Applied Mathematics

Sub Code:	18 MAV 11	IA Marks	20
No. of Lecture Hours /week	04	Exam Hours	03
Total No of Lecture Hours	50	Exam Marks	80
Practical work/Assignment, Hrs/wk	…	First Semester	16 weeks
Credits: 04			

Course Objectives: The objectives of this course is

- To introduce students to the mostly used analytical and numerical methods in the different engineering fields by making them
- To introduce students to learn Fourier series, Laplace transforms, Complex Analysis, Linear Algebra, Vector Integration, numerical methods
- To introduce students to solve algebraic and transcendental equations and Non-linear ordinary differential equations.

Module -I

Review of Fourier Series and Applications, Review of Laplace Transforms, and Applications, Eigen values and Eigen vectors. Classification of second order linear partial differential equations, Canonical forms for hyperbolic, parabolic and elliptic equations, Homogeneous and Non Homogeneous equations with constant coefficients.

Teaching Hours: 10; RBT Levels: L1,L2

Module-II

Vector Functions, General rules for differentiation, Velocity and Acceleration, Gradient of a scalar field, Directional Derivative, Properties of Gradient, Divergence of vector point function, Curl of a vector point function, Properties of Divergence and Curl. Integration of vector functions, Line integral, Circulation, Work done by a force, Surface integrals, Volume integrals, Divergence Theorem of Gauss, Green's Theorem in the plane, Stoke's Theorem, Problems on all the three theorems.

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module-III

Review of Complex analysis, Complex analysis applied to potential theory, Electrostatic fields, conformal mapping, Heat problems, Fluid flow, General properties of Harmonic functions, Complex Integration, Cauchy's Theorem, Cauchy's Integral Formula, Cauchy's Integral Formula for Derivatives, Taylor's and Laurent's series. Singular point, Residue, Method of finding Resides, Residue Theorem, Contour Integration.

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module-IV

Numerical Solutions algebraic and transcendental equations: Newton - Raphson method, Iteration method, Aitken's method, Solution of linear simultaneous equations. Gauss elimination method, Inverse of a matrix, Gauss-Seidal method, Crout's method. Solution of Ordinary Differential Equations: Taylor's Series method, Picard's method, Euler's method, Euler's Modified method, Runge-Kutta 4th order method.

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module-V

Finite differences, Interpolation, Newton's Forward & Backward Interpolation formulae, Lagrange's formula, Newton's Divided difference, Central difference formulae (all formulae with proof). Numerical Differentiation, Numerical Integration (all rules with proof).

Teaching Hours: 10; RBT Levels: L1,L2,L3

Course Outcomes: On completion of this course, students are able to:

1. Know the use of periodic signals and Fourier series to analyze circuits and system communications.
2. Solve Non-linear Partial differential equation
3. Employ appropriate numerical methods to solve algebraic and transcendental equations.
4. Apply Green's Theorem, Divergence Theorem and Stokes' theorem in various applications in the field of electro-magnetic and gravitational fields and fluid flow problems.
5. Employ appropriate numerical methods to solve Initial value problems.

Text Books:

1. Erwin Kreyszig: Advanced Engineering Mathematics, John Wiley & Sons(Asia) Pvt. Ltd. 10^{th} edition, 2010, ISBN 978-0-470-45836-5 .

2. H K Dass: Advanced Engineering Mathematics, S Chand and Company Ltd. 20^{th} edition, 2015. ISBN, : 9788121903455

References

1. Bali and Iyengar: Engineering Mathematics, Laxmi Publications (P) Ltd. 6^{th} edition, 2004.

Aircraft Communication Systems & Standards

Sub Code:	17 MAV 12	IA Marks	20
No. of Lecture Hours /week	04	Exam Hours	03
Total No of Lecture Hours	50	Exam Marks	80
Practical work/Assignment, Hrs/wk	3	First Semester	16 weeks
Credits: 04			

Course Objectives:

- To refresh fundamentals of basis communication and study how that applies to Avionics Communications
- To analyze data communication & understand how it helps in networked systems
- To understand different aeronautical communication radios and data equipment in Aircraft and on ground
- To understand various buses and advanced communication methods in aircraft

Module-I

Basics of information theory, sampling and quantization, coding, modulation, signal detection and system performance in the presence of noise. Multiplexing Techniques – TDMA, FDMA and CDMA - Theory and Performance Fundamentals of Encryption – DES and Public Key Encryption. HF, VHF and SATCOM Antennas, Radiation pattern and Impedance.

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module-II

ISO OSI Model. Line Coding- RZ, NRZ, Manchester. Error detection and correction – Parity, ARQ, CRC, Reed Solomon coding. Communication protocols – HDLC, DSL, ADSL, Ethernet Communication, IEEE 802.3, Gigabit Ethernet, Wireless IEEE 802.11, Internet Protocols – IP, UDP, TCP/IP. AFDX, ARINC 664, CANBUS, TTP/C.

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module-III

Requirements of ATN – Data and Voice Communication. HF, VHF, SATCOM Systems – Basic Principles, Frequency Spectrum, Performance. Airborne and Land based segments. Functional block diagram of different communication systems in an aircraft and inter communication. ACARS – Requirements, Principles and Implementation. Principles of SW Defined Radios, Multi-Mode Receiver

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module-IV

CMU - Requirements, HW Architecture, Interface Protocols, SW Requirements and SW Architecture. VHF Digital Radio - Mode – A,0,2,3 and 4 Requirements, Performance, HW and SW Architecture, SW requirements, Signal Processing

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module-V

Satellite Communication - Geosynchronous Satellite, IMMARSAT for Aircraft Application, uplink and downlink, Transceiver Architecture. HF Communication - Performance, Ionospheric Propagation, Transceiver Architecture. Advanced communication techniques - LDACS, WiMAX, 4G Wireless, WAIC.

Teaching Hours: 10; RBT Levels: L1,L2,L3

Course Outcomes:

- To propose and solve new communication needs in modern aircraft scenarios
- To make different communication equipment's interwork to deliver fast and content rich communication
- To visualize different components on radio and wired communications
- To come up with new data communication methods

Text Books

1. John G Proakis and Salehi. Communications Systems Engineering, Phi Publications, 2009, ISBN: 9788120327504,
2. Haykin. Communication Systems, John Wiley & Sons, Inc, 2000, ISBN 10: 0471178691

References:

1. A. Tanenbaum. Computer Networks. 1996.
2. Aircraft Communications Electronic Signaling System (SAE) by F. W Griffith
3. Alfred Helfrick, Principles of Avionics, Leesburg, VA: Avionics Communications, 2002.

