a hall of residence is not allowed to register. Each student must clear their dues and obtain a clearance certificate, upon production of which, he/she will be given necessary Course Registration Forms to complete the course registration process.

c. A student can register in a course subject to the class capacity constraints and satisfactory outcome of the pre-requisite courses. However, if a student fails in a pre-requisite course in any term, the concerned department may allow him/her to register for a course which requires a pre-requisite course condition provided that his/her class attendance, involvement and performance during the continuous assessment process for that particular pre-requisite course is found to be satisfactory.

### 5.8.3 Registration Deadline

Each student must register for the courses to be taken before the commencement of each term. Late registration is permitted only during the first week of classes. Late registration after this date will not be accepted unless the student submits a written application to the Registrar through the concerned Head of the department explaining the reasons for delay. Acceptable reasons could be on medical grounds with

supporting documents from the Medical Officer of a Medical Facility recognised by BSMRAAU or any other arguably acceptable academic commitments that prohibit enrolment prior to the last date of registration.

### 5.8.4 Penalty for Late Registration

Students who fail to register during the designated dates for registration are charged a late registration fee of Tk. 200.00 (Taka two hundred only) per course. Penalty for late registration will not be waived.

## 5.9 Limits on the Credit Hours to be taken

A student should be enrolled for at least 15 credit hours and can take a maximum of 24 credit hours. Relaxation on minimum credit hours may be allowed. A student must enrol for the sessional courses prescribed in a term within the allowable credit hour limits.

In special cases where it is not possible to allot the minimum required 15 credit hours to a student, the concerned department may permit with the approval of the Vice Chancellor, a lesser number of credit hours to suit individual requirements based on a student's academic standing, such as, Academic Probation and/or Academic Warning. Such cases are also applicable to students of Level 4 requiring less than 15 credit hours for graduation.

## 5.10 Course Add/Drop

A student has limited options to add or drop courses from the registration list. Addition of courses is allowed only within the first two weeks of a regular term and only during the first week of a short term. Dropping a course is permitted within the first four weeks of a regular term and two weeks of a short term.

Any student willing to add or drop courses must fill in a Course Adjustment Form. This must also be done in consultation with and under the guidance of the student's respective adviser. The original copy of the Course Adjustment Form must be submitted to the Registrar's Office, where the required numbers of photocopies are prepared for distribution to the concerned adviser, Head of the Departments, Dean of the Faculty, Controller of Examinations and the students.

## 5.11 Withdrawal from a Term

If a student is unable to complete the Term Final Examination due to serious illness or severe accident, he/she may apply to the Head of the degree awarding department for a total withdrawal from the term before the commencement of the term final examination. However, application may be considered during the term final examination only on special cases. The application must be supported by a medical certificate from a Medical Officer of a medical facility recognised by BSMRAAU. The concerned student may opt for retaining the sessional courses of the term. The Academic Council will take the final decision about such cases. However, the total duration for graduation will not exceed 6 academic years.

## 5.12 The Grading System

The total performance of a student in each course is based on a scheme of continuous assessment, for theory courses this continuous assessment is made through a set of quizzes, class tests, class evaluation, class participation, homework assignment/case studies and a term final examination. The assessments for sessional courses are made by evaluating performance of the student at work during the class, viva-voce during laboratory hours, quizzes and a detailed report. Besides, at the end there will be a final lab test. Each course has a certain number of credits, which describes its corresponding weightages. A student's performance is measured by the number of credits completed satisfactorily and by the weighted average of

the grade points earned. A minimum grade point average (GPA) is essential for satisfactory progress. A minimum number of earned credits must also be acquired in order to qualify for the degree. Letter grades and corresponding grade points will be given as follows:

| Score | Grade | Grade Point |
|---|---|---|
| 80% and above | A+ | 4.00 |
| 75% to below 80% | A | 3.75 |
| 70% to below 75% | A- | 3.50 |
| 65% to below 70% | B+ | 3.25 |
| 60% to below 65% | B | 3.00 |
| 55% to below 60% | B- | 2.75 |
| 50% to below 55% | C+ | 2.50 |
| 45% to below 50% | C | 2.25 |
| 40% to below 45% | D | 2.00 |
| below 40% | F* | 0.00 |
| Incomplete | I | - |
| Withdrawal | W | - |
| Project/ Thesis continuation | X | - |

* Subject in which the student gets F grade shall not be regarded as earned credit hours for the calculation of Grade Point Average (GPA).

