UNIVERSITY OF KERALA

B. TECH. DEGREE COURSE

(2013 SCHEME)

SYLLABUS FOR

VII SEMESTER

AERONAUTICAL ENGINEERING
# SCHEME -2013

## VII SEMESTER

### AERONAUTICAL ENGINEERING (S)

<table>
<thead>
<tr>
<th>Course No</th>
<th>Name of subject</th>
<th>Credits</th>
<th>Weekly load, hours</th>
<th>C A Marks</th>
<th>Exam Duration Hrs</th>
<th>U E Max Marks</th>
<th>Total Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.701</td>
<td>Avionics (S)</td>
<td>3</td>
<td>2 1 -</td>
<td>50</td>
<td>3</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>13.702</td>
<td>Mechatronics (MPSU)</td>
<td>4</td>
<td>3 1 -</td>
<td>50</td>
<td>3</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>13.703</td>
<td>Combustion Technology (S)</td>
<td>3</td>
<td>2 1 -</td>
<td>50</td>
<td>3</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>13.704</td>
<td>Rocket Propulsion (S)</td>
<td>4</td>
<td>3 1 -</td>
<td>50</td>
<td>3</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>13.705</td>
<td>Flight Dynamics (S)</td>
<td>4</td>
<td>3 1 -</td>
<td>50</td>
<td>3</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>13.706</td>
<td>Propulsion-II (S)</td>
<td>4</td>
<td>3 1 -</td>
<td>50</td>
<td>3</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>13.707</td>
<td>Elective III</td>
<td>3</td>
<td>2 1 -</td>
<td>50</td>
<td>3</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>13.708</td>
<td>Avionics Lab (S)</td>
<td>2</td>
<td>- - 2</td>
<td>50</td>
<td>3</td>
<td>100</td>
<td>150</td>
</tr>
<tr>
<td>13.709</td>
<td>Project and Project Seminar (MNPSU)</td>
<td>2</td>
<td>- - 2</td>
<td>100</td>
<td>-</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>29</td>
<td>18 7 4</td>
<td>500</td>
<td>800</td>
<td>1300</td>
<td></td>
</tr>
</tbody>
</table>

### 13.706 Elective III

<table>
<thead>
<tr>
<th>Course No</th>
<th>Name of subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.706.1</td>
<td>Computational Fluid Dynamics (S)</td>
</tr>
<tr>
<td>13.706.2</td>
<td>Cryogenics (S)</td>
</tr>
<tr>
<td>13.706.3</td>
<td>Experimental Methods (S)</td>
</tr>
<tr>
<td>13.706.4</td>
<td>Heat Transfer in Space Applications (S)</td>
</tr>
<tr>
<td>13.706.5</td>
<td>Energy Conservation and Management (S)</td>
</tr>
<tr>
<td>13.706.6</td>
<td>Research Methodology (S)</td>
</tr>
<tr>
<td>13.706.7</td>
<td>Space Mechanics (S)</td>
</tr>
<tr>
<td>13.706.8</td>
<td>Gas Turbines (S)</td>
</tr>
</tbody>
</table>
13.701 AVIONICS (S)

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

Course Objective:

- To introduce the basic of avionics and its need for civil and military aircrafts.
- To impart knowledge about the avionic architecture and various avionics data buses.
- To gain more knowledge on various avionics subsystems.

Module – I

INTRODUCTION TO AVIONICS
Need for avionics in civil and military aircraft and space systems – integrated avionics and weapon systems – typical avionics subsystems, design, technologies – Introduction to digital computer and memories.

Module – II

DIGITAL AVIONICS ARCHITECTURE

Module – III

FLIGHT DECKS AND COCKPITS
Control and display technologies: CRT, LED, LCD, EL and plasma panel – Touch screen – Direct voice input (DVI) – Civil and Military Cockpits: MFDS, HUD, MFK, HOTAS.

Module – IV

AIR DATA SYSTEMS AND AUTO PILOT
Air data quantities – Altitude, Air speed, Vertical speed, Mach Number, Total air temperature, Mach warning, Altitude warning – Auto pilot – Basic principles, Longitudinal and lateral auto pilot.

References:

**Internal Continuous Assessment (Maximum Marks-50)**

50% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.
20% - Regularity in the class

**University Examination Pattern:**

Examination duration: 3 hours  Maximum Total Marks: 100

The question paper shall consist of 2 parts.

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

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

**Course Outcome:**

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

- Ability to built Digital avionics architecture.
- Ability to design and perform analysis on air system.
13.702 MECHATRONICS (MPSU)

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

Course Objectives:
The main objectives of this course are

- To understand the features of various sensors used in CNC machines and robots.
- To study the fabrication and functioning of MEMS pressure and inertial sensors.
- To develop hydraulic/pneumatic circuit and PLC program for simple applications.

Module – I

Module – II


Module – III

System modeling - Mathematical models and basic building blocks of general mechanical, electrical, fluid and thermal systems.

Module – IV
finders. Robotic vision system - Image acquisition: Vidicon, charge coupled device (CCD) and charge injection device (CID) cameras. Image processing techniques: histogram processing: sliding, stretching, equalization and thresholding.

Case studies of Mechatronics systems: Automatic camera, bar code reader, pick and place robot, automatic car park barrier system, automobile engine management system.

References


Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, literature survey, seminar, term-project, software exercises, etc.
20% - Regularity in the class

University Examination Pattern:

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

The question paper shall consist of 2 parts.

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

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

Course outcome:

At the end of the course students will be able:

- To discuss mechanical systems used in mechatronics
- To integrate mechanical, electronics, control and computer engineering in the design of mechatronics systems.
13.703 COMBUSTION TECHNOLOGY (S)

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

Course Objectives:

Understanding fundamentals of different combustion processes and its chemistry.

Module – I

Introduction: Combustion, Applications of combustion, types of fuels and oxidizers, types of combustion modes and their domain of application, Ideal gas mixtures, partial pressure law, latent heats, Reactant and product mixtures, Enthalpy of formation.

Module – II

Thermo chemistry and kinetics:
Thermodynamics: Stoichiometry, Heat of combustion, adiabatic flame temperature, chemical equilibrium, Equilibrium products of combustion.
Kinetics of Reaction, collision theory, Arrhenius law elementary reactions, chain reaction, Multi step reactions, Global reactions.
Combustion conservation analysis: Mass conservation, momentum conservation, energy conservation, concept of conserved scalar, Transport properties, Transport in turbulent flows.

Module – III

Laminar flames:
Premixed flames: Physical description Detailed analysis, Factors Influencing flame velocity and thickness, Quenching, Flammability and Ignition Flame stabilization.
Diffusion flames: jet flame physical descriptions, flame lengths for circular port and slot burners, Soot formation and destruction.

Module – IV

Combustion and Emissions of Pollutants:
Droplet combustion: Introduction, applications, Droplet evaporation and combustion
Solids burning: Heterogeneous reactions, burning of carbon, particle burning time, coal combustion.
Emissions: Effects of pollutants, Quantification of emissions, emission from premixed combustion, Emissions from non premixed combustion.

References:


**Internal Continuous Assessment (Maximum Marks-50)**

50% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.
20% - Regularity in the class

**University Examination Pattern:**

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

The question paper shall consist of 2 parts.

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

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

**Course Outcome:**

Students successfully completing this course will have
- a sound understanding of the principles of combustion;
- a basic understanding of the mechanisms of combustion generated air pollution and the techniques that can be used to control them;
- a basic understanding of the safety and handling issues associated with combustion;
- a sound understanding of the responsibility of engineers to the community in terms of providing a safe healthy environment.
Course Objectives :

*To impart knowledge in non air-breathing and advanced propulsion methods to students so that they are familiar with various propulsion technologies associated with space launch vehicles, missiles and space probes.*