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Fundamentals of Avionics

Sub Code:	17 MAV 13	IA Marks	20
No. of Lecture Hours /week	04	Exam Hours	03
Total No of Lecture Hours	50	Exam Marks	80
Practical work/Assignment, Hrs/wk	…	First Semester	16 weeks
Credits: 04			

Course Objectives:

- To understand analyze Avionics System Requirements
- To understand evolution of Flight Deck Design
- To understand Federated and Integrated Avionics System Architectures involving MAU, LRMs and various digital Databus networks.
- To understand system assessment methods

Module-I:Avionics System Requirements & Flight Deck

Typical Standards and Agencies in civil and Military avionics, Mission oriented Avionics System Requirements – Design Drivers, Mission Analysis Techniques, Capturing Avionics Requirements - Top Down and Bottom; Safety Requirements, Human Factors Engineering, Modeling of HFE, Flight Deck Design – Philosophy, Automation & Situational Awareness,Evolution of Cockpit Instrumentation including HVGS

Teaching Hours: 10; RBT levels: L1,L2,L3

Module-II: Digital Avionics Data Bus Systems

Unidirectional and Bidirectional Data bus systems, Protocols, Topologies, Typical Avionics Data Buses: MIL-STD-1553B, ARINC-429, CSDB, CAN, ARINC-629, ASCB, AFDX;

Teaching Hours: 10; RBT levels: L1,L2,L3

Module-III: Avionics system architectures,

Evolution of Architectures, Types of System Architectures – Centralized, Distributed, Federated and Integrated Modular Avionics Architectures, MAU, LRM, GENESIS

Teaching Hours: 10; RBT levels: L1,L2,L3

Module-IV: Matching Avionics to Aircraft
Standardization of Avionics Packaging- LRU, ARINC and DOD types, system cooling, EMI/EMC requirements. Aircraft powers systems: Electrical power generation & distribution systems. Civil and Military Electrical Power requirement standards, comparing the Military and Civil Requirements and Tips for Power System Design,

Teaching Hours: 10; RBT levels: L1,L2,L3

Module-V: System Assessment Maintainability and Reliability
Hardware assessment, Fault Tree Analysis (FTA), Failure Mode and Effect Analysis(FMEA), Criticality and damaging modes and effects analysis. Avionics Software Technologies, Assessment and Validation – standards, Evolution of Automatic Test Equipment for maintenance, Evolution of Test Language – ATLAS; Introduction to Reliability.

Teaching Hours: 10; RBT levels: L1,L2,L3

Course Outcomes:

- To apply System requirement analysis methods for decomposition of functions among systems and sub systems
- To build message structures using databus concepts and to evolve conceptual avionics system architectures
- To evolve avionics test bench architecture
- To appreciate importance of HFE in Flight Deck Design and automation

Text Books

1. RPG Collinson., 'Introduction to Avionics Systems', Third edision, Springer, 2013, ISBN 978-94-007-0707-8
2. Ian Moir and Allan Seabridge., 'Civil Avionics Systems', AIAA Education Series, 2002. ISBN: 978-1-118-34180-3.

References

1. Spitzer, C.R. 'Digital Avionics Systems- Principles and Practice', The Blackburn Press, N.J., U.S.A., 2000.
2. Len Buckwalter., 'Avionics Databuses', published by Avionics Communications, 2008
3. Cary R. Spitzer, Digital Avionics Handbook, CRC Press, 2007.ISBN 0 -8483-8441-9

Flight Dynamics & Control

Sub Code:	17 MAV 21	IA Marks	20
No. of Lecture Hours /week	04	Exam Hours	03
Total No of Lecture Hours	50	Exam Marks	80
Practical work/Assignment, Hrs/wk	3	Second Semester	16 weeks
Credits: 04			

Course Objectives:

- To understand lateral and longitudinal equations of motion of aircraft
- To analyze different modes in longitudinal and lateral motions
- To analyze stability in frequency domain
- To understand various types of AFCS functions and conceptual design methods

Module-I: Flight Dynamics

Review of Basic Flight Fundamentals: Aircraft Axes system, Different Forces and Moments acting on an aircraft and their coefficients

Introduction to Rigid body Dynamics, Aircraft's Motion, Forces and Moments Equations, Equation of motion, Eulers and Hamilton, Linearization, Non Dimensional forms, Rotary Derivatives

Laplace Transformation, Frequency Response and Root locus, Introduction to linearized and small-perturbation methods of analysis.

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module-II: Modeling of Aircraft Motions

Modeling of Aircraft with aerodynamic forces, State space and transfer function representation of dynamical systems, Linearization, Nonlinear model of flight vehicle dynamics, Linear model of flight vehicle dynamics, Modes and dynamic behavior of linear systems, Flight vehicle modes: phugoid, short period, dutch roll, roll and spiral, handling qualities.

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module-III: Steady State Stability and control

Stability (Static and Dynamic), Performance and figures of merits of aircraft: CP and CG, Wind, Body, Stability and Principal Axes, Stability augmentation, control augmentation and Stability Boundaries and parameters affecting them. Longitudinal, Lateral and roll Stability: Necessary conditions and Stability Margins

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module-IV: Aircraft Controls

Introduction to Aircraft Controls systems: Direct Control, Hydraulic Powered and Power Assisted Controls, AFCS, Fly-By-Wire. High Mach Number Difficulties, Trim changes due to compressibility, Transonic Pitchup
Aircraft Flight control laws, redundancy requirements and envelop protection, MATLAB simulation of Lateral / Longitudinal Control of an aircraft. Frequency response of airplane – atmospheric disturbances and their effects on flight.

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module–V: FCS - Design orientation

Types of FCS, Classification of A/C, Flight Envelopes, Flight Phases, HQ ratings, Reliability Requirements, Governing Regulations and Standards, Need for AFCS, Aircraft Motion sensors and airdata systems for AFCS, Types of Actuation Systems- Electro hydraulic and Electromechanical, Artificial Feel Systems, Typical Operating modes of AFCS, Typical AFDS Architectures, Coupling of AFDS with primary FCS, Control law implementation in digital domain, Integration and evaluation of AFCS on ground using HIL simulation facility, Some examples of AFDS /FBW

Teaching Hours: 10; RBT Levels: L1,L2,L3

Course Outcomes:
- To represent aircraft equations of motion in SS and TF form
- To analyze stability characterizes of longitudinal and lateral motions
- To analyze AFCS functions in time and frequency domain

Text Books:

1. Bernard Etkin, 'Dynamics of Flight: Stability and Control', Wiley India, 2011, ISBN 13: 9780471089360
2. Jan Roskam., 'Airplane flight dynamics and automatic flight controls, Part-I', DAR Corp, 2003

References:

1. Brian LS and Frank LL., 'Aircraft Control and Simulation', Wiley India, 2010
2. Introduction to Aircraft Flight Mechanics: Performance, Static Stability, Dynamic Stability, and Classical Feedback Control, AIAA Education Series, by Thomas R. Yechout, Steven L. Morris, David E. Bossert, Wayne F. Hallgren
3. Aircraft systems: mechanical, electrical, and avionics subsystems integration By Ian Moir, Allan Seabridge, 3rd Edition, 2008

Aircraft Navigation Systems

Sub Code:	17 MAV 22	IA Marks	20
No. of Lecture Hours /week	04	Exam Hours	03
Total No of Lecture Hours	50	Exam Marks	80
Practical work/Assignment, Hrs/wk	3	Second Semester	16 weeks
Credits: 04			
Course Objectives: • To understand various types of aircraft navigation systems and initialization requirements • To analyze different types of navigation errors and correction methods • To understand working principles of GPS navigation, signal in space requirements and message structures • To analyze different types of navigation errors and correction methods			

Module –I: Inertial Sensors & Inertial Navigation

Gyroscopes-Mechanical-electromechanical-Ring Laser gyro- Fibre optic gyro, Accelerometers. INS components and errors-The earth in inertial space, the coriolis effect- Mechanisation. Stabilized Platform and Strap down INS system, block diagrams, Different co-ordinate systems, Schuler loop, compensation errors, Cross coupling, Gimbal lock, Alignment.

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module-II: Radio Navigation

Different types of radio navigation- ADF, VOR/DME- Doppler -LORAN and Omega

Teaching Hours: 10

Module-III: Approach and Landing aids

ILS, MLS, GLS, Ground controlled approach system, surveillance systems, radio altimeter

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module –IV: Satellite Navigation

Introduction to GPS - system description - basic principles - position and velocity determination-signal structure, Augmented GPS including WAAS and GBAS.

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module-V: Hybrid Navigation
Introduction to Kalman filtering-Estimation and mixed mode navigation-Integration of GPS and INS-utilization of navigation systems in aircraft

Teaching Hours: 10; RBT Levels: L1,L2,L3

Course Outcomes:
- To determine performance metrics of different navigation systems
- To build message structures for GPS navigation
- To be able to parse the raw binary data files of GPS navigation

Text Books:
1. Myron K and Walter R Fred., 'Avionics Navigation Systems', Wiley India, 2010, ISBN:978-81-265-2400-6
2. RPG Collinson., 'Introduction to Avionics', Springer, 2013, ISBN:978-81-322-1346-8

References
1. Nagaraja, N.S. "Elements of Electronic Navigation", Tata McGraw-Hill Pub. Co., New Delhi, 1975.
2. Sen, A.K. & Bhattacharya, A.B. "Radar System and Radar Aids to Navigation", Khanna Publishers, 1988.
3. Myron Kyton, Walfred Fried, 'Avionics Navigation Systems', John Wiley & Sons, 1997

Aircraft Display Systems

Sub Code:	17 MAV 23	IA Marks	20
No. of Lecture Hours /week	04	Exam Hours	03
Total No of Lecture Hours	50	Exam Marks	80
Practical work/Assignment, Hrs/wk	3	Second Semester	16 weeks
Credits: 04			

Course Objectives:

- To understand principles and evolution of cockpit display systems
- To acquire knowledge on functional aspects of various cockpit display instruments and control panels
- To understand computer graphics for cockpit displays

Module–I: Display Technologies
Trends in display technology – Alphanumeric displays, character display etc. Basic components of display systems. CRT displays, Plasma display, Solid state displays, LCDs and their characteristics.

Lecture Hours: 8; RBT Levels: L1,L2,L3

Module-II: Cockpit Displays – Functional View
Head up displays – Basic principles – Holographic HUDs - HUD electronics – HUD design and display generation. Helmet mounted displays – Helmet design factor – Helmet mounted sights – Head tracking system. Head down displays – Raster overlay display generation – Digitally generated color map displays. Multifunction displays – control and data entry – Multifunction keyboards-voice interactive systems.

Lecture Hours: 8; RBT Levels: L1,L2,L3

Module-III: Display Processor Requirements & Architecture
Concepts – Role of display processor – Design steps – Hardware architecture and Building blocks – Software Architecture – Symbol Generator –Display drive circuits – Display management Processor, Arinc 661 standards

Lecture Hours: 10; RBT Levels: L1,L2,L3

Module- IV: Computer Graphics
Vector generation display processors, Raster graphics, Graphic algorithms for generation of primitives, Display files, File compiler, Two and three dimensional transformation, clipping and windowing, Hidden line and hidden surface algorithms.

Lecture Hours: 12; RBT Levels: L1,L2,L3

Module-V: Graphics Standards
Graphic standards – 2D standards, 3D standards, X- Windows and their Application methods

Lecture Hours: 12; RBT Levels: L1,L2,L3

Course Outcomes:

- To apply solve system interface requirements with Pilot in Loop
- To evolve cockpit display system architectures
- To generate symbologies and widgets using computer graphics

Text Books

1. Malcolm Jukes., 'Aircraft Dsiplay Systems', Wiley Series in Aerospace, 2014
2. Giloi W.K. "Interactive Computer Graphics, Data Structures, Algorithms, Languages", Prentice – Hall, 1988.

References:

1. W.M.Newman And R.F. Sproul - Principles Of Interactive Computer Graphics, McGraw - Hill, 1981
2. Davis, Computer Displays, Prentice – Hall, 1982.
3. R.B.G. Collinson – Introduction to Avionics, 3rd Edition, Springer, 2013.
4. Cary R. Spitzer, The Avionics Handbook, CRC Press, 2000.

Flight Instrumentation and Flight Management Systems

Sub Code:	17 MAV 14	IA Marks	20
No. of Lecture Hours /week	04	Exam Hours	03
Total No of Lecture Hours	50	Exam Marks	80
Practical work/Assignment, Hrs/wk	3	Third Semester	16 weeks
Credits: 04			
Course Objectives: • To understand various types of flight and power plant instruments • To understand flight plans and architectures of FMS • To understand mission profiles and trajectory predictions • To understand Guidance functions of FMS			

Module-I: Measurement Science

Instrumentation brief review-Concept of measurement-Errors and error estimation- Functional elements of an instrument system-System representation- Static and dynamic characteristics- Mathematical modeling and system analysis, Instrumentation Amplifiers

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module-II: Power Plant Instruments

Pressure measurement, temperature measurement, fuel quantity measurement, engine power and control instruments-measurement of RPM, manifold pressure, torque, exhaust gas temperature, EPR, fuel flow, engine vibration, monitoring.

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module –III: Flight Instruments

Modeling of Atmosphere, ISA, Geopotential Altitude and Pressure Altitude, Density Altitude, Measurement of Indicated Airspeed IAS, CAS and EAS. Overview of Airdata Computer, Measurement of Vertical speed, Outside Air Temperature OAT and Angle of attack. Gyroscopic flight instruments-Gyroscope and its properties, gyro system. Earth’s magnetic field and Magnetic Variation, Direct reading compass, Magnetic Heading Reference System-MHRS, Remote Magnetic Indicator RMI,

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module-IV: FMS Architecture and functions

Functional Requirements of FMS, Typical FMS Functional Architecture, system composition and LRU interfaces. Integrated Navigation Function, Overview of LNAV, VNAV and RNP, Blending of Nav data with complementary Filters, Flight Planning Function, Navigation Database, Procedure Legs, Crew Interface - Interactive Operations with MCDU, Guidelines as per ARINC 661 and ARINC 739. Overview of CPDLC

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module-V: Mission profiles & Trajectory predictions

Typical Flight Mission Profiles and flight path requirements. Range – Payload Diagram for typical mission. Flight Path Trajectory Prediction Function, Performance Database, Predictions for climbing, Cruise, level accelerations and Descend phases, Guidance Function using AFDS– Flight Path Capture and hold, Altitude Capture and Hold, Speed Control through Auto Throttle system

Teaching Hours: 10; RBT Levels: L1,L2,L3

Course Outcomes:

- To analyze performance characteristics of various flight and power plant instruments
- To synthesize conceptual building blocks of FMS
- To predict flight path trajectories for various phases

Text Books

1. Murthy, D.V.S., 'Transducers and Measurements', Prentice Hall India Learning Private Limited, 2008, ISBN-13: 978-8120335691
2. Randy Walter, ‘Flight Management Systems’, in Avionics Hand Book, CRC press, 2007, ISBN 0 -8493-8438-9

References:

1. Myron K and Walter RF., ‘Avionics Navigation Systems’, Wiley India, 2010.
2. Ian Moir,’ Civil Avionics systems’, AIAA publications, 2003
3. M.E.Eshelby, Aircraft Performance: Theory and Practice, AIAA Education Series,2000
4. Performance Based Navigation Manual – Part-I, ICAO, 2007

Aircraft System Engineering and Standards

Sub Code:	17 MAV 151	IA Marks	20
No. of Lecture Hours /week	04	Exam Hours	03
Total No of Lecture Hours	50	Exam Marks	80
Practical work/Assignment, Hrs/wk	NIL	Third Semester	16 weeks
Credits: 03			
Course Objectives: The objectives of this course is • To introduce classical and advanced systems engineering theory that pertain to creation of multi-disciplinary solutions to complex aircraft systems • To focus on objectives, principles and practices pertaining to various systems engineering life cycle processes • To provide an overview of various development lifecycle aspects pertaining to systems engineering of aircraft systems, including certification and safety considerations at hardware and software subsystem levels			

Module-I: Avionics System Engineering Development Cycle
Establishing the Avionics System Requirements by Mission Scenario Analysis, Functional Analysis, Physical Partitioning, Avionics Architectural Design, Specification of HW/ SW of Subsystems, Development / Procurement of HW/ SW of Subsystems, SW Integration, HW/SW Integration, Standalone testing of subsystems, Avionics, HIL Simulation, System Integration in Aircraft leading to Flight Testing and Operational Test followed by SW updates and Avionics Upgrades.

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module-II: Systems Engineering Management
The Systems Engineering Process - Overview, Requirements Analysis, Functional Analysis and Allocation, Design Synthesis, Verification, Systems Engineering Process Outputs
System Analysis and Control - Work Breakdown Structure, Configuration Management, Technical Reviews and Audits, Trade Studies, Modeling and Simulation, Metrics, Risk Management, Planning, Organizing, And Managing - Systems Engineering Planning, Product Improvement Strategies, Organizing and Integrating, System Development, Contractual Considerations, Management Considerations

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module-III: Certification of Avionics Systems and Design Assurance Guidance for HW
Certification, Civil Aviation Authorities, Regulatory and Advisory Agencies, Regulation, Advisory Circular, Order, MOPS, TSO, Type Certification, Supplementary Type Certification, Certification Process, Delegation, Product Certification Process Roadmap. System Aspects of Hardware Design Assurance, Hardware Design Life Cycle, Planning Process, Hardware Design Processes, Validation and Verification Process, Configuration Management Process, Process Assurance, Certification Liaison Process, Hardware Design Life Cycle Data

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module-IV: Software Considerations in Airborne Systems and Equipment Certification

Essentials of Airborne SW Development, Typical Design Approach for SW: Process Models, Analysis Models, Architectures and CASE Tools, DOD-Std-2167, Formal methods – An overview.

DO-178B: System Aspects Relating To Software Development, Software Life Cycle, Software Planning Process, Software Development Processes, Software Verification Process, Software Configuration Management Process, Software Quality Assurance Process, Certification Liaison Process,

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module-V: Certification Considerations for Highly-Integrated/Complex Aircraft Systems (SAE ARP4754)

System Development Process Guidelines and Methods, Development Assurance and Safety Directed Development Concept, Certification Process and Coordination, Requirement Determination and Assignment of Development Assurance Level, Safety Assessment Process, Validation of Requirements, Implementation Verification, Configuration Management, Process Assurance.

Teaching Hours: 10; RBT Levels: L1,L2,L3

Course Outcomes: After completing the course, the students will be able…

- To Remember systems engineering fundamental principles, life cycle processes
- To Understand certification aspects pertaining to aircraft systems
- To Apply systems thinking in a moderately complex case study
- To Analyze applicability of specific design assurance levels for hardware & software subsystems and associated lifecycle elements
- To Create a basic systems engineering management plan for an aircraft system, covering various lifecycle aspects

Text Books:

1. Systems Engineering and Analysis (5th Edition). by Benjamin S. Blanchard , Wolter J. Fabrycky. 2010 Prentice Hall. ISBN-10: 013221735X, ISBN-13: 978-0132217354
2. Systems Engineering Principles and Practice, Alexander Kossiakoff, William N. Sweet et al. 2011 | ISBN-10: 0470405481 | ISBN-13: 978-0470405482 | Edition: 2

References

1. ISO/IEC 15288 Systems and software engineering — System life cycle processes, 2008
2. International Council On Systems Engineering (INCOSE) – Systems Engineering Handbook – A Guide For System Life Cycle Processes & Activities, V 3.2.1, Jan 2011
3. Guide to the Systems Engineering Body of Knowledge – SEBOK - http://www.sebokwiki.org/
4. RTCA DO-178B/EUROCAE ED-12B, Software Considerations in Airborne Systems and Equipment Certification, RTCA Inc.,Washington, D.C, 1992.
5. DO-254/EUROCAE ED-80, Design Assurance Guidance For Airborne Electronic Hardware, RTCA Inc.,Washington, D.C, April 19, 2000
6. ARP4754A, Guidelines for Development of Civil Aircraft and Systems, 2010
7. ARP4761, Guidelines and Methods for Conducting the Safety Assessment Process on Civil Aircraft Airborne Systems and Equipment, Warrendale, PA, 1996.
8. SysML Distilled: A Brief Guide to the Systems Modeling Language. Lenny Delligatti. Addison-Wesley Professional; 1 edition-2013. ISBN-10: 0321927869, ISBN-13: 978-0321927866

Machine Learning Systems

Sub Code:	17 MAV 152	IA Marks	20
No. of Lecture Hours /week	04	Exam Hours	03
Total No of Lecture Hours	50	Exam Marks	80
Practical work/Assignment, Hrs/wk	…	Third Semester	16 weeks
Credits: 03			

Course Objectives:

- To understand the basic concepts of learning and decision trees.
- To understand the neural networks and genetic algorithms
- To understand the Bayesian techniques
- To understand the instant based learning
- To understand the analytical learning and reinforced learning

Syllabus is same as that of 14SCS41 (for Ref)

MODULE I: INTRODUCTION, CONCEPT LEARNING AND DECISION TREES

Learning Problems – Designing Learning systems, Perspectives and Issues – Concept Learning – Version Spaces and Candidate Elimination Algorithm – Inductive bias – Decision Tree learning – Representation – Algorithm – Heuristic Space Search.

Teaching Hours: 10; RBT Levels: L1,L2,L3

MODULE II: NEURAL NETWORKS AND GENETIC ALGORITHMS

Neural Network Representation – Problems – Perceptrons – Multilayer Networks and Back Propagation Algorithms – Advanced Topics – Genetic Algorithms – Hypothesis Space Search – Genetic Programming – Models of Evolution and Learning.

Teaching Hours: 10; RBT Levels: L1,L2,L3

MODULE III: BAYESIAN AND COMPUTATIONAL LEARNING

Bayes Theorem – Concept Learning – Maximum Likelihood – Minimum Description Length Principle – Bayes Optimal Classifier – Gibbs Algorithm – Naïve Bayes Classifier – Bayesian Belief Network – EM Algorithm – Probably Learning – Sample Complexity for Finite and Infinite Hypothesis Spaces – Mistake Bound Model.

Teaching Hours: 10; RBT Levels: L1,L2,L3

MODULE IV: INSTANT BASED LEARNING AND LEARNING SET OF RULES

K- Nearest Neighbor Learning – Locally Weighted Regression – Radial Basis Functions – Case Based Reasoning – Sequential Covering Algorithms – Learning Rule Sets – Learning First Order Rules – Learning Sets of First Order Rules – Induction as Inverted Deduction – Inverting Resolution

Teaching Hours: 10; RBT Levels: L1,L2,L3

MODULE V: ANALYTICAL LEARNING AND REINFORCED LEARNING
Perfect Domain Theories – Explanation Based Learning – Inductive-Analytical Approaches - FOCL Algorithm – Reinforcement Learning – Task – Q-Learning – Temporal Difference Learning

Teaching Hours: 10; RBT Levels: L1,L2,L3

Course Outcomes:

- To Choose the learning techniques with this basic knowledge.
- To Apply effectively neural networks and genetic algorithms for appropriate applications.
- To Apply bayesian techniques and derive effectively learning rules.
- To Choose and differentiate reinforcement and analytical learning techniques

TEXT BOOK:

1. Tom M. Mitchell, "Machine Learning", McGraw-Hill Education (Indian Edition), 2013. ISBN-10: 0070428077 .

REFERENCES:

2. Ethem Alpaydin, "Introduction to Machine Learning", 2nd Ed., PHI Learning Pvt. Ltd., 2013.
3. T. Hastie, R. Tibshirani, J. H. Friedman, "The Elements of Statistical Learning", Springer; 1st edition, 2001.

Artificial Intelligence and Agent Technology

Sub Code:	17 MAV 153	IA Marks	20
No. of Lecture Hours /week	04	Exam Hours	03
Total No of Lecture Hours	50	Exam Marks	80
Practical work/Assignment, Hrs/wk	…..	Fourth Semester	16 weeks
Credits: 03			
Course Objectives: • To Apply a given AI technique to a given concrete problems • To Implement non-trivial AI techniques in a relatively large systems • To understand uncertainty and Problem solving techniques • To understand different logical systems for inference over formal domain representations			

The course is similar to 14SCS24 of CSE

MODULE I

What is Artificial Intelligence: The AI Problems, The Underlying assumption, What is an AI Technique?, The Level of the model, Criteria for success, some general references, One final word and beyond.

Problems, problem spaces, and search: Defining, the problem as a state space search, Production systems, Problem characteristics, Production system characteristics, Issues in the design of search programs, Additional Problems.

Intelligent Agents: Agents and Environments, The nature of environments, The structure of agents.

Teaching hours: 10; RBT Levels: L1,L2,L3

MODULE II

Heuristic search techniques: Generate-and-test, Hill climbing, Best-first search, Problem reduction, Constraint satisfaction, Mean-ends analysis.

Knowledge representation issues: Representations and mappings, Approaches to knowledge representation, Issues in knowledge representation, The frame problem.

Using predicate logic: Representing simple facts in logic, representing instance and ISA relationships, Computable functions and predicates, Resolution, Natural Deduction.

Logical Agents: Knowledge –based agents, the Wumpus world, Logic-Propositional logic, Propositional theorem proving, Effective propositional model checking, Agents based on propositional logic.

Teaching hours: 10; RBT Levels: L1,L2,L3

MODULE III

Symbolic Reasoning Under Uncertainty: Introduction to non-monotonic reasoning, Logic for non-monotonic reasoning, Implementation Issues, Augmenting a problem-solver, Implementation: Depth-first search, Implementation: Breadth-first search.

Statistical Reasoning: Probability and bayes Theorem, Certainty factors and rule-based systems, Bayesian Networks, Dempster-Shafer Theory, Fuzzy logic.

Quantifying Uncertainty: Acting under uncertainty, Basic probability notation, Inference using full joint distributions, Independence, Bayes' rule and its use, The Wumpus world revisited.

Teaching hours: 10; RBT Levels: L1,L2,L3

MODULE IV

Weak Slot-and-filter structures: Semantic Nets, Frames.

Strong slot-and –filler structures: Conceptual dependency, scripts, CYC.

Adversarial Search: Games, Optimal Decision in Games, Alpha-Beta Pruning, Imperfect Real-Time Decisions, Stochastic Games, Partially Observable Games, State-Of-The-Art Game Programs, Alternative Approaches, Summary

Teaching hours: 10; RBT Levels: L1,L2,L3

MODULE V

Learning From examples: Forms of learning, Supervised learning, Learning decision trees, Evaluating and choosing the best hypothesis, The theory of learning ,PAC, Regression and Classification with linear models, Nonparametric models, Support vector machines, Ensemble learning.

Learning Probabilistic Models: Statistical learning, learning with complete data, learning with hidden variables: The EM algorithm

Teaching hours: 10; RBT Levels: L1,L2,L3

Course Outcomes:

- To Design intelligent agents for problem solving, reasoning, planning, decision making, and learning.
- Apply AI technique on current applications.
- Problem solving, knowledge representation, reasoning, and learning

Text Books.

1. Elaine Rich, Kevin Knight, Shivashanka B Nair., 'Artificial Intelligence, Tata McGraw Hill 3rd edition. 2013, ISBN-13: 9780070087705
2. Stuart Russel, Peter Norvig: Artificial Intelligence A Modern Approach, Pearson 3rd edition 2013.

Reference Books:

1. Nils J. Nilsson: "Principles of Artificial Intelligence", Elsevier, ISBN-13: 9780934613101

Cloud Computing

Sub Code:	17 MAV 154	IA Marks	20
No. of Lecture Hours /week	04	Exam Hours	03
Total No of Lecture Hours	50	Exam Marks	80
Practical work/Assignment, Hrs/wk	…	Fourth Semester	16 weeks
Credits: 03			
Course Objectives: • To enable student to Define Cloud, models and Services. • To Compare and contrast programming for cloud and their applications • To Explain virtualization, Task Scheduling algorithms. • To Apply Zookeeper, Map-Reduce concept to applications.			

The course is similar to 16 SSE 254 (For Ref)

Module - I: Introduction, Cloud Infrastructure:

Cloud computing, Cloud computing delivery models and services, Ethical issues, Cloud vulnerabilities, Cloud computing the Google perspective, Microsoft Windows Azure and online services, Open-source software platforms for private clouds, Cloud storage diversity and vendor lock-in, Energy use and ecological impact, Service level agreements, User experience and software licensing. Exercises and problems

Teaching Hours:10; RBT Levels: L1,L2,L3

Module-II: Application Paradigms.:

Challenges of cloud computing, Architectural styles of cloud computing, Workflows: Coordination of multiple activities, Coordination based on a state machine model: The Zookeeper, The Map Reduce programming model, A case study on application, Cloud for aerospace engineering, High-performance computing on a cloud

Teaching Hours:10; RBT Levels: L1,L2,L3

Module –III: Cloud Resource Virtualization:

Virtualization, Layering and virtualization, Virtual machine monitors, Virtual Machines, Performance and Security Isolation, Full virtualization and Para virtualization, Hardware support for virtualization, Case Study on VMM based Para virtualization, Optimization of network virtualization, Performance comparison of virtual machines, The dark side of virtualization, Exercises and problems

Teaching Hours:10; RBT Levels: L1,L2,L3

Module – IV: Cloud Resource Management and Scheduling:

Policies and mechanisms for resource management, Application of control theory to task scheduling on a cloud, Stability of a two-level resource allocation architecture, Feedback control based on dynamic thresholds, Coordination of specialized autonomic performance managers, A utility based model for cloud-based Web services, Resourcing bundling: Combinatorial auctions for cloud resources, Scheduling algorithms for computing clouds, Fair queuing, Start-time fair queuing, Borrowed virtual time, Cloud scheduling

Teaching Hours:10; RBT Levels: L1,L2,L3

Module-V: Cloud Security, Cloud Application Development:

Cloud security risks, Security: The top concern for cloud users, Privacy and privacy impact assessment, Trust, Operating system security, Virtual machine Security, Security of virtualization, Security risks posed by OS and others, A cloud service for adaptive data streaming, Cloud based optimal FPGA synthesis. Exercises and problems

Teaching Hours:10; RBT Levels: L1,L2,L3

Course Outcomes:
• To Compare the strengths and limitations of cloud computing • To Identify the architecture, infrastructure and delivery models of cloud computing • To apply suitable virtualization concept and Choose the appropriate cloud player • To address the core issues of cloud computing such as security, privacy and interoperability

Text Books:

1. Dan C Marinescu: Cloud Computing Theory and Practice. Elsevier(MK) 2013. ISBN 10: 0124046274

Reference Books:

1. Rajkumar Buyya , James Broberg, Andrzej Goscinski: Cloud Computing Principles and Paradigms, Willey 2014.
2. John W Rittinghouse, James F Ransome:Cloud Computing Implementation, Management
and Security, CRC Press 2013.

Avionics Lab-I

Sub Code:	17 MAV 16	IA Marks	20
No. of Lecture Hours /week	04	Exam Hours	03
Total No of Lecture Hours	50	Exam Marks	80
Practical work/Assignment, Hrs/wk	04	Third Semester	16 weeks
Credits: 02			

Course Objectives:
- To familiarize with Avionics test facilities
- To familiarize with signal waveforms, Various modulation techniques, avionics networks and generate message structures in simulation environment
- To analyze time response data of test and output signals

LABORATORY WORK:

01. To simulate signal waveforms for digital modulation techniques like Orthogonal Frequency Division Multiplexing (OFDM) and other methods.
02. To simulate waveforms for wireless interconnect systems interfacing with Communication Management Unit (CMU) as per standards like Arinc 758 etc.
03. To develop message structure elements for Future Air Navigation Systems (FANS) Datalink
04. To plot Radiation Patterns for typical airborne antennae
05. To simulate electrical and logical layers and generation of message structure for of Aircraft digital interfaces like Arinc 429 and Mil Std 1553
06. To generate display widgets using Open GL tools and techniques.

Note: The above activities could be simulated on PC Desk top environment using simulation tools like MATLAB, and other open source tools.

Course Outcomes:

- To model and demonstrate various types of modulation signals and data bus bit streams & message strutures
- To determine and analyze ARP
- To generate cockpit display widgets using A661 tool set

References:

1. Alfred Helfrick, Principles of Avionics, Leesburg, VA: Avionics Communications, 2002.
2. Len Buckwalter., 'Avionics Databuses', published by Avionics Communications, 2008
3. User Manual on MATLAB
4. Arinc standards A429, A661 and A758,
5. Mil Standard 1553 B
6. User Manual on Microsoft Flight Simulator / Flight Gear

Aircraft Surveillance Systems

Sub Code:	17 MAV 24	IA Marks	20
No. of Lecture Hours /week	04	Exam Hours	03
Total No of Lecture Hours	50	Exam Marks	80
Practical work/Assignment, Hrs/wk	3	Fourth Semester	16 weeks
Credits: 04			
Course Objectives: • To understand working principles of Weather Radar • To understand working principle and functional blocks of TCAS • To understand and analyze Terrain Warning systems			

Module-I: Principles of Weather Radar

Introduction to Radar Systems ; Classes of Radar – Surveillance, Tracking and Weather Radar; Radar Range Equation, Radar Cross Section. Airborne Pulse Doppler Radar,

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module-II: Design of Weather Radar

Radar Subsystem Design – Transmitter, Receiver, Duplexer, Antenna, Data and Signal Processing and Displays. Airborne Weather Radar System Design,

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module –III: Weather Radar Signal Processing & Antennae

Signal Processing for detection of Precipitation, Turbulence and Wind shear, Advances in Radar Systems,- Active and Phased Array Antennae.

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module –IV: Enhanced Ground Proximity Warning System

Fundamentals of Terrain Avoidance Warning, Various Operating Modes – Normal and Enhanced modes, Runway Alert Awareness Systems, EGPWS Standards

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module-V: Collision Avoidance Systems

TCAS Architecture, Various Surveillance functions, Traffic and Resolution Advisories, Modes of Operation, Automatic Collision Avoidance Logic, Cockpit Presentation, Combined Traffic and Resolution Advisory Displays, Integration of ADS-B with Collision avoidance System. Aircraft Environment Surveillance Systems

Teaching Hours: 10; RBT Levels: L1,L2,L3

Course Outcomes:
- To analyze and compare performance specifications of Weather radars
- To undertake system integration of various surveillance sub systems
- To analyze and formulate terrain data base for implementations in TAWS

Text Books:

1. M. I. Skolnik, Introduction to Radar Systems, McGraw Hill Kogakusha Ltd, ISBN 0 - 07-057909-1
2. Pravas R. Mahapatra, Aviation Weather Surveillance Systems: Advanced Radar and Surface Sensors for Flight Safety and Air Traffic Management, Progress in Astronautics and Aeronautics Series Published by AIAA, 1999, ISBN: 1-56347-340-2

References:

1. Berry C Breen., Terrian Awareness, in Digital Avionics Handbook, CRC Press, 2007, ISBN: 0-8493-8438-9
2. Berry C Breen., Enhanced Situational Awareness, in The Avionics Handbook, CRC Press, 2001
3. Steve Henely, TCAS II, in The Avionics Handbook, CRC Press, 2001

Embedded Computing Systems

Sub Code:	17 MAV 251	IA Marks	20
No. of Lecture Hours /week	04	Exam Hours	03
Total No of Lecture Hours	50	Exam Marks	80
Practical work/Assignment, Hrs/wk	3	Fourth Semester	16 weeks
Credits: 03			

Course Objectives:

- To understand System composition and architecture of Embedded systems
- To understand communication protocols, interrupts and direct memory access
- To understand modelling of state machine & multiprocessors
- To understand RTOS environment

The syllabus is similar to 14 SCS 153 (For Ref)

Module-I: Introduction to Embedded Systems

Embedded Systems; Processor embedded into a system; Embedded Hardware units and devices in a system; Embedded Software in a system; Example of embedded systems; Embedded System – on – Chip (SoC) and use of VLSI circuit technology; Complex Systems Design and processors; Design process in embedded system. Formalization of System design; Desing Process and Design examples; Classification of embedded systems; Skills required for an embedded system designer

I/O types and examples; Serial communication devices; parallel device ports; Sophisticated interfacing features in device ports. Wireless devices; Timers and counting devices; Watchdog timer; Real time clock

Teaching hours: 10; RBT Levels: L1,L2,L3

Module-II: Communication Buses & Device Networks

Networked embedded systems; Serial bus communication protocols; parallel bus device protocols; Internet enabled systems; Wireless and mobile system protocols
Device access without interrupts; ISR concept; Interrupt sources; Interrupt servicing Mechanism; Multiple Interrupts; Context and the periods for context switching, interrupt latency and deadline; Classification of processors interrupt service mechanism from context- saving angle; Direct memory access; Device drivers programming

Teaching hours: 10; RBT Levels: L1,L2,L3

Module-III: Program Modeling Concepts, Processes, Threads and Tasks

Program models; DFG models; State machine programming models for event controlled program flow; Modeling of multiprocessor systems

Multiple processes in an application; Multiple threads in an application; Tasks task states; Task and data; Distinctions between functions, ISRs and Tasks

Teaching hours: 10; RBT Levels: L1,L2,L3

Module-IV: Real-Time Operating Systems

Operating System Services, Program Management; Timer functions; Event functions; Memory management; Device., file and I/O sub systems management; Interrupt routines in RTOS environment and handling of interrupt source calls.

Real-Time Operating Systems: Basic Design using RTOS; RTOS task scheduling models, interrupt latency and response times of the tasks as performance metrics; OS Security Issues

Teaching hours: 10; RBT Levels: L1,L2,L3

Module-V: Embedded Software Development Tools:

Introduction; Host and Target machines; Linking and locating software; Getting embedded software into the target system; Issues in Hardware-Software design and co-design; Testing on host machine; Simulators; Laboratory Tools

Teaching hours: 10; RBT Levels: L1,L2,L3

Course Outcomes:

- To analyze embedded system architecture and to develop I/O SW
- To analyze RTOS scheduling models and OS security issues
- To identify test requirements for SW on host machine

Text Books:

1. Rajkamal: Embedded Systems Architecture, Programming and Design, 2nd Edition, Tata McGraw Hill, 2008
2. Tammy Noergaard: Embedded Systems Architecture , Elsevier, 2005

Reference Books:

1. Wayne Wolf: Computers as components, Principles of Embedded Computer System Design, Elsevier, 2005
2. Steve Heath: Embedded Sysrems Design, 2nd Edition, Elsevier, 2003
3. Dr. KVKK Prasad: Embedded / Real-Time Systems: Concepts, Design and Programming – The Ultimate Reference, Dreamtech. Press, 2004

Big Data

Sub Code:	17 MAV 252	IA Marks	20
No. of Lecture Hours /week	04	Exam Hours	03
Total No of Lecture Hours	50	Exam Marks	80
Practical work/Assignment, Hrs/wk	…..	Fourth Semester	16 weeks
Credits: 03			

Course Objectives: This course will enable students to

- Define big data for business intelligence
- Analyze business case studies for big data analytics
- Explain managing of Big data Without SQL
- Develop map-reduce analytics using Hadoop and related tools

The syllabus is similar to 16 SSE 422 (For Ref)

Module-I: Introduction to Big Data

What is big data – why big data, Data Storage and Analysis, Comparison with Other Systems, Rational Database Management System, Grid and Volunteer Computing, convergence of key trends, Big data and algorithmic trading, introduction to Hadoop – open source technologies – cloud and big data – inter and trans firewall analytics.

Teaching hours: 10; RBT Levels: L1,L2,L3

Module-II: NOSQL Data Management:

Introduction to NoSQL – aggregate data models – aggregates – key-value and document data models – relationships – graph databases – schema less databases – materialized views – distribution models – shading –– version – map reduce – partitioning and combining – composing map-reduce calculations.

Teaching hours: 10; RBT Levels: L1,L2,L3

Module-III: Basics of Hadoop

Data format – analyzing data with Hadoop – scaling out – Hadoop streaming – Hadoop pipes – design of Hadoop distributed file system (HDFS) – HDFS concepts – Java interface – data flow – Hadoop I/O – data integrity – compression – serialization – Avro – file-based data structures.

Teaching hours: 10; RBT Levels: L1,L2,L3

Module-IV: MapReduce Applications
MapReduce workflows – unit tests with MRUnit – test data and local tests – anatomy of MapReduce job run – classic Map-reduce – YARN – failures in classic Map-reduce and YARN – job scheduling – shuffle and sort – task execution – MapReduce types – input formats – output formats

Teaching hours: 10; RBT Levels: L1,L2,L3

Module-V: Hadoop Related Tools
Hbase – data model and implementations – Hbase clients – Hbase examples –praxis. Cassandra – Cassandra data model – Cassandra examples – Cassandra clients –Hadoop integration. Pig – Grunt – pig data model – Pig Latin – developing and testing Pig Latin scripts. Hive – data types and file formats – HiveQL data definition – HiveQL data manipulation – HiveQL queries

Teaching hours: 10; RBT Levels: L1,L2,L3

Course Outcomes: Ability to

- Describe big data and use cases from selected business domains
- Explain NoSQL big data management
- Install, configure, and run Hadoop and HDFS
- Perform map-reduce analytics using Hadoop using several tools

Text Books:

1. Tom White, "Hadoop: The Definitive Guide", Third Edition, O'Reilley, 2012. ISBN: 978-1-449-31152-0.
2. Eric Sammer, "Hadoop Operations", O'Reilley, 2012.

Reference Books:

1. Vignesh Prajapati, Big data analytics with R and Hadoop, SPD 2013.
2. E. Capriolo, D. Wampler, and J. Rutherglen, "Programming Hive", O'Reilley, 2012.
3. Lars George, "HBase: The Definitive Guide", O'Reilley, 2011.
4. Alan Gates, "Programming Pig", O'Reilley, 2011

Unmanned Aerial Vehicles

Sub Code:	17 MAV 253	IA Marks	20
No. of Lecture Hours /week	04	Exam Hours	03
Total No of Lecture Hours	50	Exam Marks	80
Practical work/Assignment, Hrs/wk	3	Fourth Semester	16 weeks
Credits: 03			
Course Objectives: This course will enable students to • To introduce basic concepts of UAV and the basics of airframe • To identify and understand payloads involving various avionics systems • To know various communication systems, controls and design considerations. • To study path planning, Micro Aerial Vehicles and UAV certification standards.			

Module-I: Introduction

History of UAV, Classes and Missions of UAVs, basic terminology, Overview of UAV systems, Ground Support Equipment, models and prototypes –applications

Teaching hours: 10; RBT Levels: L1,L2,L3

Module-II: Basics of Airframe

Airframe – Dynamics – Modeling- Structures –Wing design- Propulsion - Range and Endurance performance, Control with Autopilots, Overall modes of operation

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module-III: Payloads

Reconnaissance / Surveillance payloads – Imaging sensors, Search Process, Synthetic Aperture Radar-Meteorological Sensors, Pseudo – Satellites

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module-IV: Data Links

Data-Link Functions and Attributes-Worldwide availability-Security-Data-Rates and restrictions—Data-Link Margin-Transmitter Power-Antenna Gain-Processing Gain-Data-Link Signal to Noise Budget

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module-V: Mission Planning and Control

Overview-MPCS Architecture-Physical Configuration-Planning and Navigation-MPCS interfaces

Teaching Hours: 10; RBT Levels: L1,L2,L3

Course Outcomes: Ability to

- Explain the concepts of UAVs and various associated avionics sub-systems
- Analyze and identify the high performance communication system requirements
- Analyze flight path planning and navigation concepts for UAVs

Text Books:

1. Paul Gerin Fahlstrom and Thomas James Gleason., ' Introduction to UAV Systems', Fourth edition, Wiley India, 2016
2. Armand J. Chaput, —Design of Unmanned Air Vehicle Systems||, Lockheed Martin Aeronautics Company, 2001

References:

1. Jane's Unmanned Aerial Vehicles and Targets, Jane's Information Group; ASIN: 0710612575, 1999
2. R. Said and H. Chayeb, —Power supply system for UAV||, KTH, 2002.
3. Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 1998

Flight Data Sciences

Sub Code:	17 MAV 254	IA Marks	20
No. of Lecture Hours /week	04	Exam Hours	03
Total No of Lecture Hours	50	Exam Marks	80
Practical work/Assignment, Hrs/wk	3	Fourth Semester	16 weeks
Credits: 03			

Course Objectives:

- To introduce students to the rapidly growing field and equip them with basic principles and tools
- To learn concepts and techniques as the students need to deal with various facets of data science practice
- To explain methods on data collection, integration, exploratory data analysis, predictive modeling
- To understand the data chains involved in Global Aeronautical Data Systems

Module-I: Introduction

Overview of Data Science, Current landscape and perspectives Skill sets, Statistical Modeling, Intro to R, Overview of Flight & Aeronautical data

Teaching hours: 10; RBT Levels: L1,L2,L3

Module-II: Data Learning Algorithms

Linear Regression, k-Nearest Neighbors and k-Means, Methods for Filtering Spam, Naïve Bayes Method for filtering, Data Wrangling.

Teaching hours: 10; RBT Levels: L1,L2,L3

Module –III: Feature Generation and Selection

Extracting Motivating Application from Data, Role of Domain Expertize in Feature Generation, Feature Selection Algorithms – Filters, Wrappers and Decision Trees and Random Forests,

Teaching hours: 10; RBT Levels: L1,L2,L3

Module-IV: Recommendation Systems and Visualization

Algorithmic Ingredients, