# DEPARTMENT OF AERONAUTICAL ENGINEERING

## Structure & Curriculum

## M. Tech. 3rd Semester

## As per NEP-2020

From

## Academic Year 2024-25

## Institute Vision & Mission

**Vision:**

- To emerge as a learning Center of Excellence in the National Ethos in domains of Science, Technology and Management.

**Mission:**

1. To strive for rearing standard and stature of the students by practicing high standards ofprofessional ethics, transparency and accountability.
2. To provide facilities and services to meet the challenges of Industry and Society.
3. To facilitate socially responsive research, innovation and entrepreneurship.
4. To ascertain holistic development of the students and staff members by inculcating knowledgeand profession as work practices.

## Program Outcomes (POs)

1. Engineering Knowledge
2. Problem Analysis
3. Design/development of solutions
4. Conduct investigations of complex problems
5. Modern tool usage
6. The engineer and society
7. Environment and sustainability
8. Ethics
9. Individual and team work
10. Communication
11. Project management and finance
12. Lifelong learning

## Department Vision & Mission

**Vision:**

- To foster technically skilled Aeronautical Engineers of the utmost academic principles, toconvene the needs of academia, industry and society.

**Mission:**

1. Impart quality technical education and unique interdisciplinary experiences.
2. Develop the analytical, computational and design capabilities to provide sustainable solutions.
3. Expose the students to the current trends and opportunities in the Aerospace industry.
4. Inculcate professional responsibility based on an innate ethical value system.

## Program Educational Objectives (PEOs)

1. Under graduate students will acquire knowledge to investigate and solve AeronauticalEngineering problems using basics of applied science and engineering.
2. Under graduate students will utilize the modern technology and techniques to explore new skillsand ideas to satisfy the need of society as well as industry.
3. Under graduate students will get finest employment opportunities in the field of Aeronautical Engineering.
4. To develop the environment of societal and ethical values to concern with engineering issues.
5. Under graduate students will contribute in the domain specific and inter disciplinary research through the project based learning.

## Program Specific Outcomes (PSO)

1. Develop profound working knowledge to solve combination of complex problems inaerodynamics, propulsion, structures, flight mechanics and allied courses.
2. Be equipped to use CAE packages, simulation languages and advanced tools to solve practicaldesign and analysis problems.
3. Under graduates will be able to utilize the extensive knowledge of design, manufacturing, testingor maintenance of systems and subsystems to pursue career in aeronautical engineering

# TULSIRAMJI GAIKWAD-PATIL COLLEGE OF ENGINEERING & TECHNOLOGY

Wardha Road, Nagpur - 441108
Accredited with NAAC A+ Grade
Approved by AICTE, New Delhi, Govt. of Maharashtra
(An Autonomous Institution Affiliated to Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur)

## Scheme of Instructions: Second Year M. Tech. in Aeronautical Engineering

### Semester–III (2nd Year -2025-26)

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Scheme of Instructions: Second Year M. Tech. in Aeronautical Engineering .

**Semester–III (2nd Year -2024-25)**

| Sr. No. | Course Category | Course Code | Course Title | L | T | P | Contact Hrs/Wk | Credits | EXAMSCHEME | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | CT1 | CT2 | TA/CA | ESE | TOTAL |
| 1 | PEC | MAE22301 | MOOC (8-12 Hrs) | - | - | - | - | 3 | - | - | - | - | - |
| 2 | PEC | MAE22303-06 | Program Elective-IV | 3 | - | - | 3 | 3 | 20 | 20 | - | 60 | 100 |
| 3 | P/S/IT | MAE22302 | Dissertation Phase-I | - | - | 27 | 27 | 14 | - | - | 100 | 200 | 300 |
| | | | Total | 3 | - | 27 | 30 | 20 | 20 | 20 | 100 | 260 | 400 |

**Note:**

1. MAE 22301 will be decided by respective Guide in Consultation with Program Coordinator. Course is mandatory is for student and his/her dissertation phase I will be considered incomplete without this Mandatory MOOC Course.
2. In Case, the course offered online are not completely relevant with the topic of dissertation then any course suggested by NASSCOM on recent technologies can be opted by candidate.
3. Programme coordinator will provide list of 03 MOOC courses of minimum 08 weeks duration (as per availability).Students are expected to complete any one out of three courses in order to get the required credits.
4. Student can do registration one of MOOC course from first semester to third semester and it will be considered in third Semester Results.

**L- Lecture** **T- Tutorial** **P- Practical** **CT-1- Class Test-I** **CT-2 - Class Test-2**
TA/CA - Teacher Assessment/ Continuous Assessment ESE- End Semester Examination (For Lab & Theory End Semester Exam)

**PROGRESSIVE TOTALCREDITS: 40+ 20 = 60**

Chairperson Dean Academics Principal June, 2024 1.00

Date of Release Version

Head of Department
Tulsiramji Gaikwad Patil College of Engineering and Technology Nagpur (M.S.)

Dean Academics PG and Ph.D
Tulsiramji Gaikwad-Patil College of Engineering and Technology Nagpur (M.S.)

Principal
Tulsiramji Gaikwad Patil College Of Engineering and Technology, Nagpur

# List of Program Elective Courses

| Semester III |
|---|
| **Program Elective-IV** |
| **MAE21303: Introduction to Cryogenics** |
| **MAE21304: Vibrations and Aero-elasticity** |
| **MAE21305: Aircraft Maintenance & Repairs** |
| **MAE21306: Aircraft Communication & Navigation Systems** |

## Program Elective-IV

## Second Year (Semester-III) M. Tech. Aeronautical Engineering

## Second Year M. Tech. (Semester-III)

## MAE21303- Introduction to Cryogenics

| **Teaching Scheme** | | | **Examination Scheme** | |
|---|---|---|---|---|
| **Lectures** | 3 Hr / Week | | **ESE** | 60 Marks |
| **Tutorial** | | | **CIE** | 40 Marks |
| **Practical** | - | | **Total** | 100 Marks |
| **Theory Credits : 3** | | | **Duration of Exam :** 3 Hours | |

**Course Objectives**

The Objectives of this course is:

| | |
|---|---|
| **1.** | Understand the behavior of materials at cryogenic temperatures including mechanical, thermal, and electrical properties |
| **2.** | Understand the principles of gas separation and rectification, including composition diagrams, plate and flash calculations, and rectification column analysis. |
| **3.** | Analyze various methods for achieving low temperatures, such as Joule-Thomson expansion, cascade processes, Linde-Hampson, Claude systems, and magnetic cooling. |
| **4.** | Evaluate the performance of cryogenic systems under varying parameters and configurations |
| **5.** | Investigate the role of cryogenics in superconducting devices including magnets, bearings, cryotrons, and tunnel diodes. |

**Course Contents**

| | |
|---|---|
| **Unit I** | **Introduction** Cryogenic engineering, properties of cryogenic fluids like Oxygen, Nitrogen, Argon, Neon, Florin, Helium, Hydrogen, Properties of material at cryogenic temperature, mechanical, thermal, and electrical, Super conductivity, application of cryogenic systems in space, medical, industries, biological etc. |
| **Unit II** | **Cryogenic refrigeration** Principle and Methods of production of low temperature and their analysis: Joule Thomson Expansion, Cascade processes, Ortho and para hydrogen conversion, cold gas refrigerators, Linde- Hampson cycles, Claude and cascaded systems, magnetic cooling, Stirling Cycle Cryocoolers, Philips refrigerators, Gifford single volume refrigerator, Pulse tube refrigerators. |
| **Unit III** | **Cryogenic requirement** Cryogenics Heat Exchangers, Compressors, Expanders, Effect of various parameters in performance and system optimization. Various insulations (expanded foams, gas filled, fibrous, vacuum, multi- layer etc.) and Storage equipment for cryogenic fluids, industrial storage and transfer of cryogenic fluids. |
| **Unit IV** | **Gas separation and purification** Ideal gas, mixture characteristics composition diagrams, gas separation, principle of rectification, plate calculation, flash calculation rectification column analysis, separation of air, hydrogen and helium. |
| **Unit V** | **Cryogenic instrumentation and safety** Properties and characteristics of instrumentation, strain displacement, pressure, flow, liquid level, density and temperature measurement in cryogenic range. Safety in cryogenic fluid handling, storage and use. Safety against cryogen hazards like |

| | |
|---|---|
| | burns, frostbite, asphyxiation, hypothermia etc. Application Super conductive devices such as bearings, motors, cryotrons, magnets, D.C. transformers, tunnel diodes, space technology, space simulation, cryogenics in biology and medicine. |
| **Text Books** | |
| **1** | Randal F. Barron, Cryogenic Systems, Oxford University Press, New York, 1999 |
| **2** | T.M Flynn, Cryogenic Engineering, Maxwell Dekker, 1997. |
| **3** | Scoot, Cryogenic Engineering, Van Nostrand Co. Inc. 1985. |
| **Reference Books** | |
| **1** | R W Yance and WM Duke, Applied Cryogenic Engineering, John Willey. |
| **2** | Klaus D. Timmerhaus, Richard Palmer Reed, Cryogenic Engineering: 50 years of progress, Springer, 2007. |
| **3** | Aerodynamics for Engineering Students by E. L. Houghton, Steven H. Collicott, P. W. Carpenter, Daniel T., 7th Edition, 2016. |
| **Useful Links** | |
| **1** | http://www.nptelvideos.in/2012/12/cryogenic-engineering.html |
| **2** | https://nptel.ac.in/courses/112/101/112101004/ |
| **3** | https://nptel.ac.in/courses/112/106/112106190/ |

| MAE21303 | Course Outcomes |
|---|---|
| **CO1** | **Understand** the basic properties of cryogenic fluids. |
| **CO2** | **Understand** the basic concepts of refrigeration and liquefaction |
| **CO3** | **Solve** the problems on basic concepts cryogenic insulation. |
| **CO4** | **Solve** the problems on the principle of storage and processing of cryogenic liquids. |
| **CO5** | **Solve** problems on the equipment in cryogenic liquids. |

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## Program Elective-IV

## Second Year (Semester-III) M. Tech. Aeronautical Engineering

## Second Year M. Tech. (Semester-III)

# MAE21304: Vibrations and Aero-elasticity

| **Teaching Scheme** | | | **Examination Scheme** | |
|---|---|---|---|---|
| **Lectures** | 3 Hr / Week | | **ESE** | 60 Marks |
| **Tutorial** | - | | **CIE** | 40 Marks |
| **Practical** | - | | **Total** | 100 Marks |
| **Theory Credits : 3** | | | **Duration of Exam :** 3 Hours | |

**Course Objectives**

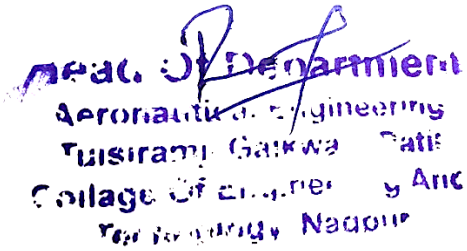
| | |
|---|---|
| **1.** | To make students aware about the unforced and force response system vibration. |
| **2.** | To make the student understand the concept of dynamics of multi Degree of freedom system.. |
| **3.** | To get the knowledge of principles of aero-elasticity.. |
| **4.** | To make students aware about the unforced and force response system vibration. |

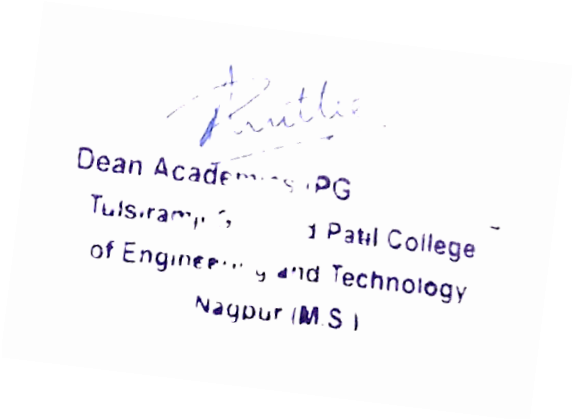
## Course Contents

| | |
|---|---|
| **Unit I** | **Introduction**<br>Overview of the course, practical applications and research trends, harmonic and periodic motions, vibration terminology, introduction to spring and mass system, representation of practical problems in spring and mass system, vibration model, equation of motion. |
| **Unit II** | **Single-DOF Free Vibrations**<br>Natural frequency energy method, Rayleigh method, Principle of virtual work, Damping models. Viscously damped free vibration, Special cases: oscillatory, non-oscillatory and critically damped motions. Logarithmic decrement, Experimental determination of damping coefficient, Forced harmonic vibration, Magnification factor. Rotor unbalance, Transmissibility, Vibration Isolation Equivalent viscous damping, Sharpness of resonance. |
| **Unit III** | **Two-DOF Free Vibrations**<br>Generalized and Principal coordinates, derivation of equations of motion Lagrange's equation, Coordinate coupling, Forced Harmonic vibration, Tuned absorber, determination of mass ratio. Tuned and damped absorber, unturned viscous damped Forced Harmonic vibration. |
| **Unit IV** | **Vibration Absorber**<br>Tuned absorber, determination of mass ratio. Tuned and damped absorber, unturned viscous damper.<br>**Multi-DOF Vibration**<br>Derivation of equations of motion, influence coefficient method, Properties of vibrating systems: flexibility and stiffness matrices, reciprocity theorem, Modal analysis: undammed, Modal analysis: damped. |
| **Unit V** | **Introduction Aero elastic Problems**<br>Deformation of Structures and Influence Coefficients. Energy Method. Classification and Solution of Aero elastic Problems, Static Aero elasticity. Divergence of 2-D airfoil and Straight Wing. Aileron Reversal. Control Effectiveness. Wing loading and deformations. Swept Wing. Dynamic Aero elasticity. Dynamic/Flutter model of 2-D Airfoil. Finite State Model. Flutter Calculation. U-g Method. P-k Method. Exact Treatment of Bending - Torsion Flutter of Uniform Wing. |

| | |
|---|---|
| **Text Books** | |
| **1** | P. Srinivasan, Mechanical Vibration Analysis, Tata Mc Graw Hill, New Delhi, 4th edition, 1985. |
| **2** | J. P. Den Hartog, Mechanical Vibration, Mc Graw Hill, New York, 4th edition, 2005. |
| **3** | E.H. Dowell, A Modern Course in Aero elasticity, Springer-Verlag, 5th edition, 2012. |
| **Reference Books** | |
| **1** | N. L. Meirovitch, Elements of vibration Analysis, Mc Graw Hill, New York, 1st edition, 1986. |
| **2** | R. L. Bisplingh off, H. Ashley and R. L. Halfman, Aero elasticity, Addison- Wesley, 1st edition, 1955. |
| **3** | Applied Finite Element Analysis - Larry J. Segelind - John Wiley. |
| **Useful Links** | |
| **1** | https://nptel.ac.in/content/syllabus_pdf/101104005.pdf |
| **2** | https://nptel.ac.in/courses/112/103/112103111/ |
| **3** | https://nptel.ac.in/courses/112/103/112103112/ |

| MAE21304 | Course Outcomes |
|---|---|
| **CO1** | **Estimate** unforced and force response for damped and undammed system. |
| **CO2** | **Differentiate** Dynamic, static and impulse loading and **estimate** damping ratio. |
| **CO3** | **Analyze** dynamics of multi Degree of freedom and rotating system. |
| **CO4** | **Synthesis** the dynamics of aircraft structures. |
| **CO5** | **Explicate** principles of aero-elasticity with Classification and Solution of Aero elastic Problems. |





## Program Elective-IV

## Second Year (Semester-III) M. Tech. Aeronautical Engineering

## Second Year M. Tech. (Semester-III)

## MAE21305- AIRCRAFT MAINTAINENCE AND REPAIR

| **Teaching Scheme** | | | **Examination Scheme** | |
|---|---|---|---|---|
| **Lectures** | 3 Hr / Week | | **ESE** | 60 Marks |
| **Tutorial** | | | **CIE** | 40 Marks |
| **Practical** | - | | **Total** | 100 Marks |
| **Theory Credits : 3** | | | **Duration of Exam :** 3 Hours | |

**Course Objectives**

The Objectives of this course is:

| | |
|---|---|
| **1.** | Provide an understanding of welding processes and maintenance of aircraft structural components. |
| **2.** | Introduce the maintenance and repair techniques for plastic and composite materials in aircraft. |
| **3.** | Familiarize students with procedures for aircraft jacking, weighing, and rigging. |
| **4.** | Develop knowledge of hydraulic and pneumatic systems, and their maintenance in aircraft |
| **5.** | Emphasize safety practices, handling hazardous materials, and proper troubleshooting techniques. |

## Course Contents

| | |
|---|---|
| **Unit I** | **WELDING IN AIRCRAFT STRUCTURAL COMPONENTS** Equipment's used in welding shop and their maintenance, ensuring quality welds, welding. Jigs and fixtures, Soldering and brazing. Sheet Metal Repair and Maintenance: Selection of materials; Repair schemes; Fabrication of replacement patches; Tools, power/hand; Repair techniques; Close tolerance fasteners; Sealing compounds; forming/shaping; Calculation of weight of completed repair; Effect of weight, change on surrounding structure. Sheet metal inspection, N.D.T. Testing. Riveted repair design, Damage investigation, Reverse engineering. |
| **Unit II** | **PLASTICS AND COMPOSITES IN AIRCRAFT Plastics in Aircraft:** Review of types of plastics used in airplanes, Maintenance and repair of plastic components, Repair of cracks, holes etc., and various repairs schemes, Scopes. Advanced Composites in Aircraft: Cleaning of fibre reinforced plastic (FRP) materials prior to repair; Break test, Repair Schemes; FRP/honeycomb sandwich materials; laminated FRP structural members and skin panels; Tools/equipment; Vacuum-bag process. Special precautions, Autoclaves. |
| **Unit III** | **AIRCRAFT JACKING, ASSEMBLY AND RIGGING** Airplane jacking and weighing and C.G. Location. Balancing of control surfaces, Inspection, Maintenance. Helicopter flight controls. Tracking and balancing of main rotor. |
| **Unit IV** | **REVIEW OF HYDRAULIC AND PNEUMATIC SYSTEM** Trouble shooting and maintenance practices - Service and inspection - Inspection and maintenance of landing gear systems, Inspection and maintenance of air-conditioning and pressurization system, water and waste system. Installation and maintenance of Instruments, handling, Testing, Inspection. Inspection and maintenance of auxiliary systems, Fire protection systems, Ice protection system, Rain removal system, Position and warning system, Auxiliary Power Units (APUs). |

| | |
|---|---|
| **Unit V** | **SAFETY PRACTICES** Hazardous materials storage and handling, Aircraft furnishing practices, troubleshooting. Theory and practices. |

| **Text Books** | |
|---|---|
| **1** | J. Gordon Leishman, Principles of Helicopter Aerodynamics, Cambridge University Press, 2002 |
| **2** | George H. Saunders, Dynamics of Helicopter Flight, John Wiley & Sons, Inc, NY,1975. |
| **3** | Stepniewski & Keys: Rotary wing Aerodynamics, Dover Publications, 3rd Edition, 2004 |
| **Reference Books** | |
| **1** | Wayne Johnson: Helicopter Theory, Dover Publications. |
| **2** | Gordon Leishman: Principles of Helicopter Aerodynamics, Cambridge Aerospace Series. |
| **Useful Links** | |
| **1** | https://nptel.ac.in/courses/101/104/101104017/ |
| **2** | https://nptel.ac.in/courses/101/104/101104015/ |

| **MAE21305** | **Course Outcomes** |
|---|---|
| **CO1** | **Explain** the different configurations of helicopter. |
| **CO2** | **Solve** the problems on the concepts of rotor dynamics and related theories. |
| **CO3** | **Compute** the Performance of Helicopter. |
| **CO4** | **Examine** the stability and control of forward moving helicopter. |
| **CO5** | **Study** the Standards, and Specifications |

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## Program Elective-IV

## Second Year (Semester-III) M. Tech. Aeronautical Engineering

## Second Year M. Tech. (Semester-III)

## MAE21306- Aircraft Navigation & Communication System

| **Teaching Scheme** | | | **Examination Scheme** | |
|---|---|---|---|---|
| **Lectures** | 3 Hr / Week | | **ESE** | 60 Marks |
| **Tutorial** | | | **CIE** | 40 Marks |
| **Practical** | - | | **Total** | 100 Marks |
| **Theory Credits : 3** | | | **Duration of Exam :** 3 Hours | |

**Course Objectives**

The Objectives of this course is:

| | |
|---|---|
| **1.** | To make students aware about flight control systems and operation of flight control system |
| **2.** | To get the knowledge to Flight data recorder & Cockpit voice recorder system |
| **3.** | To get the knowledge to Flight data recorder & Cockpit voice recorder system |
| **4.** | Infer about the basic concepts air space managements. |
| **5.** | Introduce the aircraft emergency. |

## Course Contents

| | |
|---|---|
| **Unit I** | Introduction to Communication System: Radio communication system fundamentals, EM waves, medium of propagation, Radio frequency spectrum, uses and limitation of R.F. bands. Radio wave propagation, ground wave, sky wave, radiation angle, skip distance, diffraction, field strength, absorption, Scattering, reflection, fading, ducting, critical frequency, Antenna Fundamentals. Dipole, half wave dipole, resonant and Nonresonant antenna. Antenna gain, directional power, Antenna Loses and efficiency, band width, beam width, band width, polarization Grounding of antenna, loading of antenna, requirements of the avionic systems for various channels in radio communication, surface taxing, air to ground/ATC, air to air, emergency radio communication, distress channel etc, purpose and usage, physical qualities required. ACARS communication systems. |
| **Unit II** | Types of Communication Systems: Very High Frequency (VHF), High Frequency (HF), Ultra High Frequency (UHF), Satellite communication (SATCOM), Intercom for pilots and the crew, Public address System (PA system) for air crew to passengers are explained to the students VHF, HF, UHF Systems used, their merits, demerits. |
| **Unit III** | Navigation System: Basic block level explanation for working of VHF, HF, UHF communication systems used in air craft, their frequency bands, limitations. Aircraft PA systems, intercom and Passenger entertainment systems: Brief explanations of block level PA system, intercom and passenger entertainment system. |
| **Unit IV** | FDR, CVR and GNSS Systems: FDR: Brief explanation of block diagram level working of FDR and its special construction. List of important flight parameters which are recorded in FDR, Purpose and use of FDR in training, planning of spares, accident investigation, Validity of warranty etc. Location of FDR and reason for it is explained CVR: Brief explanation of working of a CVR Purpose and use of CVR in accident |

| | |
|---|---|
| | investigation, air crew coordination training, location of CVR. GPS, DGPS, LAAS and WAAS Systems |
| **Unit V** | Introduction to RADAR Systems Explanation of basic working principles of RADAR with block diagram. Radar range equation- statement of equation and explanation of the terms involved in Radar range equation Purpose and use RADAR in various fields. Basic explanation of meaning of Primary RADAR, Third array RADAR, advantages, and disadvantages Working of various types of RADARS: Third array Surveillance, Doppler, INS, GPS: block diagram level working of Third array surveillance RADAR, Purpose and areas of use. block diagram level working of Doppler navigational RADAR, Purpose and areas of use. block diagram level working of Inertial Navigation System (INS) Purpose and application areas for INS. working principles of satellite navigation system using GPS, Advantages, disadvantages of GPS. |
| **Text Books** | |
| **1** | Radio Communication by D. C. Green, Longman, 2nd edition, 2000. |
| **2** | Introduction to Radar systems by M. Skollnik, Mc Graw Hill, India, 3rd edition, 2017. |
| **3** | Principles of Avionics Albert Helfrick, Airline Avionics Publisher, 3rd edition, 2004. |
| **Reference Books** | |
| **1** | Philip Lockin D, "Economics of Transportation", English Book House, New Delhi-I. |
| **2** | Indian Aircraft manual", Published by DGGA, New Delhi-I. |
| **3** | Alexander T Wells, "Air Transportation", Wadsworth Publishing Company, California, 1993. |
| **Useful Links** | |
| **1** | https://nptel.ac.in/content/syllabus_pdf/101104005.pdf |
| **2** | https://nptel.ac.in/courses/101/104/101104071/ |
| **3** | https://www.nptelvideos.com/lecture.php?id=5030 |

| MAE21306 | Course Outcomes |
|---|---|
| **CO1** | Describe fundamentals of electronic communication systems and their application in aviation |
| **CO2** | Examine Different types of Navigation & communication system |
| **CO3** | Scrutinize different types of Flight data recorder & Cockpit voice recorder system |
| **CO4** | Perform qualitative analysis on simple electronic communication system |
| **CO5** | Study the RADAR & INS System and its application to an aircrafts. |

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