Module – I


Module – II


Module – III


Module – IV

Electric and advanced propulsion: Electric propulsion: Electromagnetic thrusters- magneto plasma dynamic (MPD), pulsed plasma (PPT), Hall effect and variable Current technology of electric propulsion engines, applications.
Nuclear propulsion- Principles, fuel elements, exhaust velocity, operating temperature. Fission fragment propulsion, radioisotope nuclear rocket, fusion propulsion, inertial, electrostatic and magnetic confinement fusion.
Propellant less Propulsion - Photon rocket, beamed energy propulsion, solar, magnetic sails.
References:


Internal Continuous Assessment (Maximum Marks-50)

- 50% - Tests (minimum 2)
- 30% - Assignments (minimum 2) such as homework, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.
- 20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours Maximum Total Marks: 100

The question paper shall consist of 2 parts.

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

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

Course Outcome:

- Understanding various propulsion systems
- Knowledge in rocket propulsion systems
- Knowing the applications and principles of liquid and solid-liquid propulsion systems
- Application of nuclear propulsion in rocketry.
13.705 FLIGHT DYNAMICS (S)

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

Course Objective:

To study the performance of airplanes under various operating conditions and the static and dynamic responses of aircraft for both voluntary and involuntary changes in flight conditions.

Module – I

Drag on airplane, international standard atmosphere- forces and moment acting on a flight vehicle- equation of motion of a rigid flight vehicle- different types of drag- drag polars of vehicle from low speeds to high speeds – variation of thrust, power and SFC with velocity and altitude for air breathing engines and rockets- power available and power required curves.

Module – II

Aircraft performance- performance of aircrafts in level flight- maximum speed in level flight- conditions for minimum drag and power required- range and endurance- climbing and gliding flight(maximum rate of climb and steepest angle of climb, minimum rate of sink and shallowest angle of glide)- turning performance(turning rate turn radius). Bank angle and load factor – limitations of pull up and push up diagram and load factor.

Module – III

Static longitudinal stability- degree of freedom of rigid bodies in space- static and dynamic stability- purpose of controls in airplanes- inherently stable and marginal stable airplanes- static, longitudinal stability- stick fixed stability- basic equilibrium equation- stability criterion- effect of fuselage and nacelle- influence of CG location- power effects- stick fixed neutral point- stick free stability- hinge moment coefficient –stick free neutral points- symmetric manoeuvres- stick force gradients- stick force per ‘g’ – aerodynamic balancing – determination of neutral points and manoeuvre points from flight test.

Module – IV

References:


**Internal Continuous Assessment (Maximum Marks-50)**

50% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project etc.
20% - Regularity in the class

**University Examination Pattern:**

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

The question paper shall consist of 2 parts.

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

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

**Note:** Use of approved data book is permitted in the examination hall.

**Course Outcome:**

After successful completion of the course, the student will be able to:

- Understand the static stability of aircraft
- Understand the dynamic response of aircraft
- Understand the flying qualities of aircraft.
Course Objective:

*To introduce basic concepts and salient features of engine components of jet propelled engines which are operated in atmosphere. To familiarise with advanced jet propulsion methods like hypersonic propulsion and space propulsion systems.*

Module – I

Compressors: Principal of operation of centrifugal compressor - Work done and pressure rise Euler’s Turbo machinery equations.
Axial flow compressor analysis, cascade action, flow field. Euler’s equation, velocity diagrams, flow annulus area stage parameters. Degree of reaction, cascade airfoil nomenclature and loss coefficient, diffusion factor, stage loading and flow coefficient, stage pressure ratio, Blade Mach No., repeating stage, repeating row.

Module – II

Turbines: Introduction to turbine analysis, mean radius stage calculations, stage parameters, stage loading and flow coefficients degree of reaction, stage temperature ratio and pressure ratio, blade spacing, radial variation, velocity ratio. Axial flow turbine, stage flow path, Dimensional stage analysis. Steps of turbine design: single stage and two stages.

Module – III


Module – IV

Space propulsion systems: Fundamentals of Solid, Liquid and hybrid propulsion- Electric rocket propulsion– types of electric propulsion techniques - Ion propulsion – Nuclear rocket –comparison of performance of these propulsion systems with chemical rocket propulsion systems –future applications of electric propulsion systems - Solar sail.

References:

3. James Award, Aerospace Propulsion System

Internal Continuous Assessment (Maximum Marks-50)

50% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, quiz, literature survey, seminar, term-project, software exercises, etc.
20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours    Maximum Total Marks: 100

The question paper shall consist of 2 parts.

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

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

Course Outcome:

After this programme students are expected to have

• Ability to identify the engine components of jet propelled engines
• Knowledge on the details of advanced Jet propulsion and hypersonic propulsion.
13.707.1 COMPUTATIONAL FLUID DYNAMICS (S) (Elective III)

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

Course Objectives:

- To introduce Governing Equations of viscous fluid flows.
- To introduce numerical modeling and its role in the field of fluid flow and heat transfer.
- To enable the students to understand the various discretization methods, solution procedures and turbulence modeling.
- To create confidence to solve complex problems in the field of fluid flow and heat transfer by using high speed computers.

Module – I

Basic aspects of computational aerodynamics: why computational Fluid dynamics? What is CFD? - CFD as a research tool- as a design tool. Applications in Various branches of engineering - models of fluid flow- finite control volume, infinitesimal fluid element. Substantial derivative- physical meaning of divergence of velocity.

Governing equations and physical boundary conditions: derivation of continuity, momentum and energy equations- physical boundary conditions significance of conservation and non-conservation forms and their implication on CFD applications- strong and weak conservation forms- shock capturing and shock fitting approaches.

Module – II


Module – III


Module – IV


References


Internal Continuous Assessment *(Maximum Marks-50)*

50% - Tests (minimum 2)

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

20% - Regularity in the class

University Examination Pattern:

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

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

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

Course outcome:

- Understand and be able to numerically solve the governing equations for fluid flow
- Understand and apply finite difference, finite volume and finite element methods to fluid flow problems
- Understand how grids are generated
- Understand and apply turbulence models to engineering fluid flow problems
- Be able to numerically solve a heat transfer problem
**Course Objectives:**

- To know about the cryogenic temperature production, superconductivity and applications.
- To know about various liquefaction processes.
- To know about various thermal insulations, properties of cryogenic fluids.
- To know about the measuring devices used for cryogenic fluids and storage and transportation of cryogenic fluids.

**Module – I**

**INTRODUCTION:** Historical Background - Introduction to cryogenic propellants - Liquid hydrogen, liquid helium, liquid nitrogen and liquid oxygen, material properties at cryogenic temperatures- mechanical, thermal electrical and magnetic. Application areas of cryogenics, Superconductivity applications.


**Module – II**

**CRYOGENIC LIQUEFACTION PROCESSES:** Theoretical minimum work for liquefaction, Figure of Merit for actual liquefaction processes.

**LIQUEFACTION PROCESSES FOR ARGON, NITROGEN AND OXYGEN:** simple Linde-Hampson, Pre-cooled Linde Hampson, Simple Claude, Kapitza, Heylandt processes.

**LIQUEFACTION PROCESSES FOR NEON AND HYDROGEN:** Pre-cooled Linde Hampson process, Pre-cooled Claude process, Philips Hydrogen liquefaction process.

**LIQUEFACTION PROCESSES FOR HELIUM:** Pre-cooled Linde Hampson Helium liquefaction process, Collins Helium Liquefaction Process, Philips Helium liquefaction process, Simon Helium liquefaction process.

**Module – III**

THERMAL INSULATION OF CRYOGENIC SYSTEMS: Vacuum, Porous and Fibrous, Multilayer, microsphere insulation, Typical insulation system for space propulsion.

Module – IV

MEASUREMENT DEVICES AT CRYOGENIC TEMPERATURES: Temperature- metallic resistance thermometer, constant volume gas thermometer, vapours pressure thermometer, superconducting thermometer, thermocouple, magnetic thermometer.

Sub-atmospheric pressure/ vacuum: McLeod gauge, thermal conductivity gauge, viscosity gauge, ionization gauge. Liquid level measurement: Hydrostatic gauge, electric resistance gauge, capacitance gauge, thermodynamic liquid level probe, magnetic probe, optical level indicator.

Flow Rate: Orifice meter, venturi meter, turbine flow meter, mass flow meter, displacement meter.

STORAGE AND TRANSPORTATION OF CRYOGENIC FLUIDS: Storage vessel, thermal shield and insulation, heat in-leak, factors affecting heat in-leak, transfer and draining of cryogenic liquids, transportation of cryogenic fluids- liquid nitrogen shielded Dewar, helium refrigerated storage vessel, hydrogen refrigerated Dewar, powder insulated Dewar, two phase flow during transfer- cool down time and its calculation. Safety devices for storage and transfer of cryogenic fluids.

References

1. Mamata Mukhopadhyay, Fundamentals of Cryogenic Engineering, PHI.

Internal Continuous Assessment (Maximum Marks-50)

50% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, literature survey, seminar, term-project, software exercises, etc.
20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours Maximum Total Marks: 100

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.
Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course outcome:

- Having knowledge about the cryogenic temperature production, superconductivity and applications and about various liquefaction processes.
- Get acquainted about various thermal insulations, properties of cryogenic fluids.
- Get apprehend about the measuring devices used for cryogenic fluids and storage and transportation of cryogenic fluids.
13.707.3 EXPERIMENTAL METHODS (S) (Elective III)

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

Course Objectives:

- To provide details, operating principles and limitations of forces, pressure, velocity and temperature measurements.
- To describe flow visualization techniques and to highlight in depth discussion of analog methods.

Module – I


Module – II


Module – III


Module – IV


References


**Internal Continuous Assessment (Maximum Marks-50)**

50% - Tests (minimum 2)

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

20% - Regularity in the class

**University Examination Pattern:**

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

The question paper shall consist of 2 parts.

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

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

**Course outcome:**

- Knowledge on measurement techniques in aerodynamic flow.
- Acquiring basics of wind tunnel measurement systems
- Specific instruments for flow parameter measurement like pressure, velocity, temperature etc.
13.707.4 HEAT TRANSFER IN SPACE APPLICATIONS (S) (Elective III)

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

Course Objectives:

- To know about the thermal environment of space craft
- To know about various thermal control techniques
- To know about various phase change materials, thermal contact resistance.

Module – I


Module – II

THERMAL CONTROL TECHNIQUES: Passive thermal control techniques: thermal coating materials, thermal insulation, heat sinks, phase change materials – Active thermal control techniques: electrical heaters, thermal louvers, HPR fluid systems, heat pipes, space borne cooling systems.


Module – III


Module – IV

THERMAL CONTACT RESISTANCE AND ITS CALCULATION: Parameters influencing thermal joint resistance – effect of oxidation and interstitial effects.


References

2. NASA SP 8105

**Internal Continuous Assessment (Maximum Marks-50)**

50% - Tests (minimum 2)

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

20% - Regularity in the class

**University Examination Pattern:**

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

The question paper shall consist of 2 parts.

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

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

**Course outcome:**

*Having knowledge about the thermal environment of space craft, about various thermal control techniques, various phase change materials, thermal contact resistance*
13.707.5 ENERGY CONSERVATION AND MANAGEMENT (S) (Elective III)

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

Course Objectives:
- To obtain Energy conservation principles
- To identify Procedures and Techniques
- To know the Energy Policy & Planning
- To know the Energy Balance & Energy Audit.

Module – I

General Aspects:


Module – II

Procedures and Techniques:

Data gathering: Level of responsibilities, energy sources, control of energy and uses of energy get Facts, figures and impression about energy/fuel and system operations, Past and Present operating data, Special tests, Questionnaire for data gathering.

Analytical Techniques: Incremental cost concept, mass and energy balancing techniques, inventory of Energy inputs and rejections, Heat transfer calculations, Evaluation of Electric load characteristics, process and energy system simulation.

Evaluation of saving opportunities: Determining the savings in Rs, Noneconomic factors, Conservation opportunities, estimating cost of implementation.

Energy Audit Reporting: The plant energy study report- Importance, contents, effective organization, report writing and presentation.

Module – III

Energy Policy Planning and Implementation:


Module – IV


References


Internal Continuous Assessment (Maximum Marks-50)

50% - Tests (minimum 2)
30% - Assignments (minimum 2) such as home work, problem solving, literature survey, seminar, term-project, software exercises, etc.
20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours Maximum Total Marks: 100

The question paper shall consist of 2 parts.

Part A (20 marks) - Ten Short answer questions of 2 marks each. All questions are compulsory. There should be at least two questions from each module and not more than three questions from any module.
Part B (80 Marks) - Candidates have to answer one full question out of the two from each module. Each question carries 20 marks.

Course outcome:

13.707.6 RESEARCH METHODOLOGY (S) (Elective II)

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

**Course Objectives:**
- To impart scientific, statistical and analytical knowledge for carrying out research work effectively.

**Module – I**

**Introduction to Research:** The hallmarks of scientific research – Building blocks of science in research – Concept of Applied and Basic research – Quantitative and Qualitative Research Techniques – Need for theoretical frame work – Hypothesis development – Hypothesis testing with quantitative data. Research design – Purpose of the study: Exploratory, Descriptive, Hypothesis Testing.

**Module – II**


**Module – III**


**Module – IV**

**Multivariate Statistical Techniques:** Data Analysis – Factor Analysis – Cluster Analysis – Discriminant Analysis – Multiple Regression and Correlation – Canonical Correlation  

**References**


**Internal Continuous Assessment (Maximum Marks-50)**

50% - Tests (minimum 2)

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

20% - Regularity in the class

**University Examination Pattern:**

Examination duration: 3 hours  
Maximum Total Marks: 100

The question paper shall consist of 2 parts.

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

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

**Course outcome:**

At the end of this course the students will be able to accomplish scientific, statistical and analytical knowledge for carrying out research work effectively.
13.707.7 SPACE MECHANICS (S) (Elective III)

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

Course Objectives:

- To introduce concepts of satellite injection and satellite perturbations, trajectory computation for interplanetary travel and flight of ballistic missiles based on the fundamental concepts of orbital mechanics.

Module – I

SPACE ENVIRONMENT: Peculiarities of space environment and its description—effect of space environment on materials of spacecraft structure and astronauts—manned space missions—effect on satellite life time.

Module – II


Module – III

SATELLITE INJECTION AND SATELLITE PERTURBATIONS: General aspects of satellite injection—satellite orbit transfer—various cases—orbit deviations due to injection errors—special and general perturbations—Cowell’s method and Encke’s method—method of variations of orbital elements—general perturbations approach.

Module – IV

INTERPLANETARY TRAJECTORIES: Two-dimensional interplanetary trajectories—fast interplanetary trajectories—three dimensional interplanetary trajectories—launch of interplanetary spacecraft—trajectory estimation about the target planet—concept of sphere of influence—Lambert’s theorem

BALLISTIC MISSILE TRAJECTORIES: Introduction to ballistic missile trajectories—boost phase—the ballistic phase—trajectory geometry—optimal flights—time of flight—re-entry phase—the position of impact point—influence coefficients.

References


**Internal Continuous Assessment** *(Maximum Marks-50)*

- 50% - Tests *(minimum 2)*
- 30% - Assignments *(minimum 2)* such as home work, problem solving, literature survey, seminar, term-project, software exercises, etc.
- 20% - Regularity in the class

**University Examination Pattern:**

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

The question paper shall consist of 2 parts.

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

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

**Course outcome:**

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

- Perform satellite injection, satellite perturbations and trajectory control.
- Apply orbital mechanics to control ballistic missile.
Course Objectives:

• To familiarize various working principle of Gas Turbine Power plant.
• To study basic equation of power cycles
• To study flow through centrifugal compressor and axial flow compressor, Turbines and combustion systems
• To study Performance predictions.

Module – I

INTRODUCTION: Open cycle single shaft and twin shaft multi speed arrangement – Closed cycle – Aircraft propulsion – Industrial application – Environmental issues - Future – Possibilities


Module – II


Module – III


Module – IV

References


Internal Continuous Assessment *(Maximum Marks-50)*

- 50% - Tests (minimum 2)
- 30% - Assignments (minimum 2) such as home work, problem solving, literature survey, seminar, term-project, software exercises, etc.
- 20% - Regularity in the class

University Examination Pattern:

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

The question paper shall consist of 2 parts.

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

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

Course outcome:

*At the end of this course the students will be familiar to working principle of Gas Turbine Power plant, basic equation of power cycles, flow through centrifugal compressor and axial flow compressor, Turbines and combustion systems and thereby to their Performance predictions.*
13.708 AVIONICS LAB (S)

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

Course Objective:

This laboratory is divided into three parts to train the students to learn about basic digital electronics circuits, programming with microprocessors, design and implementation of data buses in avionics with MIL – Std. 1553B and remote terminal configuration and their importance in different applications in the field of Avionics.

List of Experiments:

DIGITAL ELECTRONICS

- Addition/Subtraction of binary numbers.
- Multiplexer/Demultiplexer Circuits.
- Encoder/Decoder Circuits.
  - Timer Circuits, Shift Registers, Binary Comparator Circuits.

MICROPROCESSORS

- Addition and Subtraction of 8-bit and 16-bit numbers.
- Sorting of Data in Ascending & Descending order.
- Sum of a given series with and without carry.
- Greatest in a given series & Multi-byte addition in BCD mode.
- Interface programming with 4 digit 7 segment Display & Switches & LED’s.
- 16 Channel Analog to Digital Converter & Generation of Ramp, Square, Triangular wave by Digital to Analog Converter.

AVIONICS DATA BUSSENTROUS

- Study of Different Avionics Data Buses.
- MIL-Std – 1553 Data Buses Configuration with Message transfer.
  - MIL-Std – 1553 Remote Terminal Configuration.

Internal Continuous Assessment (Maximum Marks-50)

40% - Test  
40% - Class work and Record  
20% - Regularity in the class

University Examination Pattern:

Examination duration: 3 hours  
Maximum Total Marks: 100  
Questions based on the list of experiments prescribed.
80% - Procedure, conducting experiment, results, tabulation and inference
20% - Viva voce

Candidate shall submit the certified fair record for endorsement by the external examiner.

Course Outcome:

Students will get an insight into the use of different experimental techniques used in Avionics.
13.709 PROJECT AND PROJECT SEMINAR (MNPSU)

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

Course Objective:

- To identify a problem for the final-year project, outline a solution, and prepare a preliminary design for the solution.

- To do a detailed study on the selected topic based on current journals or published papers and present seminars

- To improve the ability to perform as an individual as well as a team member in completing a project work.

- The seminar based on the project provides students adequate exposure to presentations to improve their communication skills.

The student shall do a project (project phase 1) in the seventh semester, which shall be continued in the eighth semester. He/she shall submit an interim report at the end of the seventh semester and the final project report shall be submitted at the end of the eighth semester. The student shall present two seminars in the seventh semester on the work carried out during project phase 1. The first seminar should highlight the definition of problem, novelty of the project, literature survey and work plan/ methodology. The second seminar should include preliminary results. The students may be assessed individually/ and in groups.

Internal Continuous Assessment (Maximum Marks-100)

40% - Assessment by the Guide

40% - Assessment by the Committee.

20% - Regularity in the class

Course Outcome:

At the end of the course, the students would have acquired the basic skills to for performing literature survey and paper presentation. This course shall provide students better communication skills and improve their leadership quality as well as the ability to work in groups, and thus aid them in building a successful career as an engineer.