JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY: KAKINADA

KAKINADA – 533 003, Andhra Pradesh, India

INSTITUTE OF SCIENCE AND TECHNOLOGY

R25 - COURSE STRUCTURE & SYLLABUS
M.Tech AVIONICS Programme

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

INSTITUTE OF SCIENCE AND TECHNOLOGY

R25 M.TECH AVIONICS COURSE STRUCTURE AND SYLLABUS

Programme Structure

R25 MTech (Avionics) Structure

I - Semester

S. No.	Course Title	L	T	P	C
1	Flight Mechanics	3	1	0	4
2	Avionics Systems	3	1	0	4
3	Flight Instrumentation	3	1	0	4
4	Program Elective — I	3	0	0	3
5	Program Elective — II	3	0	0	3
6	Flight Mechanics and Engineering Lab	0	1	2	2
7	Flight Instrumentation and Communication Lab	0	1	2	2
8	Seminar-I	0	0	2	1
	TOTAL	15	5	6	23

List of Professional Elective Courses in I Semester (Electives — I & II)

S.No.	Course Title
1	AI-Driven Condition Monitoring in Avionics Systems
2	Aircraft Communication Systems
3	Missile and Space Vehicle Mechanics
4	Airborne ISR (Intelligence, Surveillance, and Reconnaissance)
5	Advanced Drone Technologies and Applications
6	Astrophysics and Stellar Evolution

@ Minimum 2/3 themes per elective

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II — Semester

S. No.	Course Title	L	T	P	C
1	Flight Stability and Control	3	1	0	4
2	Aircraft Navigation	3	1	0	4
3	Avionics Embedded Systems	3	1	0	4
4	Program Elective — Ill	3	0	0	3
5	Program Elective - IV	3	0	0	3
6	Guidance, Navigation and Control Lab	0	1	2	2
7	Avionics Embedded Systems Lab	0	1	2	2
8	Seminar — II	0	0	2	1
	TOTAL	15	5	6	23

List of Professional Elective Courses in II Semester (Electives III & IV)

S.No.	Course Title
1	Indian Space Program: A History and Future
2	Safety-Critical Avionics: Design Assurance and Environmental Compliance
3	Missile and Space Vehicle Guidance and Control
4	Space-Based Observational Astronomy and Instrumentation
5	Electric Aircraft Systems
6	Aircraft Lighting Systems Design, Certification, and Integration

@ Minimum 2/3 themes per elective

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MTech (Avionics) - III Semester

S.No.	Course Title	L	T	P	C
1	Research Methodology and IPR / Swayam 12-week MOOC course — RM&IPR	3	0	0	3
2	Summer Internship/ Industrial Training (8-10 weeks) *	-	-	-	3
3	Comprehensive Viva#	-	-	-	2
4	Dissertation Part — A$	-	-	20	10
	TOTAL	3	-	20	18

*** Student attended during summer / year break and assessment will be done in 3rd Sem. # Comprehensive viva can be conducted courses completed upto second sem.**
$ Dissertation — Part A, internal assessment

MTech. (Avionics) — IV Semester

S. No.	Course Title	L	T	P	C
1	Dissertation Part —B%	-	-	32	16
	TOTAL	-	-	32	16

% External Assessment

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Program Educational Objectives (PEOs) for M.Tech (Avionics): R25

PEO1: Advanced Technical Expertise
Graduates will excel in solving complex engineering problems in avionics systems, embedded control, flight instrumentation, and navigation, leveraging their advanced domain knowledge.

PEO2: Research and Industry Readiness
Graduates will contribute to cutting-edge research, innovation, and product development in aerospace, defence, or allied sectors, or pursue doctoral studies in avionics and related areas.

PEO3: Leadership and Professionalism
Graduates will demonstrate leadership, communication, teamwork, and ethical practices while working in multidisciplinary teams and managing avionics projects across global aviation industries.

Program Outcomes (POs) for M.Tech (Avionics): R25

PO1: Research and Development Proficiency
An ability to independently carry out research, investigation, and development work to solve practical problems.

PO2: Technical Documentation and Communication Skills
An ability to write and present a substantial technical report/document.

PO3: Subject Mastery in Avionics Specialization
Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program, at a level higher than that of an appropriate bachelor program.

PO4: System Design and Simulation Proficiency
Graduates will be able to design, simulate, and analyze avionics subsystems using tools like MATLAB, Simulink, LabVIEW, and embedded platforms, applying them to aircraft, UAV, and space applications.

PO5: Multidisciplinary Integration and Innovation
Graduates will demonstrate the ability to integrate knowledge from multiple domains such as electronics, control systems, embedded software, and aerospace engineering to develop innovative solutions in avionics.

PO6: Professional Ethics, Safety, and Lifelong Learning
Graduates will recognize ethical responsibilities, aviation safety standards, environmental impacts, and the need for continuous learning in the fast-evolving aerospace sector.

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I Semester	FLIGHT MECHANICS	L	T	P	C
		3	1	0	4

Course Objectives:

- To provide a foundational understanding of the evolution of aviation and atmospheric conditions influencing aircraft performance.
- To explain low-speed aerodynamic behavior including viscous flows, boundary layers, lift, drag, and their dependence on shape and wing geometry
- To introduce the working principles of various aircraft engines and propulsion systems, focusing on performance and efficiency
- To analyze and compute the flight performance of fixed-wing aircraft under various operational conditions and maneuvers.
- To explore the fundamentals of helicopter flight mechanics including hovering, level flight, performance, and control.

Course Outcomes (COs):
By the end of this course, students will be able to:

CO1: Describe the history of aviation and atmospheric properties that affect flight. **[K2]**
CO2: Analyze low-speed aerodynamic phenomena such as boundary layers, flow separation, and lift/drag behavior based on wing and aero foil geometry. **[K3]**
CO3: Compare and explain the operation, performance, and fuel efficiency of various aircraft propulsion systems. **[K4]**
CO4: Apply the equations of motion to evaluate steady and dynamic aircraft performance across different flight conditions. **[K5]**
CO5: Understand helicopter configurations and assess performance in hovering, level flight, and control scenarios. **[K5]**

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	1	1	1
CO2	2	0	3	3	2	1
CO3	2	1	3	2	2	1
CO4	3	1	3	3	2	1
CO5	2	0	3	2	1	1

Syllabus Content:

UNIT I History of Aviation and Introduction to Atmospheric Flight
History of Aviation Introduction, Flying, Static and dynamic aviation, Forces on the aeroplane Lift, drag and thrust Properties of air, The earth’s atmosphere, The standard atmosphere, Atmospheric flight.

UNIT II Low-Speed Aerodynamics
Speed regimes, steady and viscous flow equations, boundary layer behavior, flow separation, drag, and effects of shape and scale. Wing functions, aerofoil shapes, lift and circulation, aerofoil

characteristics, wing geometry, and performance of high and low aspect ratio wings, including whole-aircraft considerations.

UNIT III Aircraft Engines and Propulsion

History of engine development, Fundamentals of reaction propulsion, Engine efficiency and fuel consumption, Piston engines in aviation, Gas turbine engine components, non-reheated turbojet and turbofan engines, Turboprop and turbo shaft engines, Gas turbine engine operation, Propeller performance.

UNIT IV Aircraft Performance

Introduction, Airspeed and altitude, Equations of motion for symmetric flight, Steady straight and level flight, Climb and descent, Gliding flight, Cruising flight, Take-off and landing, Horizontal steady turn, Maneuver, and gust loads.

UNIT V Helicopter Flight Mechanics

Helicopter general arrangements, Hovering flight, The rotor in level flight, Flight performance, Stability and control

TEXT BOOKS:

1. E. Torenbeek, H. Wittenberg, "Flight Physics", Springer Science+Business Media, B.V. 2009.
2. John D Anderson Jr., "Introduction to Flight", 7th Edition, TMH.

REFERENCES:

1. C. Kermode., "Mechanics of Flight", Pearson Education Limited; III edition, 2012.
2. RanjanVepa, "Flight Dynamics, Simulation, and Control for Rigid and Flexible Aircraft" CRC Press Taylor & Francis Group, 2015.

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I Semester	AVIONICS SYSTEMS	L	T	P	C
		3	1	0	4

Course Objectives:

- To introduce the core avionics systems and human-machine interfaces used in modern aircraft.
- To explain different avionics system architectures, including distributed and integrated modular systems.
- To provide detailed knowledge of aerospace-specific data buses and communication standards.
- To study terrain awareness and warning systems, including their functionalities and safety features.
- To understand traffic alert and collision avoidance systems and modern surveillance technologies like ADS-B.

Course Outcomes (COs):
By the end of this course, students will be able to:

CO1: Identify and explain the key avionics systems and display technologies used in aircraft cockpits. **[K2]**
CO2: Differentiate among various avionics architectures and their advantages in aerospace applications. **[K3]**
CO3: Describe and analyze aerospace data buses such as ARINC 429 and MIL-STD-1553B and their roles in avionics communication. **[K4]**
CO4: Explain the working principles and operational modes of Terrain Awareness Warning Systems (TAWS) for enhanced flight safety. **[K5]**
CO5: Understand and evaluate Traffic Alert and Collision Avoidance Systems (TCAS) and Automatic Dependent Surveillance-Broadcast (ADS-B) technologies for air traffic management. **[K5]**

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	2	2	1
CO2	2	1	3	2	3	1
CO3	2	2	3	3	3	1
CO4	2	1	3	2	2	2
CO5	2	1	3	2	2	2

Syllabus Content:

UNIT I INTRODUCTION TO AVIONICS
Introduction: Core avionic systems, The Avionic Environment. Displays and Man Machine Interaction - Head up displays. Helmet mounted displays, Head Down Displays (HDD), Control and data entry, Direct Voice Input (DVI).

UNIT II AVIONICS ARCHITECTURES
Distributed analogue architecture, Distributed Digital Architecture, Federated Digital Architecture, Integrated Modular Architecture.

UNIT III AEROSPACE-SPECIFIC DATA BUSES
ARINC 429, MIL- STD-1553B, STANAG 3910., JIAWG architecture, COTS data buses, Real-time operating systems, RF integration, Pave Pace/F-35 shared aperture architecture.

UNIT IV TERRAIN AWARENESS WARNING SYSTEMS (TAWS)
System overview, System warnings and protection, External references, Ground proximity modes, forward looking terrain awareness (FLTA).

UNIT V TRAFFIC ALERT AND COLLISION AVOIDANCE SYSTEM
Introduction, SSR modes, Interrogation, Mode-S. Traffic Alert and Collision Avoidance System (TCAS II) - Introduction, Block diagram. Automatic Dependent Surveillance Broadcast (ADS-B) – benefits, theory of operation

TEXT BOOKS:

1. Ian Moir, Allen Seabridge., "Military Avionics Systems"., AIAA , 2006
2. Collinson R.P.G., "Introduction to Avionics Systems", Springer; 3rd ed. 2014

REFERENCES:

1. Cary R. Spitzer., "The Avionics Handbook"., CRC; 1st edition , 2006
2. Mike Tooley and David Wyatt ,"Aircraft Communications and Navigation Systems" Elsevier 2018
3. Mike Tooley and David Wyatt ,"Aircraft Electrical and Electronic Systems" Elsevier 2018

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I Semester	FLIGHT INSTRUMENTATION	L	T	P	C
		3	1	0	4

Course Objectives

This course is designed to:

- Introduce the fundamental components, characteristics, and standards associated with aircraft instrumentation.
- Explain the principles and measurements involved in air data instruments and their role in flight operations.
- Describe gyroscopic and magnetic instruments used for attitude and heading indications in aircraft.
- Detail the working principles of power plant instrumentation including engine speed, pressure, temperature, and fuel-related sensors.
- Familiarize students with modern electronic instrumentation systems including EFIS, ECAM, and flight recorders.

Course Outcomes (COs)

Upon successful completion of this course, students will be able to:

CO1: Explain the construction, characteristics, and performance of basic aircraft instrument elements and their mechanical mechanisms. **[K2]**
CO2: Describe the operation and importance of air data instruments including altimeters, airspeed indicators, and angle-of-attack sensors. **[K3]**
CO3: Analyze attitude and heading indicators using gyroscopic and magnetic principles, including associated errors and compensations. **[K4]**
CO4: Understand the measurement systems used in engine monitoring including tachometers, thermocouples, fuel flow sensors, and EPR indicators. **[K5]**
CO5: Evaluate modern electronic instrumentation systems and flight recorders, including EFIS, EICAS/ECAM, FDR, and CVR systems. **[K5]**

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	2	2	1
CO2	2	1	3	2	2	1
CO3	2	1	3	2	2	1
CO4	2	1	3	2	2	2
CO5	2	2	3	3	2	2

Syllabus Content:

UNIT I Instrument Elements, Mechanisms and Displays

Aircraft instruments Requirements and standards, Elements of an Instrument, Static and dynamic characteristics, Errors in measurement – Gross errors, systematic errors. Mechanisms and Temperature compensation. Instrument displays – qualitative, quantitative and director displays, Panels and Layouts, Instrument Grouping.

UNIT II Air Data Instruments
The Air Data Quantities and Their Importance - Air Data Information for the Pilot, Air Data for Key Sub-systems. Pitot Static system, Pressure error and Alternate pressure sources. Measurement of Altitude, Airspeed indicator - Square Law compensation, Mach meter, Vertical air speed indicators, Angle of attack and side slip angle measurement, Aircraft Central Air Data Computer.

UNIT III Attitude and Heading Indicating Instruments
Gyroscope Principles and its properties, Limitations of a free gyro: Apparent Drift and Transport Wander. Artificial Horizon, Turn and bank indicator.
Terrestrial Magnetism, Direct Reading Compass – principal features, construction, Acceleration errors and turning errors. Directional Gyro, Remote indicating compass, Compass deviation – Sources of aircraft magnetism, deviation compensation devices.

UNIT IV Power Plant Instruments
Measurement of Engine speed, Temperature measurement – methods and applications, sensing elements, thermocouple principle and types, exhaust gas temperature, Radiation pyrometer, Pressure measurement- pressure sensing method, Fuel quantity measurement – various techniques, Fuel flow. EPR, Engine vibration monitoring.

UNIT V Electronic Instrumentation systems and Flight Recorders
Display technologies- CRT, LCD and LED, Electronic Flight Instrumentation System (EFIS), Engine Indicating and Crew Alerting Systems (EICAS), Electronic Centralized Aircraft Monitoring (ECAM), Flight Data Recorder (FDR), Cockpit Voice Recorder (CVR).

TEXT BOOKS:
1. Pallet, E.H.J. “Aircraft Instruments”,2nd edition, Pearson, 2009.
2. U.A. Bakshi and A.V. Bakshi, “Electrical Measurements and Instrumentation”, Technical Publication, 1st edition, 2014.

REFERENCES:
1. Mike Tooley, David Wyatt, “Aircraft Electrical and Electronics Systems”, 1st edition, A Butterworth-Heinemann Title, 2008.
2. Mike Tooley, “Aircraft Digital Electronic and Computer System”, Elsevier, 2013
3. R.P.G. Collinson, “Introduction to Avionics Systems”, 3rd edition, Springer, 2014.
4. David Harris, “Flight instrumentation and Automatic flight control”, 6th edition, Blackwell science, 2004.

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I Semester	ELECTROMAGNETIC INTERFERENCE AND ELECTROMAGNETIC COMPATIBILITY (EMI & EMC)	L	T	P	C
		3	0	0	3

Course Objectives:

- To introduce the fundamentals of electromagnetic interference and compatibility, including natural and artificial sources of EMI.
- To study the mechanisms of EMI generation in circuits, devices, and systems, and techniques for measurement.
- To understand radiated and conducted EMI, electrostatic discharge (ESD), and surge immunity standards.
- To provide detailed knowledge on grounding, shielding, bonding, and filtering methods to suppress EMI.
- To familiarize students with EMC considerations in cable and component design and with international EMC standards.

Course Outcomes (COs):
Upon successful completion of the course, students will be able to:

CO1: Explain the sources and effects of natural, nuclear, and man-made electromagnetic interference. **[K2]**
CO2: Identify EMI generation in devices and circuits, and conduct open area EMI tests and site measurements. **[K4]**
CO3: Perform measurements of radiated and conducted EMI, and evaluate immunity to electrostatic and surge phenomena. **[K5]**
CO4: Apply principles of grounding, shielding, bonding, and filtering for EMI suppression in electronic systems. **[K5]**
CO5: Evaluate EMC performance of cables, connectors, and components in accordance with global standards. **[K5]**

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	2	2	2
CO2	2	1	3	3	2	2
CO3	3	1	3	3	2	2
CO4	2	1	3	3	2	2
CO5	2	1	3	2	2	3

Syllabus Content:

UNIT 1: Introduction, Natural and Nuclear Sources of EMI / EMC:
Electromagnetic environment, History, Concepts, Practical experiences and concerns, frequency spectrum conservations, An overview of EMI / EMC, Natural and Nuclear sources of EMI.

UNIT II: EMI from Apparatus, Circuits and Open Area Test Sites:
Electromagnetic emissions, Noise from relays and switches, Non-linearities in circuits, passive intermodulation, Cross talk in transmission lines, Transients in power supply lines, Electromagnetic interference (EMI), Open area test sites and measurements.

UNIT III: Radiated and Conducted Interference Measurements and ESD:
Anechoic chamber, TEM cell, GH TEM Cell, Characterization of conduction currents / voltages, Conducted EM noise on power lines, Conducted EMI from equipment, Immunity to conducted EMI detectors and measurements, ESD, Electrical fast transients / bursts, Electrical surges.

UNIT IV: Grounding, Shielding, Bonding and EMI filters:
Principles and types of grounding, Shielding and bonding, Characterization of filters, Power lines filter design.

UNIT V: Cables, Connectors, Components and EMC Standards:
EMI suppression cables, EMC connectors, EMC gaskets, Isolation transformers, optoisolators, National / International EMC standards.

TEXT BOOKS:

1. Engineering Electromagnetic Compatibility - Dr. V.P. Kodali, IEEEPublication, Printed in India by S. Chand & Co. Ltd., New Delhi, 2000.
2. Electromagnetic Interference and Compatibility IMPACT series, IIT – Delhi

REFERENCES:

1. Introduction to Electromagnetic Compatibility - Ny, John Wiley, 1992, by C.R. Pal.

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I Semester	AI-DRIVEN CONDITION MONITORING IN AVIONICS SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives:

- To introduce the principles and importance of condition monitoring in avionics subsystems, emphasizing safety, reliability, and maintenance strategies.
- To understand various sensors and data acquisition techniques used in aircraft systems for real-time monitoring and diagnostics.
- To develop analytical skills in signal processing and feature extraction for effective health assessment of avionics components.
- To apply AI/ML algorithms for intelligent fault detection and anomaly classification in avionics systems.
- To design deep learning-based prognostic models for predicting remaining useful life (RUL) and supporting predictive maintenance in aerospace platforms.

Course Outcomes (COs):
Upon successful completion of this course, students will be able to:
CO1: Explain the need and techniques for condition monitoring in avionics systems. **[K2]**
CO2: Select and apply appropriate sensors and signal processing techniques for CM. **[K3]**
CO3: Use machine learning for diagnostics and anomaly detection in components. **[K4]**
CO4: Develop deep learning models for predicting the health and RUL of avionics subsystems. **[K5]**
CO5: Integrate predictive maintenance into avionics health monitoring architectures. **[K5]**

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	2	3	1
CO2	2	1	3	3	3	1
CO3	3	1	3	3	3	1
CO4	3	1	3	3	3	2
CO5	3	1	3	3	3	2

Syllabus Content:

UNIT I Fundamentals of Condition Monitoring (CM)

Need for CM in avionics: safety, cost, reliability. Types: Vibration-based, Thermal, Acoustic, Electrical signal CM. Health and Usage Monitoring Systems (HUMS). Diagnostic vs Prognostic approaches. Case studies in avionics: engines, flight control systems, electrical systems.

UNIT II Sensor Technologies & Data Acquisition

Sensors for CM: accelerometers, strain gauges, thermocouples, piezo sensors. Signal conditioning and DAQ systems. Data quality, redundancy, fusion techniques. Real-time data logging challenges in avionics.

UNIT III Signal Processing for CM

Time-domain, frequency-domain, and time–frequency domain analysis. FFT, wavelet transforms, envelope detection. Feature extraction and selection. Condition indicators and trend analysis

UNIT IV AI/ML Techniques for Fault Diagnosis

Overview of ML techniques: k-NN, SVM, Random Forest. Deep learning: CNNs and LSTMs for sequence modeling. Fault classification using supervised learning. Anomaly detection with unsupervised learning. Transfer learning and few-shot learning in aircraft systems

UNIT V Prognostics and Remaining Useful Life (RUL) Prediction

Basics of RUL modeling. Physics-based vs data-driven prognostics. LSTM/GRU for time-series RUL prediction. Battery, engine, and actuator life estimation. Deployment and integration into aircraft FMS/MRO platforms

Textbooks / References:

1. D. Galar, U. Kumar, & A. El-Koujok, *Machine Learning in Condition Monitoring*, Elsevier, 2016.
2. H. Liu, Z. Yu, J. Cheng, *Intelligent Fault Diagnosis and Remaining Useful Life Prediction*, Springer, 2022.
3. D. Mantegazza, *Data-Driven Condition Monitoring using Deep Learning*, Springer, 2021.
4. H. Ahmed & A. K. Nandi, *Condition Monitoring with Vibration Signals*, Wiley, 2019.
5. J. Lee et al., *Prognostics and Health Management of Engineering Systems*, Wiley, 2014.

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I Semester	AIRCRAFT COMMUNICATION SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives

This course aims to:

- Provide a foundational understanding of electromagnetic wave behavior, radio spectrum allocation, and aeronautical communication system evolution.
- Introduce various modulation, multiple access, and channel coding schemes used in modern aviation systems.
- Explain cryptographic principles and encryption standards used to secure communication in airborne and ground-based systems.
- Familiarize students with legacy and contemporary aircraft and UAV data link systems, protocols, and their operational attributes.
- Explore future airborne communication technologies, including software-defined radio, cognitive radio systems, and airport-based broadband communication frameworks.

Course Outcomes (COs)

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

CO1: Explain the fundamentals of radio wave propagation, radio horizon calculations, and aeronautical spectrum management. **[K2]**

CO2: Analyze and differentiate between various modulation techniques, access methods, and channel coding schemes relevant to aviation. **[K4]**

CO3: Apply cryptographic concepts and evaluate modern encryption algorithms such as DES, AES, and RSA in communication systems. **[K5]**

CO4: Identify and describe aircraft and UAV data link systems such as ACARS, VDL series, Link-11/16, and telemetry channels. **[K3]**

CO5: Evaluate the architecture, advantages, and limitations of advanced airborne communication systems including SDR, AeroMACS, and cognitive radios. **[K5]**

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	2	3	1
CO2	2	1	3	3	2	1
CO3	2	2	3	2	2	2
CO4	2	1	3	2	2	2
CO5	2	1	3	2	3	2

Syllabus Content:

UNIT I Introduction

The EM wave & radio frequency spectrum, Communication frequency bands and allotment, Isotropic Power Source and Free Space Path Loss, Radio Geometry - Radio Horizon Calculations, Earth Bulge Factor – *k* Factor, Great-circle Distances, Radio wave propagation – LOS & Complex Propagation: Refraction, Absorption, Non-LOS Propagation, Evolution of aeronautical mobile radio systems, Aeronautical radio spectrum, Organizational Structure of Aviation Communications Disciplines.

UNIT II Modulation, Access and Channel coding schemes
Modulation types: AM, FM, PM, ASK, FSK, PSK, BPSK, 8DPSK, QPSK, OQPSK, MSK and GFSK. Multiplexing and Access Schemes: – FDMA, TDMA, CDMA. Channel Coding Schemes: Convolutional, RS Codes.

UNIT III Encryption standards in Communication Systems
Introduction to Cryptography: – crypto systems and types. Traditional ciphers - Caesar Cipher, Transposition Cipher, Substitution Cipher. Modern ciphers: - DES, AES and RSA Algorithms.

UNIT IV Aircraft and UAV Data Links
Aircraft Data Link: VHF data link – ACARS, VDL 2, VDL 3, and VDL 4. UHF data link - Link-11, Link-16. SELCAL, ALE and HF Data link. UAV Data link functions and attributes, Video & Telemetry Links.

UNIT V Future Airborne Communication Systems
Software Defined Radio (**SDR**)- Need, characteristics and benefits, Implementation issues – challenges of receiver design, RF front end – purpose, receiver topologies and importance of components. Flexible RF using MEMS, Sampling rate conversion principles. Cognitive Radios: - introduction, spectrum sensing algorithms. Aeronautical Mobile Airport Communication System (AeroMACS), Airborne Internet.

TEXT BOOKS:

1. Dale Stacey**.**, **“**Aeronautical Radio Communication Systems and Networks”, Wiley (March 31, 2008)
2. Mike Tooley and David Wyatt, “Aircraft Communications and Navigation Systems”, 2nd edition, Taylor & Francis Group, 2018.
3. William Stallings, “Cryptography and Network Security Principles and Practice”, Pearson 6th Edition.
4. Jeffrey H. Reed, “Software Radio: A Modern Approach to Radio Engineering”, 2002, PEA publication.

REFERENCES:

1. Simon Plass., “Future Aeronautical Communications”. InTech**,** September, 2011
2. Nigel Smart., “Cryptography: An Introduction” (3rd Edition)
3. “Software Defined Radios” by Wireless Innovation Forum, July 2016
4. Fette B.A.(ed), “Cognitive Radio Technology”, communication engineering Series, Elsevier2006.
5. https://wimaxforum.org/Page/AeroMACS
6. https://canso.fra1.digitaloceanspaces.com/uploads/2023/02/Emerging_Technologies_WhitePaper_Airborne_Capabilities.pdf

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I Semester	MISSILE AND SPACE VEHICLE MECHANICS	L	T	P	C
		3	0	0	3

Course Objectives:

- To provide a comprehensive understanding of missile systems, their classification, and key components including ground systems and radars.
- To introduce the fundamentals of missile and rocket aerodynamics and their influence on vehicle performance.
- To explain propulsion principles for jet engines, solid rockets, and ramjets, including nozzle theory and flight performance evaluation.
- To analyze aerodynamic forces, loads, and drag mechanisms affecting missiles and rockets during flight.
- To impart knowledge of orbital mechanics, including planetary motion, gravitational forces, and orbital velocity estimation.

Course Outcomes (COs):
After successful completion of this course, the student will be able to:
CO1: Describe the classification and main components of missile systems, including ground support and coordinate frameworks. **[K2]**
CO2: Apply aerodynamic principles to analyze missile performance and interpret wind tunnel and flight test data. **[K3]**
CO3: Explain the propulsion mechanisms of rockets and jet engines and evaluate their performance parameters. **[K4]**
CO4: Analyze aerodynamic loads and drag forces on rockets, and understand design elements such as boat-tailing and nozzle adaptation. **[K5]**
CO5: Apply Kepler’s laws and Newtonian mechanics to solve problems in orbital mechanics, including escape velocity and multi-body interactions. **[K5]**

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	2	2	1
CO2	2	1	3	3	3	1
CO3	3	1	3	2	3	1
CO4	2	1	3	2	2	1
CO5	2	1	3	2	2	2

Syllabus Content:

UNIT I Missile Systems

Introduction - history - classification - missile system elements, missile ground systems - radars – launchers, coordinate frames, basics of trajectory dynamics.

UNIT II Missile Aerodynamics

Missile aerodynamics- design methodology, aerodynamic prediction method, aerodynamic loads & performance analysis, wind tunnel and flight testing of missile models and missile prototypes.

UNIT III Propulsion

Principles of jet propulsion and rocketry, nozzle theory and performance parameters of solid rockets and ramjet and compound jet engines – evaluation of flight performance - forces acting on vehicle - basic relations of motion.

UNIT IV Rocket Aerodynamics

Description of various loads experienced by a rocket passing through atmosphere – drag estimation – wave drag, skin friction drag, form drag and base pressure drag – Boat-tailing in missiles – performance at various altitudes – conical and bell shaped nozzles – adapted nozzles – rocket dispersion – launching problems.

UNIT V Orbital Mechanics

Description of solar system – Kepler‟s Laws of planetary motion – Newton„s Law of Universal gravitation – Two body and Three-body problems – Jacobi‟s Integral, Librations points - Estimation of orbital and escape velocities.

TEXTBOOKS:

1. Van de Kamp, “Elements of Astromechanics”, Pitman Publishing Co., Ltd., London, 1980.
2. E.R. Parker, “Materials for Missiles and Spacecraft”, McGraw-Hill Book Co., Inc., 1982.

REFERENCES:

1. G. Merrill, “Dictionary of Guided Missiles and Space Craft”, D. Van Nostrand and Company, Inc, 1959.
2. S. S. Chin, “Missile Configuration Design”, McGraw Hill, 1961.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
INSTITUTE OF SCIENCE AND TECHNOLOGY
R25 M.TECH AVIONICS COURSE STRUCTURE AND SYLLABUS

I Semester	AIRBORNE ISR (INTELLIGENCE, SURVEILLANCE, AND RECONNAISSANCE)	L	T	P	C
		3	0	0	3

Course Objectives:

- To impart an understanding of the principles of modern radar systems including Doppler, SAR, and phased arrays.
- To explore radar applications in airborne platforms, weather detection, and surveillance systems like AWACS.
- To introduce electronic warfare systems and infrared detection techniques.
- To equip students with the ability to analyze and interpret radar and IR imaging data.

Course Outcomes (COs):

At the end of the course, students will be able to:

CO1: Understand and explain the functioning of various airborne radar modes. **[K2]**
CO2: Analyze Doppler radar systems and SAR imaging modes. **[K3]**
CO3: Interpret weather radar outputs and system enhancements. **[K4]**
CO4: Demonstrate understanding of electronic warfare and IR imaging) systems. **[K5]**
CO5: Evaluate surveillance systems such as AWACS in real-world applications. **[K5]**

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	2	3	1
CO2	3	1	3	3	3	1
CO3	3	1	3	3	3	1
CO4	2	1	3	3	3	2
CO5	2	2	2	1	2	3

Syllabus Content:

UNIT I – Radar Fundamentals and Airborne Radar Modes

Review of radar principles, airborne radar modes including air-to-air search, tracking, and track-while-scan, ground mapping using radar, Doppler radar principles and applications, target tracking systems, pulsed Doppler radar operation and implementation, pulse compression techniques, advanced antennas such as phased arrays and AESA (Active Electronically Scanned Array).

UNIT II – Synthetic Aperture and Weather Radar Systems

Synthetic Aperture Radar (SAR) and its modes including Spotlight SAR, Doppler Beam Sharpening, and Inverse SAR (ISAR), millimeter wave radar principles and aerospace applications.

Overview of weather radar systems, airborne weather equipment, detection of precipitation and turbulence, enhancements in weather radar technology, lightning detection techniques.

UNIT III – Electronic Warfare Systems

Introduction to Electronic Warfare (EW), Signals Intelligence (SIGINT), ELINT, COMINT, Electronic Support Measures (ESM), Electronic Countermeasures (ECM), Electronic Counter-Countermeasures (ECCM), defensive aids and electronic deception techniques.

UNIT IV – Infrared Radiation and Imaging Systems

Infrared (IR) Radiation including emission, absorption, and spectral emittance, geometric spreading and IR atmospheric transmission, IR sources, targets, and background signatures, infrared system imagery interpretation, Forward Looking Infrared (FLIR) systems and Infrared Line scan Systems (IRLS), Synthetic Vision.

UNIT V – Advanced Surveillance Systems

Airborne Warning and Control Systems (AWACS): Introduction and role, AWACS surveillance radar including block diagram and subsystem analysis such as Antenna Array, Radar Control and Maintenance Panel (RCMP), Surveillance Radar Computer (SRC).

TEXT BOOKS:

1. Ian Moir, Allen Seabridge., "Military Avionics Systems"., AIAA , 2006
2. Collinson R.P.G., "Introduction to Avionics Systems", Springer; 3rd ed. 2014
3. NAVAIR, Electronic Warfare and Radar Systems Engineering Handbook, US Naval Air Systems Command
4. Maurice W. Long, Airborne Early Warning: Design, Detection, and Control of Radar Systems, IET Press.

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R25 M.TECH AVIONICS COURSE STRUCTURE AND SYLLABUS

I Semester	ADVANCED DRONE TECHNOLOGIES AND APPLICATIONS	L	T	P	C
		3	0	0	3

Course Objectives (COs)

- Understand the fundamental concepts, history, and classification of drones along with basic aerodynamic principles.
- Analyze drone hardware components, including propulsion systems, sensors, and communication modules.
- Learn flight dynamics, control methods, and autonomous navigation techniques for UAVs.
- Comprehend regulatory frameworks, safety protocols, and ethical considerations in drone operations.
- Explore advanced technologies such as AI, IoT, and cybersecurity impacting modern UAV systems.

Course Outcomes (COs)
CO1: Describe drone classifications, flight principles, and components with clarity. **[K2]**
CO2: Identify and evaluate drone hardware design and sensor integration techniques. **[K3]**
CO3: Apply control algorithms and navigation methods for stable and autonomous drone flight. **[K4]**
CO4: Interpret and apply drone regulations and safety standards effectively. **[K5]**
CO5: Analyze emerging technologies and cybersecurity challenges relevant to UAV applications. **[K5]**

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	2	3	2
CO2	2	1	3	2	3	2
CO3	3	1	3	3	3	2
CO4	2	1	2	2	2	3
CO5	3	2	3	3	3	3

Syllabus Content:

Chapter 1: Fundamentals of Drone Technology
Introduction to Unmanned Aerial Vehicles (UAVs), history and evolution of drones, classification of drones – fixed-wing, rotary-wing, lighter-than-air systems, aerodynamic forces – lift, thrust, drag, gravity, principal flight axes – yaw, pitch, roll, anatomy of a drone – airframe, motors, ESCs, propellers, GPS, IMU, flight controllers, applications in military, agriculture, logistics, and surveillance, emerging drone trends and societal impact.

Chapter 2: Drone Hardware Systems and Design Principles

Airframe materials and structural types, propulsion systems – brushless motors, ESCs, propeller design, battery technologies – LiPo, smart batteries, electronic subsystems – gyroscope, barometer, GPS, magnetometer, telemetry systems, RC transmitters and receivers, types of UAV configurations – VTOL, hybrid drones, tilt-rotor systems, hardware–software integration, firmware platforms – ArduPilot, PX4, payload management and sensor integration.

Chapter 3: Drone Flight Dynamics, Control, and Navigation

Drone kinematics and dynamics, PID control systems, flight stabilization techniques, flight modes – manual, altitude hold, GPS, autonomous, mission planning, waypoint-based navigation, obstacle detection and avoidance, intelligent flight systems, simulation tools, post-flight data analysis, drone communication protocols, telemetry and telemetry logging, role of ground control stations, redundancy and fail-safe mechanisms.

Chapter 4: Regulatory Framework, Safety and Industrial Applications

Indian Drone Rules 2021, DGCA guidelines for UAV operation, classification by weight and functionality, licensing and compliance, geo-fencing and no-fly zones, airworthiness and drone registration, safety regulations and emergency protocols, ethical concerns and privacy issues, industrial applications – agriculture, mapping, mining, construction, disaster response, law enforcement, delivery systems, entertainment and media, drone-as-a-service (DaaS) models.

Chapter 5: AI, IoT, Cybersecurity and Future Research Trends

Artificial Intelligence in UAVs – object detection, path planning, target tracking, machine learning for drone decision-making, swarm coordination algorithms, reinforcement learning for navigation, IoT-enabled drones in smart cities, agriculture, public health, and energy systems, cybersecurity threats and mitigation, intrusion detection systems, blockchain in drone security, future UAV trends – edge computing, digital twin, autonomous air mobility, research challenges and future scope.

Textbooks & References:

1. S. N. Mohanty, J. V. R. Ravindra, G. S. Narayana, C. R. Pattnaik, and Y. M. Sirajudeen, *Drone Technology: Future Trends and Practical Applications*. Hoboken, NJ, USA: Wiley-Scrivener, 2023.
2. A. Juniper, *The Complete Guide to Drones*, Extended 2nd ed. Beverly, MA, USA: Wellfleet Press, 2017.
3. R. Austin, *Unmanned Aircraft Systems: UAV Design, Development and Deployment*. Chichester, UK: John Wiley & Sons, 2010.
4. R. D'Andrea, "Swarm robotics and autonomous drone control," *IEEE Robotics & Automation Magazine*, vol. 23, no. 4, pp. 100–109, Dec. 2016. [Online]. Available: https://ieeexplore.ieee.org/document/7744818

5. Directorate General of Civil Aviation (DGCA), *Drone Rules 2021* and *Civil Aviation Requirements (CAR)* - *Section 3*, *Series X*, *Part I*. Ministry of Civil Aviation, Govt. of India, Aug. 2021. [Online]. Available: https://dgca.gov.in

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
INSTITUTE OF SCIENCE AND TECHNOLOGY
R25 M.TECH AVIONICS COURSE STRUCTURE AND SYLLABUS

I Semester	ASTROPHYSICS AND STELLAR EVOLUTION	L	T	P	C
		3	0	0	3

Course Objectives:

- To introduce the solar system and celestial mechanics governing planetary motion.
- To familiarize students with tools and techniques used in observational astronomy.
- To provide an understanding of stellar properties, classification, and the Sun as a typical star.
- To explain the internal structure and life cycle of stars, including evolutionary paths and stellar remnants.
- To explore binary systems and the formation of compact stellar objects.

Course Outcomes (COs):
After successful completion of this course, the student will be able to:
CO1: Describe the solar system, apply celestial mechanics, and understand planetary structures. **[K3]**
CO2: Use astronomical observational methods and instruments to interpret celestial phenomena. **[K4]**
CO3: Classify stars, interpret spectral lines and the H-R diagram, and analyze the Sun's structure. **[K4]**
CO4: Explain stellar interiors, energy transport, and various phases of stellar evolution. **[K4]**
CO5: Understand star formation, binary systems, and the nature of compact objects like white dwarfs, neutron stars, and black holes. **[K2]**

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	1	1	2
CO2	2	1	2	1	1	2
CO3	2	1	3	1	1	2
CO4	3	1	3	2	2	2
CO5	2	1	3	2	2	2

Syllabus Content:

UNIT I : The Solar System and Celestial Mechanics
Celestial mechanics, Elliptical orbits, Kepler's laws, Virial theorem, Earth–moon system, Tidal forces, Precession of Earth's axis, Interior and atmosphere of Earth and Moon, Terrestrial planets, Jovian planets, Coordinates and time, Blackbody radiation, Specific intensity and flux density

UNIT II: Observational Astronomy and Instrumentation
Stellar parallax, Apparent and absolute magnitudes, Colour index, Basic optics, Optical telescopes, Radio telescopes, Infrared telescopes, Ultraviolet telescopes, X-ray telescopes.

UNIT III: The Sun and the Stars

Classification of stars, Formation of spectral lines, Hertzsprung–Russell diagram, Stellar atmospheres, Radiation field description, Opacities, Radiative transfer, Structure of spectral lines, Solar interior, Solar atmosphere, Solar activity, Helioseismology

UNIT IV: Stellar Structure and Evolution

Hydrostatic equilibrium, Equation of state for pressure, Energy sources in stars, Energy transport, Convection, Stellar model building, Main sequence, Evolution on the main sequence, Late stages of evolution, Fate of massive stars, Supernovae, White dwarfs, Chandrasekhar limit, Neutron stars, Pulsars

UNIT V: Star Formation and Binary Systems

Interstellar dust and gas, Formation of protostars, Pre-main sequence evolution, Classification of binary stars, Mass determination in binaries, Accretion disks in close binaries, White dwarfs in binaries, Neutron stars in binaries, Black holes in binaries

TEXT BOOKS:

1. Modern Astrophysics, B. W. Carroll and D. A. Ostlie, Addison-Wesley Publishing Co.
2. Introductory Astronomy & Astrophysics, M. Zeilik and S. A. Gregory, 4th Edition, Saunders College Publishing.
3. Theoretical Astrophysics, Vol II:Stars and Stellar Systems, T. Padmanabhan, Cambridge University Press.

REFERENCES:

1. The Physical Universe: An Introduction to Astronomy, F. Shu, Mill Valley: University Science Books.
2. Textbook of Astronomy and Astrophysics with Elements of Cosmology, V. B. Bhatia, Pb-New Delhi, Narosa Publishing House.
3. The New Cosmos, A. Unsold and B. Baschek, New York:Springer Verlag.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
INSTITUTE OF SCIENCE AND TECHNOLOGY
R25 M.TECH AVIONICS COURSE STRUCTURE AND SYLLABUS

I Semester	FLIGHT MECHANICS AND ENGINEERING LAB	L	T	P	C
		0	1	2	2

S.No	Name of The Experiment
1.	Develop code to perform Analog Pulse Compression.
2.	Develop code to perform Digital Pulse Compression.
3.	Develop code to estimate minimum velocity of an aircraft.
4.	Develop code to estimate coefficient of drag and form pressure.
5.	Develop code to calculate lift and drag forces.
6.	Develop code to simulate free fall condition of a parachute with load.
7.	Develop code for takeoff airborne section and design of an aircraft.
8.	Develop code to simulate time analysis of hodograph.
9.	Develop code to perform time to climb analysis of an aircraft.
10.	Develop code to simulate parabolic path for a zero-gravity flight.

- Code development can be performed using MATLAB/LabVIEW/python programming environments.
- Fundamental knowledge regarding the flight simulator is provided using experiment/case study using Flight Gear/X-plane/any other of relevance prescribed by the department.

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R25 M.TECH AVIONICS COURSE STRUCTURE AND SYLLABUS

I Semester	FLIGHT INSTRUMENTATION AND COMMUNICATION LAB	L	T	P	C
		0	1	2	2

Sl.No	Name of The Experiment
1.	Design a model to Estimate Aircraft Altitude using Static pressure.
2.	Design a model to Estimate Aircraft Speed and Mach Number using pitot pressure.
3.	Design a model to controller the brightness of LED using NI myDAQ.
4.	Design a model to Estimate surrounding temperature using NI myDAQ.
5.	Design a model to control the 7-segment display using NI myDAQ.
6.	Design a model to Estimate the distance of the obstacle using NI myDAQ and IR proximity sensor.
7.	Develop code for Performance evaluation of image filters under the influence of noise.
8.	Develop code to decode the MAV link messages.
9.	Develop code to Encrypt and Decrypt a given message using RSA algorithm.
10.	Design a model to Perform AM Modulation and Demodulation.

- Code/Model development can be performed using MATLAB/LabVIEW model-based design environments.
- Any other case studies related to communication prescribed by the department.

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INSTITUTE OF SCIENCE AND TECHNOLOGY
R25 M.TECH AVIONICS COURSE STRUCTURE AND SYLLABUS

II Semester	FLIGHT STABILITY AND CONTROL	L	T	P	C
		3	1	0	4

Course Objectives:

1. To introduce the principles of static and dynamic stability and control in aircraft motion.
2. To derive and understand aircraft equations of motion using small disturbance theory and aerodynamic modeling.
3. To analyze longitudinal and lateral modes of motion and the influence of stability derivatives.
4. To study aircraft response to control inputs and atmospheric disturbances, including turbulence and wind shear.
5. To apply classical and modern control theories in designing autopilot systems and stability augmentation systems for aircraft.

Course Outcomes (COs):

Upon successful completion of this course, students will be able to:

- **CO1:** Analyze the static stability and control characteristics in longitudinal, directional, and lateral modes. **[K2]**
- **CO2:** Derive aircraft equations of motion using rigid body dynamics and small disturbance theory. **[K3]**
- **CO3:** Evaluate dynamic behavior in pitch, roll, and yaw motions using stability derivatives and linearized models. **[K4]**
- **CO4:** Predict aircraft response under control inputs and external atmospheric effects using turbulence models. **[K5]**
- **CO5:** Design and apply classical and modern control strategies to aircraft autopilot and stability augmentation systems. **[K5]**

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	3	2	1
CO2	2	1	3	3	2	1
CO3	2	1	3	3	2	1
CO4	2	1	3	2	2	2
CO5	3	1	3	3	3	2

Syllabus Content:

Chapter 1: Static Stability and Control
Static stability and control principles, Longitudinal control, Stick force calculations, Directional stability and control, Roll stability and control, Concept of trim and restoring moments

Chapter 2: Equations of Motion – Fundamentals
Rigid body equations of motion derivation, Orientation and position of aircraft, Gravitational and thrust force modeling, Small disturbance theory, Aerodynamic force and moment representation

Chapter 3: Equations of Motion – Application to Longitudinal and Lateral Modes
Pitching motion analysis, Stick-fixed longitudinal motion, Longitudinal approximations, Stability derivatives and their influence, Rolling and yawing motion, Lateral-directional equations of motion

Chapter 4: Aircraft Response and Atmospheric Disturbances
Longitudinal and lateral flying qualities, Inertial coupling, Equations in a non-uniform atmosphere, Vertical/plunging motion, Atmospheric turbulence effects, Harmonic analysis, Turbulence models and wind shear

Chapter 5: Control Systems in Aircraft Design
Classical Control Theory Applications:
Aircraft transfer functions, Displacement autopilots, Stability augmentation, Instrument landing systems
Modern Control Theory Applications:
State-space models, Longitudinal and lateral augmentation, Modern autopilot design principles

TEXT BOOKS:

1. Robert C Nelson., "Flight Stability and Automatic Control"., Tata McGraw-Hill Second 2nd Edition,2007

REFERENCES:

1. RanjanVepa., "Flight Dynamics, Simulation, and Control for Rigid and Flexible Aircraft" CRC Press Taylor & Francis Group, 2015.
2. Blakelock, J.H "Automatic control of Aircraft and missiles" John Wiley Sons, New York, 1990.
3. Stevens B.L & Lewis F.L, "Aircraft control & simulation", John Wiley Sons, New York, 1992.

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INSTITUTE OF SCIENCE AND TECHNOLOGY
R25 M.TECH AVIONICS COURSE STRUCTURE AND SYLLABUS

II Semester	AIRCRAFT NAVIGATION SYSTEMS	L	T	P	C
		3	1	0	4

Course Objectives
The course is designed to:

- Introduce students to the principles, types, and evolution of terrestrial radio navigation systems used in aviation.
- Provide in-depth knowledge of inertial sensors such as accelerometers and gyroscopes used in modern aircraft navigation.
- Explain the architecture, reference frames, and operational principles of Inertial Navigation Systems (INS).
- Examine satellite-based navigation systems such as GPS and hybrid navigation techniques combining GNSS and INS.
- Explore precision landing aids and the mechanisms involved in low-visibility approach and landing operations.

Course Outcomes (COs)
Upon successful completion of this course, students will be able to:

CO1: Describe the working principles and configurations of terrestrial radio navigation systems such as ADF, VOR, DME, TACAN, VORTAC, and radar altimeters. **[K2]**
CO2: Explain the operating principles, classifications, and technologies of inertial sensors, including MEMS accelerometers and gyroscopes. **[K3]**
CO3: Analyze the navigation process in an inertial frame, including reference frames, strap-down systems, and error propagation. **[K4]**
CO4: Evaluate GPS-based satellite navigation, error sources, differential operations, and fusion with INS using Kalman filtering. **[K5]**
CO5: Discuss aircraft landing aids, including ILS, satellite-based landing systems, and carrier landing systems for low visibility operations. **[K5]**

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	3	2	1
CO2	2	1	3	2	2	1
CO3	2	1	3	2	2	2
CO4	3	2	3	3	2	2
CO5	2	1	3	2	2	2

Syllabus Content:

UNIT I Terrestrial Radio Navigation Systems

Different Types of navigation, Common geometric position fixing schemes, Automatic Direction Finder, VHF Omni-directional Range, Distance Measuring Equipment, Tactical Air Navigation, VORTAC, Doppler Navigation –Beam Configurations, Doppler Frequency Equations, Components of Doppler Navigation System. Radar Altimeters –Pulsed Radar Altimeter, FM CW Radar Altimeter.

UNIT II Inertial Navigation Sensors

Accelerometer - operating principle, classification- open loop pendulous, closed loop pendulous, vibrating beam and interferometric fiber optic accelerometer.

Gyroscope – Coriolis vibrating gyro, optical gyro – RLG, IFOG – Principle of operation, construction and working. MEMS accelerometer and gyro – principle of operation.

UNIT III Inertial Navigation System

Inertial navigation, Geometry of earth, gravitation and gravity, Reference frame ECI, LPI, ECEF and ENU. Navigation in rotating earth frame, Inertial system, Strap-down navigation, error propagation in strap-down INS, strap-down system technology.

UNIT IV Satellite and Hybrid Navigation System

GPS, position and velocity determination- Error sources, GDOP, position computation process. Range error minimization schemes- Differential operation, Dual frequency measurement, Carrier phase measurement. Velocity measurement, Precise Point Positioning (PPP), comparison of INS and GPS. Integrated inertial navigation – processing of measurements, Complimentary nature of sensors, GNSS and INS fusion using Kalman filter.

UNIT V Landing aids

Low visibility operation, Mechanics of landing. Instrument Landing System (ILS) and its limitations, Satellite Landing Systems, Carrier-Landing Systems.

TEXT BOOKS:

1. Myron Kayton, Walter R. Fried.., “Avionics Navigation Systems”. Wiley-Inter science 2nd edition, 2009.
2. Amitava Bose, K.N.Bhat, Thomas Kurian, “Fundamentals of Navigation and inertial sensors” PHI learning Private limited, 2014.
3. Byron Edde, “Radar Principles, Technology, Applications”, LPE, Pearson 1995.

REFERENCES:

1. Mike Tooley, David Wyatt, “Aircraft Communications & Navigation Systems: Principles, Operation and Maintenance”, Butterworth-Heinemann an imprint of Elsevier, 2009
2. Mohinder S. Grewal, Lawrence R. Weill, Angus P. Andrews., “Global Positioning Systems, Inertial Navigation and Integration”. Wiley-Interscience; 2nd edition,2013

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R25 M.TECH AVIONICS COURSE STRUCTURE AND SYLLABUS

II Semester	AVIONICS EMBEDDED SYSTEMS	L	T	P	C
		3	1	0	4

Course Objectives:

- To introduce the architecture, components, and development tools of embedded systems with avionics relevance.
- To provide a deep understanding of real-time operating systems (RTOS) and their use in time-critical aerospace applications.
- To explore fault-tolerant system designs applicable to aircraft embedded control systems.
- To explain the design, operation, and certification principles behind Fly-by-Wire control systems.
- To familiarize students with the emerging domain of Integrated Vehicle Health Management (IVHM) systems and their implementation in aerospace.

Course Outcomes (COs):

Upon successful completion of this course, students will be able to:

CO1: Describe the architecture, components, and software frameworks involved in embedded system development for avionics. **[K2]**

CO2: Apply RTOS concepts to develop and manage time-critical aviation tasks, resources, and inter-process communication. **[K4]**

CO3: Analyze and design fault-tolerant embedded systems, both hardware and software, suitable for aerospace safety. **[K5]**

CO4: Explain the working principles and system-level design aspects of Fly-by-Wire aircraft control systems. **[K5]**

CO5: Evaluate the concepts and technologies involved in Integrated Vehicle Health Management systems, including diagnostics and prognostics. **[K5]**

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	2	3	2
CO2	2	1	3	2	3	2
CO3	3	1	3	3	3	2
CO4	3	1	3	3	3	2
CO5	3	1	3	2	3	3

Syllabus Content:

UNIT I EMBEDDED SYSTEM DEVELOPMENT

Categories, Overview of architecture, Characteristics, Recent trends, Architecture of Embedded systems: Hardware Architecture: CPU, Memory, Clock, Watchdog timer, I/O, Debug port, Communication interface, Power Supply. Software Architecture: Operating System, Application software, communication software, Executable image, development/Test tools.

UNIT II RTOS

Real time concepts, Kernel Structure, Tasks and Scheduler, Time Management, Event Control blocks, Semaphore management, Mutex, Event Management, Message mail box management, Message Queue management, memory management.

UNIT III Fault-Tolerant Avionics-I

Introduction, System Level Fault Tolerance, Hardware-Implemented Fault Tolerance (Fault-Tolerant Hardware Design Principles), Software-Implemented Fault Tolerance—State Consistency, Software Fault Tolerance.

UNIT IV Fault-Tolerant Avionics-II

Introduction, Fly-by-Wire Principles, Main System Features, Failure Detection and Reconfiguration: Flight Control Laws, Actuator Control and Monitor, Comparison and Robustness, Latent, Failure, Reconfiguration, System Safety Assessment, Warning and Caution. Design, Development, and Validation Procedures: Fly-by-Wire System Certification Background, Future Trends.

UNIT V Vehicle Health Management Systems

Introduction, Definition of Integrated Vehicle Health, Evolution of VHM Standards. Key Technologies: Member System Concept, Diagnostics, Prognostics, Intelligent Reasoners.
State-of-the-Art IVHM Systems, Future Trends in IVHM.

TEXT BOOKS:

1. Cary R. Spitzer., "The Avionics Handbook"., CRC; 1st edition (November 30, 1999)

2. K.V.K.K.Prasad., "Embedded /Real-Time Systems: Concepts, Design & Programming", Dreamtech Press, 2012.

2. Cary R. Spitzer.," AVIONICS - Elements, Software and Functions" 2nd edition

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II Semester	AIRCRAFT UTILITY SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives
The course aims to:

- Introduce the design, operation, and integration of various aircraft subsystems including fuel, engine control, electrical, hydraulic, and environmental systems.
- Examine modern civil aircraft fuel systems with emphasis on safety, operational modes, and cold fuel management.
- Explain the engine control architecture, with a focus on FADEC systems and engine-airframe interaction.
- Analyze electrical and hydraulic systems including braking, steering, and emergency systems in civil and military aircraft.
- Familiarize students with the structure, functions, and performance capabilities of modern Flight Management Systems (FMS).

Course Outcomes (COs)
Upon successful completion of the course, students will be able to:

CO1: Describe the operation and safety requirements of fuel systems in modern aircraft, including pressurization, transfer, and polar operation considerations. **[K2]**
CO2: Explain the architecture and working principles of engine control systems, including FADEC, engine starting, oil systems, and reverse thrust mechanisms. **[K3]**
CO3: Analyze the design and operation of electrical and hydraulic systems, including power generation, braking, steering, and landing gear functionalities. **[K4]**
CO4: Evaluate the design principles and safety features of environmental control systems, emergency systems, and crew/passenger protection mechanisms. **[K5]**
CO5: Understand the structure and functionality of Flight Management Systems, including navigation, flight planning, guidance, and performance computation. **[K5]**

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	3	2	2	2
CO2	2	1	3	2	2	2
CO3	3	1	3	3	3	2
CO4	2	1	3	2	2	3
CO5	3	2	3	3	3	2

Syllabus Content:

UNIT I Fuel Systems
Characteristics, Fuel system components, Fuel System Operating Modes: pressurization, Engine feed, Fuel transfer, Refuel Defuel, Fuel jettison. Integrated Civil Aircraft Systems, Fuel Tank Safety, Polar Operations, Cold Fuel Management.

UNIT II Engine Control Systems
Engine/Airframe Interfaces, The control problem- Fuel flow, Air flow, control system. Engine starting, Engine Oil Systems, Engine Off takes, Reverse Thrust, Engine Control on Modern Civil Aircraft- FADEC.

UNIT III Electrical and Hydraulic Systems
Electrical Power Evolution, Aircraft Electrical system, Aircraft Electrical power generation types, Power Distribution, Typical Aircraft DC System, Electrical loads, Emergency Power Generation. Hydraulic Systems – Introduction, Hydraulic Circuit Design, A380 and B767 Hydraulic system. Landing Gear Systems: Braking Anti-Skid and Steering, Electronic Control, Automatic Braking, Multi-Wheel Systems, Brake Parachute.

UNIT IV Environmental Control and Emergency Systems
Need for a Controlled Environment, Cabin pressurization system, Hypoxia, oxygen system, g-tolerance, Anti-Misting and De-Misting, Aircraft Icing.
Emergency Warning Systems, Fire Detection and Suppression, Explosion Suppression, Emergency Oxygen, Passenger Evacuation, Crew Escape, Computer Controlled Seats, Emergency Landing.

UNIT V Flight Management System (FMS)
Introduction: Fundamentals, Navigation – Performance and receiver management. Flight planning-Flight plan construction; Lateral flight planning, Vertical flight planning. Trajectory predictions: Lateral profile, vertical profile. Performance computations – Speed schedule computation, Maximum and optimum altitudes. Guidance: – Lateral and vertical guidance.

TEXT BOOKS:

1. Ian Moir, Allan Seabridge., “Aircraft Systems - Mechanical, electrical, and avionics subsystems integration”. Wiley; 3rd edition, 2008

REFERENCES:

1. EHJ Pallet**., “**Aircraft Electrical systems*”*. Prentice Hall; 3 edition, 1997
2. Ian Moir, Allan Seabridge., “Military Avionics Systems”. AIAA ,2006
3. Ian Moir, Allan Seabridge, Malcolm Jukes., “Civil Avionics Systems”. Wiley; 2nd edition, 2013

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
INSTITUTE OF SCIENCE AND TECHNOLOGY
R25 M.TECH AVIONICS COURSE STRUCTURE AND SYLLABUS

II Semester	INDIAN SPACE PROGRAM: A HISTORY AND FUTURE	L	T	P	C
		3	0	0	3

Course Objectives:

- Introduce students to the origins and historical development of the Indian Space Research Organisation (ISRO) and the foundational visionaries who shaped it.
- Provide a comprehensive understanding of India's key satellite missions and their scientific, technological, and societal impacts.
- Examine the major technological and organizational challenges overcome by ISRO, and highlight its strategic achievements in space-based services.
- Explore current and future prospects of India's space program, including human spaceflight and international collaboration initiatives.
- Critically evaluate ethical, legal, and policy considerations associated with space activities in the Indian and global context.

Course Outcomes (COs):
Upon successful completion of this course, students will be able to:

CO1: Describe the historical evolution of the Indian space program, including the role of key individuals and institutions. **[K2]**
CO2: Analyze major Indian spacecraft missions such as Chandrayaan and Mangalyaan, and assess their scientific and technological relevance. **[K5]**
CO3: Evaluate the challenges faced and innovations developed by ISRO, and assess their impact on national security, disaster management, and economic development. **[K5]**
CO4: Interpret the current trends and future prospects of Indian space exploration, including human spaceflight and international cooperation. **[K4]**
CO5: Critically assess the ethical, environmental, legal, and policy issues related to India's space activities in a global framework. **[K5]**

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	1	1	2
CO2	2	2	2	1	2	2
CO3	2	1	2	1	2	3
CO4	2	1	2	1	2	3
CO5	2	2	2	1	2	3

Syllabus Content:

Chapter 1: Introduction to the Indian Space Program
Genesis and early years of ISRO, Contributions of Vikram Sarabhai and other pioneers, Organizational structure, and major facilities, International collaborations and strategic vision.

Chapter 2: Indian Spacecraft and Missions
Satellite development and multi-domain applications, Chandrayaan missions and lunar exploration, Mars Orbiter Mission (Mangalyaan) and interplanetary initiatives, Growth of remote sensing and communication satellite capabilities.

Chapter 3: Challenges and Achievements
Technological hurdles and indigenous innovations, Milestone missions and success stories, ISRO's contributions to disaster management and defense, Growth of the space economy and commercialization.

Chapter 4: Prospects and International Collaboration
Gaganyaan and India's human spaceflight mission, Prospective planetary and deep-space exploration, Innovations in satellite and launch technologies, India's expanding footprint in international space partnerships.

Chapter 5: Ethical and Policy Considerations
Space debris and long-term sustainability, Legal and policy frameworks in India's space governance, Global space law and treaties, Ethical responsibilities and future challenges in space exploration.

References

1. ISRO, *From Fishing Hamlet to Red Planet: India's Space Journey*. ISRO Publications, 2015.
2. M. Annadurai, "Vikram Sarabhai: A Pioneer of Indian Space Programme," ISRO, 2019. [Online]. Available: https://www.isro.gov.in
3. G. Singh, *Indian Space Programme: Mercury to Mars*. Astrotalkuk Publications, 2014.
4. P. Bagla, "Chandrayaan-2: India's Second Moon Mission," *National Geographic*, 2019. [Online]. Available: https://www.nationalgeographic.com
5. ISRO, "Missions Overview," Indian Space Research Organisation. [Online]. Available: https://www.isro.gov.in/missions.html
6. G. Raj, *Reach for the Stars: The Evolution of India's Rocket Programme*. Viking by Penguin Books India, 2000.
7. A. Gupta, "ISRO's Role in Enhancing India's National Security," *Institute for Defence Studies and Analyses (IDSA)*, 2018. [Online]. Available: https://idsa.in
8. ISRO, "Economic Impact of Space in India," *ISRO Reports*, 2021. [Online]. Available: https://www.isro.gov.in
9. ISRO, *Gaganyaan: India's Human Spaceflight Programme*, ISRO Publications, 2022.
10. R. P. Rajagopalan, "India's Expanding Role in Space Diplomacy," *The Diplomat*, 2020. [Online]. Available: https://thediplomat.com
11. I. H. Ph. Diederiks-Verschoor and V. K. Dempsey, *Space Law: A Treatise*, 3rd ed. Alphen aan den Rijn, The Netherlands: Kluwer Law International, 2008.
12. C. Giri, "Space Debris and Sustainability: Policy Implications for India," *Observer Research Foundation (ORF)*, 2017. [Online]. Available: https://www.orfonline.org
13. United Nations Office for Outer Space Affairs (UNOOSA), "Space Law and Treaties," 2021. [Online]. Available: https://www.unoosa.org

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R25 M.TECH AVIONICS COURSE STRUCTURE AND SYLLABUS

II Semester	SAFETY-CRITICAL AVIONICS: DESIGN ASSURANCE AND ENVIRONMENTAL COMPLIANCE	L	T	P	C
		3	0	0	3

Course Objectives
The course is designed to:

- Provide a structured understanding of systems engineering practices relevant to the development of airborne and avionics systems.
- Familiarize students with the ARP4754A standard and its role in civil aircraft and system development, safety assessment, and assurance processes.
- Enable students to understand the DO-178B/DO-178C standards and their application in the development and certification of safety-critical avionics software.
- Introduce the DO-254 standard for airborne electronic hardware and its life cycle processes including verification, validation, and certification.
- Expose students to environmental testing standards including DO-160, MIL-STD-810, and MIL-STD-461, and build competencies in EMI/EMC compliance.

Course Outcomes (COs)
Upon successful completion of this course, the student will be able to:

CO1: Apply the principles of systems engineering to define, design, and verify complex avionics systems. **[K4]**
CO2: Analyze and implement the aircraft and system development lifecycle as per ARP4754A, including functional allocation, system architecture, and safety assessment. **[K5]**
CO3: Apply the DO-178B/DO-178C standards for the development, verification, and certification of airborne software in compliance with civil aviation regulations. **[K5]**
CO4: Interpret and implement the DO-254 standard for design assurance of airborne electronic hardware, including configuration and quality assurance. **[K5]**
CO5: Conduct environmental qualification testing in accordance with DO-160, MIL-STD-810, & MIL-STD-461, and assess systems for electromagnetic interference and compatibility. **[K5]**

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	2	3	3
CO2	3	1	3	2	3	3
CO3	3	1	3	2	3	3
CO4	3	1	3	2	3	3
CO5	3	1	3	3	3	3

Syllabus Content:

Unit I – Systems Engineering
Definition and purpose of systems and systems engineering, Systems Engineering Management, Systems Engineering Process, System requirements definition, architecture development, detailed design and implementation, system integration, verification and validation processes.

Unit II – ARP4754A Standard: Development of Civil Aircraft and Systems
Overview of ARP4754A, aircraft and system development process, functional development and allocation, system architecture definition, requirements traceability and verification, safety assessment methodologies, development assurance level (DAL) assignment, configuration management, quality assurance using AS9100, certification planning and coordination.

Unit III – DO-178B/C Standard: Software Assurance for Airborne Systems
System aspects related to software, software planning and development lifecycle, verification and validation techniques, configuration management, software quality assurance, certification liaison activities, documentation and life cycle data, overview of aircraft and engine certification in relation to software, differences in between DO-178B and DO-178C.

Unit IV – DO-254 Standard: Hardware Design Assurance for Airborne Systems
Hardware design lifecycle processes, planning and development stages, requirements validation and verification, configuration and process assurance, certification planning, hardware safety and traceability, development of hardware life cycle data packages.

Unit V – Environmental Testing and Compliance
Environmental qualification tests as per DO-160 and MIL-STD-810 standards, categories and procedures for vibration, temperature, humidity, shock, and altitude. EMI/EMC principles and testing procedures, international standards, and compliance criteria, MIL-STD-461E for military EMC requirements.

References:

1. RTCA DO-178C, Software Considerations in Airborne Systems and Equipment Certification, RTCA Inc., 2011.
2. RTCA DO-254, Design Assurance Guidance for Airborne Electronic Hardware, RTCA Inc., 2000.
3. SAE ARP4754A, Guidelines for Development of Civil Aircraft and Systems, SAE International, 2010.
4. RTCA DO-160G, Environmental Conditions and Test Procedures for Airborne Equipment, RTCA Inc., 2010.
5. MIL-STD-810H, Environmental Engineering Considerations and Laboratory Tests, U.S. Department of Defense, 2019.
6. MIL-STD-461E, Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment, U.S. Department of Defense, 1999.
7. D. Gesbert, Avionics Certification: A Complete Guide to DO-178C, DO-254, ARP4754A, and DO-160, Wiley, 2021.

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II Semester	MISSILE AND SPACE VEHICLE GUIDANCE AND CONTROL	L	T	P	C
		3	0	0	3

Course Objectives:

- To provide a comprehensive understanding of missile aerodynamics, control configurations, and autopilot design.
- To develop knowledge of guidance laws, including proportional navigation and optimal control techniques.
- To explain the principles and dynamics involved in strategic missiles, including ballistic and cruise missile systems.
- To introduce orbital mechanics concepts and techniques for orbital transfers and maneuvering.
- To explore satellite and space vehicle guidance systems with an emphasis on open and closed loop guidance methods.

Course Outcomes (COs):
Upon successful completion of the course, the student will be able to:

CO1: Analyze missile airframes, control configurations, and autopilot systems used for pitch, yaw, and roll stabilization. **[K3]**
CO2: Explain and derive key missile guidance laws and evaluate their performance in tactical applications. **[K3]**
CO3: Describe and apply principles of ballistic and cruise missile motion, atmospheric re-entry, and missile tracking. **[K4]**
CO4: Apply orbital mechanics for satellite transfers, including Hohmann and non-coplanar maneuvers. **[K5]**
CO5: Evaluate satellite and launch vehicle guidance systems, distinguishing between various guidance methods and strategies. **[K5]**

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	3	3	2
CO2	3	1	3	3	3	2
CO3	3	1	3	3	3	2
CO4	3	1	3	3	3	2
CO5	3	1	3	3	3	2

Syllabus Content:

UNIT I Missile Airframes, Autopilots and Control
Missile aerodynamics: - Force Equations, Moment Equations, Phases of missile flight, Missile control configurations. Missile Mathematical Model, Autopilots - Definitions, Types of Autopilots, Example Applications. Open-loop autopilots, Inertial instruments and feedback.

Autopilot response, stability, and agility: - Pitch Autopilot Design, Pitch-Yaw-Roll Autopilot Design.

UNIT II Missile Guidance Laws

Tactical Guidance Intercept Techniques, Derivation of the Fundamental Guidance Equations, explicit, Proportional Navigation, Augmented Proportional Navigation, beam riding, bank to turn missile guidance, Three-Dimensional Proportional Navigation, comparison of guidance system performance, Application of Optimal Control of Linear Feedback Systems.

UNIT III Strategic Missiles

Introduction, The Two-Body Problem, Lambert's Theorem, First-Order Motion of a Ballistic Missile Correlated Velocity and Velocity-to-Be-Gained Concepts, Derivation of the Force Equation for Ballistic Missiles, Atmospheric Reentry, Ballistic Missile Intercept, Missile Tracking Equations of Motion, Introduction to Cruise Missiles , The Terrain-Contour Matching (TERCOM) Concept.

UNIT IV Orbital Transfers and Plane Change Maneuvers

Orbital Transfers: -Impulse Transfer between Circular Orbits, Hofmann Transfer, Other Coplanar and Non-coplanar Transfers-Orbital Plane Changes.

UNIT V Satellite Guidance

Space Flight, Space Vehicle Trajectories, Launch Vehicle Guidance Implicit and Explicit Guidance-Open loop and Closed loop Guidance, FE guidance- E guidance-VG guidance-Q guidance-Delta guidance.

TEXTBOOKS:

1.Roger R. Bate, 'Fundamentals of Astrodynamics‟, Dover Publications Inc., New York, 1971.
2.Francis Joseph Hale, 'Introduction to Space Flight‟, Prentice-Hall Inc., 1994.
3.Marshall H. Kaplan ,"Modern Spacecrafts Dynamics and Control‟, John Wiley & Sons.
4.Edward V. B. Stearns, „Navigation and Guidance in Space‟, Prentice-Hall Inc., Englewood Cliffs, New Jersey.

REFERENCES:

1.William E. Wiesel, „Space Flight Dynamics‟, McGraw-Hill Book Company, Third Edition, 2010.
2.Siouris, G.M, "Missile Guidance and control systems", Springer, 2003.

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II Semester	SPACE-BASED OBSERVATIONAL ASTRONOMY AND INSTRUMENTATION	L	T	P	C
		3	0	0	3

Course Objectives:
- To provide an understanding of the fundamentals and importance of space-based astronomy.
- To introduce the physical phenomena observable from space, including the electromagnetic spectrum and cosmic particles.
- To familiarize students with various detectors and their working principles for space applications.
- To explain techniques in detector calibration, data acquisition, and the specific challenges of space instrumentation.
- To study India’s planetary missions and its first dedicated space observatory, AstroSat, including its instruments.

Course Outcomes (COs):
Upon successful completion of the course, students will be able to:
- **CO1:** Explain the need for and advantages of space-based observations over ground-based astronomy. **[K2]**
- **CO2:** Identify and describe major celestial observables and the methods used to detect them from space. **[K3]**
- **CO3:** Understand the working principles of particle and photon detectors used in space missions. **[K4]**
- **CO4:** Demonstrate knowledge of space instrumentation calibration, data acquisition, and operational challenges. **[K4]**
- **CO5:** Analyze planetary missions and describe the design and performance of Indian instruments like AstroSat and LAXPC. **[K5]**

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	2	1	2	2
CO2	2	1	3	1	2	2
CO3	2	1	3	2	2	2
CO4	2	2	3	2	2	2
CO5	2	2	3	2	2	2

Syllabus Content:

Chapter 1: Fundamentals of Space-Based Astronomy
Historical perspective, Motivation for space-based astronomy, Basics of space observations, Ground-based vs space-based instruments, Challenges of operating in space, Earth’s atmospheric limitations.

Chapter 2: Observables and Spectroscopy in Space
Electromagnetic spectrum, Continuous and discrete spectra, Cosmic rays, Solar wind, Solar flares, Magnetic fields, Spectroscopic techniques for composition analysis, Photon–matter interactions

Chapter 3: Detectors for Space Applications
Charged particle and photon interaction with matter, Types of detectors: nuclear emulsions, GM counters, proportional counters, scintillation detectors, semiconductor detectors, electromagnetic wave detectors, Focusing and non-focusing techniques

Chapter 4: Techniques and Instrumentation Challenges
Background modeling, Detector calibration techniques, Data acquisition systems, Space qualification procedures, Environmental effects, Past instruments and mission examples, Atmospheric interference

Chapter 5: Space Missions and Indian Contributions
Moon and Mars exploration missions, Planetary mapping techniques, Meteorites and lunar samples, Overview of AstroSat and its five instruments: All-sky monitor, SXT, LAXPC, CZTI, UVIT, Detailed focus on LAXPC – design, working, challenges, and performance analysis

TEXT BOOKS:

1. G. Abell, D. Morrison, and S. Wolff, Exploration of the Universe, Thomson Brooks/Cole, 2000.
2. V. L. Pisacane, Fundamentals of Space Systems, Oxford University Press, 2005.
3. M. S. Longair, High-Energy Astrophysics, Cambridge University Press, 2011.
4. M. G. Kivelson and C. T. Russell, Introduction to Space Physics, Cambridge University Press, 1995.
5. ISRO/URSC, AstroSat: India's Multi-wavelength Space Observatory, ISRO Publications, 2015.

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II Semester	ELECTRIC AIRCRAFT SYSTEMS	L	T	P	C
		3	0	0	3

Course Objectives:

- To introduce students to the technological shift toward electric propulsion in aviation.
- To provide foundational knowledge of electrical systems, components, and architectures in electric aircraft.
- To analyze power generation, distribution, conversion, and storage in More Electric and All-Electric Aircraft.
- To examine integration of propulsion and thermal systems, along with safety, efficiency, and certification concerns.
- To explore current and future developments in hybrid-electric and electric aircraft platforms.

Course Outcomes (COs):
Upon successful completion of the course, students will be able to:

CO1: Describe the evolution of electric propulsion and the principles behind More Electric Aircraft (MEA) concepts. **[K2]**
CO2: Analyze electric power generation, conversion, and distribution architectures in modern aircraft. **[K3]**
CO3: Evaluate the design and operation of electric propulsion, energy storage, and thermal management systems. **[K4]**
CO4: Understand the implications of system-level integration for efficiency, reliability, and certification. **[K5]**
CO5: Assess future trends in hybrid-electric and all-electric aircraft and associated regulatory frameworks. **[K5]**

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	2	3	2
CO2	3	1	3	2	3	2
CO3	3	1	3	3	3	2
CO4	3	1	3	3	3	3
CO5	3	1	3	3	3	3

Syllabus Content:

UNIT I: Introduction to Electric Aircraft Systems
Aviation propulsion evolution, Principles of electric propulsion, Definitions: MEA (More Electric Aircraft), AEA (All-Electric Aircraft), Trends and key motivators for electrification (weight, efficiency, maintenance), Overview of power balance in electric aircraft.

UNIT II: Power Generation and Distribution
Electrical power generation methods (IDGs, APU, fuel cells), High-voltage DC (HVDC) and AC architectures, Electrical distribution systems: centralized vs distributed, Safety considerations in power systems, Electrical system losses and optimization

UNIT III: Power Conversion and Energy Storage
Power electronics: inverters, rectifiers, converters, Battery technologies and energy density limitations, Supercapacitors and energy management, Motor controllers and high-speed drives, Battery management systems (BMS) and state-of-charge estimation

UNIT IV: Propulsion, Integration and Thermal Systems
Electric motor characteristics and sizing, Propeller–motor integration, Thermal management: cooling loops, heat exchangers, heat pipes, Integration of electric propulsion into aircraft design, Reliability, redundancy, and failure modes

UNIT V: Hybrid Systems, Certification and Future Trends
Parallel and series hybrid propulsion, Control systems for hybrid-electric aircraft, Environmental impact and sustainability, Challenges in certification of electric aircraft (DO-311, DO-160 relevance), Emerging platforms and future aircraft concepts (e.g., eVTOL, regional e-aircraft)

Textbook:
1. Pascal Thalin, Fundamentals of Electric Aircraft, SAE International, 2018.

References:
1. I. Moir, A. Seabridge, and M. Jukes, Civil Avionics Systems, 2nd ed., IET, 2013.
2. T. Wild, Electrical Power Systems for Aircraft, Ships and Automobiles, Wiley, 2016.
3. R. Langton, C. Clark, M. Hewitt, and L. Richards, Aircraft Fuel Systems, Wiley, 2009.
4. A. Filippone, Advanced Aircraft Flight Performance, Cambridge University Press, 2021.
5. F. J. Bianchi, H. De Battista, and R. J. Mantz, Wind Turbine Control Systems: Principles, Modelling and Gain Scheduling Design, Springer, 2006.

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R25 M.TECH AVIONICS COURSE STRUCTURE AND SYLLABUS

II Semester	AIRCRAFT LIGHTING SYSTEMS: DESIGN, CERTIFICATION, AND INTEGRATION	L	T	P	C
		0	0	0	0

Value added courses (Non- Program Core / Program Elective)

** case study: model syllabus for Skill development, covered through guest lectures and talks.

Course Objectives

The course aims to:

- Introduce students to the classification, functions, and regulatory frameworks governing aircraft lighting systems.
- Develop a strong foundation in the design and operational requirements of both interior and exterior lighting systems.
- Explain the significance of emergency lighting and human factors in lighting design, particularly for safety and night operations.
- Provide insights into system integration, power supply design, environmental challenges, and testing protocols.
- Equip students with the knowledge to analyze safety risks, assess certification standards, and apply real-world lighting solutions in both civilian and military aircraft.

Course Outcomes (COs)

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

CO1: Explain the purpose, classification, and regulatory requirements (FAA, EASA, DO-160, DO-178C, DO-254) applicable to aircraft lighting systems. **[K2]**
CO2: Design and evaluate interior and exterior lighting solutions based on photometric, ergonomic, and operational constraints. **[K3]**
CO3: Analyze emergency lighting requirements and apply human factors principles in lighting system design for enhanced safety and usability. **[K4]**
CO4: Demonstrate understanding of lighting system integration, power and dimming control methods, and environmental qualification processes. **[K5]**
CO5: Interpret testing standards and safety assessment techniques, and apply knowledge to case studies involving lighting upgrades, certification, and military applications. **[K5]**

CO / PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	3	2	3	3
CO2	3	1	3	2	3	3
CO3	3	1	3	2	3	3
CO4	3	1	3	2	3	3
CO5	3	1	3	2	3	3

Syllabus Content:

Chapter 1: Fundamentals and Regulatory Framework

Purpose and classification of aircraft lighting systems, Overview of interior, exterior, emergency, and indication/display lighting. Airworthiness and operational safety relevance. Regulatory bodies and standards overview: FAA, EASA, ICAO, ARINC, and MIL. Detailed certification requirements from DO-160 (environmental), DO-178C (software), DO-254 (hardware), and FAR/CS Parts 23/25/27/29. Role of ARP4754A, ARP4761, and AS9100D in lighting system development and safety assurance. Understanding TSO, ETSO, and military specifications (e.g., MIL-DTL-7788).

Chapter 2: Exterior and Interior Lighting Systems
Design and application of exterior lighting: navigation lights, anti-collision lights (strobes/beacons), landing and taxi lights, formation and search lights, ice detection lighting. Photometric and chromaticity requirements (SAE ARP5825, MIL-L-81174). Interior lighting systems: cockpit and cabin lighting, NVIS-compatible designs, task lights (map, chart), dimming techniques, and control systems. EMI/EMC considerations relevant to DO-160 Sections 20 and 21.

Chapter 3: Emergency Systems and Human Factors
Design and redundancy in emergency lighting: exit signs, floor/path markings, activation triggers, power backup, and maintenance protocols. Certification per FAR Part 25 requirements. Human-centric lighting design: ergonomics, color perception, glare mitigation, NVG/NVIS compatibility (MIL-STD-3009), and pilot workload considerations. Illumination levels and design requirements for cockpit and cabin usability.

Chapter 4: System Integration, Power, and Environmental Factors
System architecture and avionics integration, wiring, grounding, and connectors. Selection and integration of lighting sources: incandescent, halogen, LED, EL. Optical design: beam shaping, diffusion, photometric testing (lux, cd/m²). Power supply and voltage regulation, dimming technologies (PWM, rheostats, command boxes), redundancy and fault tolerance, safety protocols per DO-160 Section 16. Environmental reliability: temperature, vibration, humidity, IP ratings, thermal management, MTBF/MTTR, ESS testing.

Chapter 5: Testing, Maintenance, Safety, and Real-World Applications
Testing methodologies: type testing, environmental qualification (DO-160, MIL-STD-810), photometric and NVIS testing, EMC/EMI evaluations. Maintenance and supportability: LRUs, BITE, inspection cycles, ATA iSpec 2200 documentation, and light degradation metrics (L70). Safety risk assessments: FMEA, FTA, hazard classification (ARP4761), and mitigation planning. Design assurance processes: traceability, configuration management, V&V, DQTP/DATP. Case studies: Chetak/Cheetah systems, NVIS upgrades, LED retrofits, and military formation lighting examples.

References:

1. M. Marston, *Aircraft Lighting Systems: Design and Safety*. Warrendale, PA: SAE International, 2012.
2. T. K. Eismin, *Aircraft Electricity and Electronics*, 6th ed. New York, NY: McGraw-Hill Education, 2013.
3. Federal Aviation Administration (FAA), *Aviation Maintenance Technician Handbook – Airframe*, *Volume 1*, FAA-H-8083-31A, 2013. [Online]. Available: https://www.faa.gov

4. RTCA, *DO-160G: Environmental Conditions and Test Procedures for Airborne Equipment*, Washington, DC: RTCA Inc., 2010.
5. RTCA, *DO-178C: Software Considerations in Airborne Systems and Equipment Certification*, Washington, DC: RTCA Inc., 2011.
6. RTCA, *DO-254: Design Assurance Guidance for Airborne Electronic Hardware*, Washington, DC: RTCA Inc., 2000.
7. SAE International, *ARP4754A: Guidelines for Development of Civil Aircraft and Systems*, Warrendale, PA: SAE International, 2010.
8. SAE International, *ARP4761: Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment*, Warrendale, PA: SAE International, 1996.
9. U.S. Department of Defense, *MIL-STD-810H: Environmental Engineering Considerations and Laboratory Tests*, Washington, DC: DoD, 2019.
10. U.S. Department of Defense, *MIL-STD-3009: Lighting, Aircraft, Night Vision Imaging System (NVIS) Compatible*, Washington, DC: DoD, 2001.
11. SAE International, *ARP5825A: Aviation Lighting – Photometric and Color Measurement Standards*, Warrendale, PA: SAE International, 2013.
12. U.S. Department of Defense, *MIL-L-81174C: Lighting System Requirements for Military Aircraft*, Washington, DC: DoD, 1983.
13. SAE International, *AS9100D: Quality Management Systems – Requirements for Aviation, Space, and Defense Organizations*, Warrendale, PA: SAE International, 2016.
14. European Union Aviation Safety Agency (EASA), *Certification Specifications for Large Aeroplanes (CS-25)*, Cologne, Germany: EASA, latest ed.
15. Federal Aviation Administration (FAA), *FAR Part 25 – Airworthiness Standards: Transport Category Airplanes*, Washington, DC: U.S. Department of Transportation, latest ed.
16. ATA, *iSpec 2200: Information Standards for Aviation Maintenance*, Air Transport Association, Washington, DC, latest ed.
17. ICAO, *Annex 6: Operation of Aircraft* and *Annex 8: Airworthiness of Aircraft*, Montreal, Canada: International Civil Aviation Organization, latest ed.
18. FAA, *Advisory Circular 25.812-2A: Emergency Lighting and Marking*, Washington, DC: U.S. Department of Transportation, 2000.
19. Hindustan Aeronautics Limited (HAL), *Chetak/Cheetah Maintenance and Retrofit Manuals*, Bengaluru, India: HAL, internal publication.

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II Semester	GUIDANCE, NAVIGATION AND CONTROL LAB	L	T	P	C
		0	1	2	2

Sl.No **Name of The Experiment**

1. Develop code perform Coordinate Conversion from GPS To Navigation Frame using math script window.
2. Develop a PID controller for pitch attitude autopilot.
3. Design a model for Height Hold Autopilot using State Feedback System.
4. Develop code to perform comparative analysis of digital fading memory filters (G & H) in reducing the effect of noise on various signals.
5. Develop code to estimate accurate GPS position of an object in the presence of noise.
6. Develop code/model to analyze the effect of PI controller.
7. Develop code/model to analyze the effect of PD controller
8. Develop code/model to study the effect of addition of zeros to forward path transfer function of a closed loop system.
9. Develop code/model to study the effect of addition of poles to forward path transfer function of a closed loop system.
10. Design a FOPID control system for Longitudinal Autopilot.

- Code/Model development can be performed using MATLAB/LabVIEW model-based design environments.

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II Semester	AVIONICS EMBEDDED SYSTEMS LAB	L	T	P	C
		0	1	2	2

Sl.No	Name of The Experiment
1.	Design a model to control the Rotation of Servo Motor Using PWM Signal.
2.	Design a model for Attitude estimation of a platform using Accelerometer.
3.	Develop code to perform PCA based image fusion of enhanced vision.
4.	Develop code to perform Laplacian pyramid-based image fusion of enhanced vision.
5.	Design a model for event detection and counting using photo interrupter.
6.	Recording and Playing a functional java Script Using Script Recording Function.
7.	Performing Data Driven Test by Creating A Data Pool
8.	Inserting A Verification Point to Test the Functional Aspects of a Given Application.
9.	Perform Traceability, File Insertion and Object Linking Embedded in IBM Rational DOORS software.
10.	Perform compliance test for the given code according to MISCRA rules.

- Code/Model development can be performed using MATLAB/LabVIEW model-based design environments.

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA
INSTITUTE OF SCIENCE AND TECHNOLOGY
R25 M.TECH AVIONICS COURSE STRUCTURE AND SYLLABUS

III Semester	RESEARCH METHODOLOGY & IPR	L	T	P	C
		3	0	0	3

Course Objectives:

By the end of this course, students will be able to:

- Understand the principles, processes, and methods involved in identifying, formulating, and addressing research problems.
- Acquire knowledge about research design, data collection, analysis, and ethical research practices including plagiarism.
- Develop skills in technical and scientific writing, research proposal preparation, and academic communication.
- Understand the fundamentals of Intellectual Property Rights (IPR), including patents, copyrights, designs, and trademarks.
- Explore the process of patenting, licensing, and recent developments in IPR, including case studies and applications in technology sectors.

Course Outcomes (COs)

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

CO1: Define and formulate a research problem with clarity by identifying sources, scope, and objectives. **[K2]**
CO2: Analyze and synthesize literature effectively and practice research ethics including avoidance of plagiarism. **[K4]**
CO3: Apply the principles of technical writing to prepare research reports, proposals, and present them to stakeholders. **[K3]**
CO4: Demonstrate an understanding of different types of intellectual property and the processes involved in obtaining them. **[K5]**
CO5: Evaluate patent rights, licensing procedures, and recognize the significance of recent IPR developments and case studies. **[K5]**

CO \ PO	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	2	0	1	2
CO2	2	2	2	0	1	3
CO3	2	3	2	1	2	2
CO4	1	1	1	0	1	3
CO5	1	1	1	0	1	3

Syllabus Content:

UNIT I

Meaning of research problem, Sources of research problem. Criteria: Characteristics of a good research problem. Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, Analysis, interpretation, Necessary instrumentations

UNIT II
Effective literature studies approaches, analysis Plagiarism and Research ethics

UNIT III
Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

UNIT IV
Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting and development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT V
Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

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5. Mayall, "Industrial Design", McGraw Hill, 1992.
6. Niebel, "Product Design", McGraw Hill, 1974.
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8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Propertyin New Technological Age", 2016.
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