### 5.13 Distribution of Marks

#### 5.13.1 Theory

Thirty percent (30%) of marks of a theoretical course shall be allotted for continuous assessment, i.e. quizzes, home assignments/case studies, class tests (CT) and observations/class participation. These marks must be submitted to the Office of the Controller of Examinations before the commencement of final exam. The rest of the marks will be allotted to the Term Final Examination. The duration of final examination will be three (03) hours. The scheme of continuous assessment that a teacher would follow for a course will be announced on the first day of the classes. Distribution of marks for a given course per credit is as follows:

| | |
|---|---|
| Class Performance | 5% |
| Class Assignments/Case Studies | 20% |
| Mid Term Test | 15% |
| Final Exam | 60% |
| **Total** | **100%** |

#### 5.13.2 Sessional/Practical Examinations

Sessional courses are designed and conducted by the concerned departments. Examination on sessional/practical subjects will be conducted by the respective department before the commencement of term final examination. The date of practical examination will be fixed by the respective department. Students will be evaluated in the sessional courses based on the followings (all or as decided by the Examination Sub-Committee):

| | |
|---|---|
| Class Performance | 25% |
| Report Writing | 15% |
| Mid Term Evaluation | 20% |
| Final Evaluation | 30% |
| Viva Voce | 10% |
| **Total** | **100%** |

### 5.13.3 Sessional Course in English

Students in English sessional course shall be evaluated based on the following:

| | |
|---|---|
| Class Participation/Observation | 5% |
| Written Assignment | 20% |
| Oral Performance | 25% |
| Listening Skill | 10% |
| Group Presentation | 30% |
| Viva Voce | 10% |
| **Total** | **100%** |

## 5.14 Collegiate and Non-Collegiate

Students having class attendance of 80% or above in individual subject will be treated as collegiate and less than 80% and up to 70% will be treated as non-collegiate in that subject. The non-collegiate student(s) may be allowed to appear in the examination subject to payment of non-collegiate fee/fine of an amount fixed by BSMRAAU. Students having class attendance below 70% will be treated as dis-collegiate and will not be allowed to appear in the examination and treated as fail. But in a special case such students may be allowed to appear in the examination with the permission of Vice Chancellor and it must be approved by the Academic Council.

## 5.15 Calculation of CGPA

Grade Point Average (GPA) is the weighted average of the grade points obtained of all the courses passed/completed by a student. For example, if a student passes/completes *n* courses in a term having credits of $C_1$, $C_2$, ..., $C_n$ and his grade points in these courses are $G_1$, $G_2$, .... $G_n$ respectively, then

$$GPA = \frac{\text{Grade points earned in the semester}}{\text{Credits completed in the semester}}$$

$$\Rightarrow GPA = \frac{\text{Summation of (credit hours in a course} \times \text{grade points earned in that course)}}{\text{Total number of credit hours completed}}$$

$$\Rightarrow GPA = \frac{\sum_i^n C_i G_i}{\sum_{i=1}^n C_i}$$

The Cumulative Grade Point Average (CGPA) is the weighted average of the GPA obtained in all the terms passed/completed by a student. For example, if a student passes/ completes n terms having total credits of $TC_1$, $TC_2$, ... , $TC_n$ and his GPA in these terms are $GPA_1$, $GPA_2$,... , $GPA_n$, respectively then

$$CGPA = \frac{\sum_{i=1}^n TC_i GPA_i}{\sum_{i=1}^n TC_i}$$

### 5.15.1 Example of CGPA Calculation

Suppose a student has completed eight courses in a term and obtained the following grades:

| **Course** | **Credits,** | **Grade** | **Grade** | **$C_I$*$G_i$** |
|---|---|---|---|---|

| | $C_i$ | | Points, $G_i$ | |
|---|---|---|---|---|
| ASE 4101 | 1.50 | A- | 3.50 | 5.250 |
| ASE 4165 | 3.00 | A+ | 4.00 | 12.000 |
| CHM 4101 | 3.00 | A | 3.75 | 11.250 |
| MAT 4201 | 3.00 | B | 3.00 | 9.000 |
| HUM 4611 | 3.00 | B- | 2.75 | 8.250 |
| HUM 4713 | 3.00 | B | 3.00 | 9.000 |
| PHY 4201 | 3.00 | A+ | 4.00 | 12.000 |
| CSE 4102 | 1.50 | A | 3.75 | 5.625 |
| **Total** | **21.00** | | | **72.375** |

GPA = 72.375/21.00 = 3.45

Suppose a student has completed four terms and obtained the following GPA.

| Semester | Credit Hours Earned, $TC_I$ | GPA Earned, $GPA_i$ | $GPA_i$*$TC_i$ |
|---|---|---|---|
| 1 | 21.00 | 3.73 | 78.330 |
| 2 | 20.50 | 3.93 | 80.565 |
| 3 | 19.75 | 3.96 | 78.210 |
| 4 | 20.25 | 4.00 | 81.000 |
| **Total** | **81.50** | | **318.105** |

CGPA = 318.105/81.50 = 3.90

### 5.16 Minimum Earned Credit and GPA Requirement for Obtaining Degree

Minimum credit hour requirements for the award of bachelor's degree in engineering (B.Sc. Engineering) and other discipline will be decided as per existing rules. The minimum GPA requirement for obtaining a bachelor's degree in Engineering is 2.20.

### 5.17 Impacts of Grade Earned

The courses in which a student has earned a 'D', or a higher grade will be counted as credits earned by him/her. Any course in which a student has obtained an 'F' grade will not be counted towards his/her earned credits or GPA calculation. However, the 'F' grade will remain permanently on the Grade Sheet and the Transcript.

A student who obtains an 'F' grade in a core course will have to repeat that course. However, if a student gets an 'F' in an optional course, he/she may choose to repeat that course or take a substitute course if available. When a student will repeat a course in which he/she has previously obtained an 'F', he/she will not be eligible to get a grade better than 'B+' in that repeated course.

If a student obtains a grade lower than 'B+' in a course, he/she will be allowed to repeat the course only once for the purpose of grade improvement. However, he/she will not be eligible to get a grade better than 'B+' for an improvement course.

A student will be permitted to repeat for grade improvement purposes a maximum of 6 courses in BSc. Engineering program.

If a student obtains a 'B+' or a better grade in any course, he/she will not be allowed to repeat the course for the purpose of grade improvement.

### 5.18 Classification of Students

At BSMRAAU, regular students are classified according to the number of credit hours completed/earned towards a degree. The following classification applies to all the students:

| Level | Credit Hours Earned |
|---|---|
| Level 1 | 0.0 to 36.0 |
| Level 2 | More than 36.0 to 72.0 |
| Level 3 | More than 72.0 to 108.0 |
| Level 4 | More than 108.0 |

However, before the commencement of each semester all students other than new batch are classified into three categories:

a. **Category 1 (Good Standing).** This category consists of students who have passed all the courses described for the term. A student belonging to this category will be eligible to register for all courses prescribed for the upcoming term.

b. **Category 2 (Academic Probation).** This category consists of students who have earned a minimum of 15 credits but do not belong to category 1. A student belonging to this category is advised to take at least one course less since he might have to register for one or more backlog courses as prescribed by his/her adviser.

c. **Category 3 (Academic Warning).** This category consists students who have failed to earn the minimum required 15 credits in the previous term. A student belonging to this category is advised to take at least two courses less than a category 1 student subject to the constraint of registering at least 15 credits. However, he/she will also be required to register for backlog courses as prescribed by the adviser.

#### 5.18.1 Graduating Student

Graduating students are those who will have $\leq 24$ credit hour left for completing the degree requirement.

### 5.19 Performance Evaluation

The performance of a student will be evaluated in terms of two indices, viz. Term Grade Point Average and Cumulative Grade Point Average which is the grade average for all the terms completed.

Students will be making normal progress toward a degree if their Cumulative Grade Point Average (CGPA) for all work attempted is 2.20 or higher. Students who regularly maintain a term GPA of 2.20 or better are making good progress toward the degrees and are in good standing with BSMRAAU. Students who fail to maintain this minimum rate of progress will not be in good standing. This can happen when any one of the following conditions exists.

a. The term GPA falls below 2.20.
b. The Cumulative Grade Point Average (CGPA) falls below 2.20.

c. The earned number of credits falls below 15 multiplied by the number of terms/semesters attended.

All such students can make up their deficiencies in GPA and credit requirements by completing courses in the subsequent term(s) and backlog courses, if there are any, for better grades. When the minimum GPA and credit requirements are achieved the student is again returned to good standing.

### 5.20 Minimum Earned Credit and GPA Requirement for Obtaining Degree

Minimum credit hour requirements for the award of bachelor's degree in engineering (BSc. Engg.) will be decided by the respective department. However, at least 154 credit hours for engineering must be earned to be eligible for graduation, and this must include the specified core courses. The minimum GPA requirement for obtaining a bachelor's degree in engineering is 2.20.

### 5.21 Application for Graduation and Award of Degree

A student who has fulfilled all the academic requirements for bachelor's degree will have to apply to the Controller of Examinations through his/her Adviser for graduation. Provisional Degree will be awarded by BSMRAAU on completion of credits and GPA requirements.

### 5.22 Time Limits for Completion of bachelor's degree

A student must complete his studies within a maximum period of six years for engineering program.

### 5.23 Attendance, Conduct and Discipline

BSMRAAU has strict rules regarding the issues of attendance in class and discipline.

#### 5.23.1 Attendance

All students are expected to attend classes regularly. The university believes that attendance is necessary for effective learning. The first responsibility of a student is to attend classes regularly and one is required to attend the classes as per BSMRAAU rules.

#### 5.23.2 Conduct and Discipline

During their stay at BSMRAAU all students are required to abide by the existing rules, regulations and code of conduct. Students are strictly forbidden to get involved in forming student organization or political party, club, society etc., other than those set up by BSMRAAU authority in order to enhance student's physical, intellectual, moral and ethical development. Zero tolerance is strictly observed in and around the campus with regards of sexual abuse and harassment in any forms and drug abuse and addiction.

### 5.24 Lecturer-Student Interaction

The academic system in BSMRAAU encourages students to come in close contact with the teachers. For promotion of high level of lecturer-student's interaction, a course coordinator (CC) is assigned to each course. Students are free to discuss with CC about all academic matters. Students are also encouraged to meet other teachers at any time for assistance and guidance for academic matters. The Heads of the Departments, the Director of Administration, the Director of Students Welfare (DSW) and the Dean may address the students at intermittent intervals.

### 5.25 Absence during a Term

A student should not be absent from quizzes, tests, etc. during the term. Such absence will naturally lead to reduction in points/marks, which count towards his/her final grade. Absence in the Term Final Examination will result in an F grade in the corresponding course. A student who has been absent for short periods, up to a maximum of three weeks due to illness, should approach the course teacher(s) or the course coordinator(s) for make-up quizzes or assignments immediately upon returning to classes. Such request must be supported by medical certificate from competent authority (e.g. BSMRAAU Medical Officer).

### 5.26 Recognition of Performance

As recognition of performance and ensure continued studies BSMRAAU awards medals, scholarships and stipends will be given as per existing rules and practices.

### 5.27 Types of Different Examination

Following different types of final Examinations will be conducted in BSMRAAU to evaluate the students of Undergraduate Programs:

a. **Semester Final Examination.** At the end of each normal term (after 22wk or so), Semester Final Examination will be held. Students will appear in the Term Final Examination for all the theory courses they have taken in the Semester.

b. **Short Term Examination.** Short Term may be conducted after one-week completion of an Even Semester final examination. Students will be allowed to take maximum three theoretical courses in the Short Term. Examination will be conducted at the end of Short Term ($6^{th}$ week class). However, Head of concerned department with the approval of the Vice Chancellor may decide to take Supplementary examination instead of Short Term. No Laboratory/Sessional Courses can be taken in short term.

c. **Supplementary Examination.** It will take place once in a year, after each Odd Semester (semesters 1, 3, 5 and 7) break. It should be completed within first 3 weeks of a new term. Students will be allowed to appear this examination for maximum two subjects at a time. Graduating students will be allowed to appear maximum three subjects during supplementary examination in their last Semester. However, Head of the concerned department with the approval of the Vice Chancellor may decide to take another Supplementary Examination instead of Short Term. In that case, a student will be allowed to take maximum three failed courses or improvement courses in the Supplementary Examination. This examination will be conducted in the previous week of the beginning of odd semesters. Highest achieved grade for all courses of Supplementary Examination will be B+.

d. **Improvement Examination.** It will be taken during supplementary and Short-Term examination. Questions will be same as the question of the regular examination of that Short-Term Final Examination (if any). Student can take maximum three subjects at a time and maximum6 subjects in the whole academic duration. If a student obtains a grade lower than 'B+' in a course, he/she will be allowed to repeat the course only once for grade improvement. However, he/she will not be eligible to get a grade better then 'B+' for an improvement course. Among the previous result and improvement examination result, best one will be considered as result for an individual student. However, performance of all examination i.e. before improvement examination, shall be reflected in the transcript.

## 5.28 Rules of Different Examinations

### 5.28.1 Semester Final Examination

Following rules are to be followed:

a. Registration to be completed before commencement of the class. A student must register his/her desired courses paying registration, examination fee and other related dues.

b. Late registration will be allowed without penalty within first one week of the semester.

c. Within 1st two weeks of a semester a student can Add/Drop course/courses. To add a course, in the 3rd week, one must register the course by paying additional fees. To drop a course, one must apply within three weeks and paid fees will be adjusted/refunded. If anyone wants to drop a course after three weeks and within 4 weeks, that will be permitted but paid fees will not be refunded in that case.

d. Registrar office will finalize registration of all courses within 7 (seven) weeks, issue registration slips followed by issuing an Admit Card.

e. Semester Final Examination to be conducted in the 18-20th week of the Semester as per the approved Academic Calendar.

### 5.28.2 Short Term Examination

Following rules are to be followed:

a. Short Term for a period of 6 weeks may be offered by a department after one week of completion of an Even Semester Final Examination.

b. Short Term Final Examination is to be conducted on the 7th week of the Short Term.

c. Only repeat course can be offered, not any new course.

d. Classes will be arranged for the students who register in a failed course in the Short Term.

e. After 6 (six) weeks of class, in the 7th week short Term Examination will be held. Academic calendar for this Short Term will be declared by the Department during the Mid-Semester break of an Even Semester.

f. One student can take only three (failed/improvement) courses at a time in the Short Term.

g. Students will have to complete registration of course for Short Term by paying all the fees, before starting of the Even Semester final Exam.

h. Graduating students may register for Short Term examinations after finalizing the result of the Even Semester final Exam.

i. Maximum grading to be awarded will be ‘B+’.

j. Question Setting, Moderation, Result Publication will be done following the same rules of Semester Final Exam as per Exam Policy. Separate Tabulation sheet will be made for this examination.

k. However, Head of concerned department with the approval of the Vice Chancellor may decide to take Supplementary Examination instead of Short Term. Students will be allowed to take maximum three failed courses/improvement courses in that supplementary examination.

#### 5.28.2.1 Supplementary Examination

Following rules to be followed:

a. After the final break of each Odd Semester, Supplementary Examination will be held (once in a year).

b. Examination will be taken on 70% marks like Term Final examination. Remaining 30% marks on continuous assessment earned previously in that course will be counted. If a student fails in a course more than once in regular terms, then the best one among all the continuous assessment will be counted.

c. A student will be allowed to take a maximum of two courses at a time for each supplementary examination, but in the graduating Semester, one student can take a maximum of three courses if required.

d. Highest grade for supplementary examination will be 'B+'.

e. Registration for supplementary courses to be done during the mid-semester break of an Odd Semester, upon paying the required fees.

f. Examination will be completed after an Odd Semester End break within the three weeks of an Even Semester.

g. If any student fails in a course, he can clear the course retaking it $2^{nd}$ time or, he/she can clear the examination appearing at the supplementary examination as well. But anyone fails twice in a course consecutively, he/she must take approval from the Academic Council of BSMRAAU for appearing third/last time in a course and need to pay extra financial penalty.

h. If anyone fails in the sessional course, that course cannot be cleared in the supplementary examination.

i. Question setting, Moderation, Result Publication will be done following the same rules of Semester Final Examination as per Examination Policy.

j. However, the Head of the concerned department with the approval of the Vice Chancellor may decide to take another Supplementary Examination instead of Short Term. In that case, a student will be allowed to take maximum three failed courses or improvement courses in that Supplementary Examination. This examination will be conducted in the previous week of the beginning of an Odd Semester. Registration of that Supplementary Examination should be completed during registration of Short-Term course.

#### 5.28.2.2 Improvement Examination

Following rules are to be followed:

a. Any student receiving a grading below 'B+' and desiring to improve that course, he/she will be allowed to appear at the improvement examination for that course.

b. Highest grade for Improvement examination will be 'B+'.

c. One student can appear at the Improvement exam in 6 (six) courses in his/her whole graduation period taking maximum three courses at a time.

d. For Improvement examination, registration is to be done before an Even Semester Final Examination with the Short-Term Courses or, during the registration of Supplementary Courses by paying all the dues.

e. Improvement examination is to be taken during the supplementary and short-term examinations.

f. Choice of Improvement course is restricted within the offered courses of that Short Term by the Departments and in two courses at a time.

g. Question Setting, Moderation and Result Publication are to be done with courses of regular Semester Final Examination.

### 5.28.3 Special Referred Examination

Following rules are to be followed:

a. Immediately after the finalization of results for an Even Semester final exam for a particular year, all the other failed/leftover courses, special referred examination will be arranged, and students will have to register for the courses for taking the examination by paying required fees and charges. Following the registration, an Admit Card will be issued.

b. Examination will be held before the commencement of an Odd Semester of the following year.

c. One student can appear at all his/her failed courses (Referred/Backlog) in the Referred Examination including current level-repeat students.

d. Highest grade for all courses in this Examination will be 'B+'.

e. Question Setting, Moderation and Result Publication will be done following the same rules of Semester Final Examination as per the Examination Policy.

f. Separate Tabulation Sheet will be prepared for this special referred examination.

## 5.29 Irregular Graduation

If any graduating student clears his/her failed course in an Odd Semester and his graduation requirements are fulfilled, his graduation will be effective from the result publication date of that Odd Semester and that student will be allowed to apply for a provisional certificate.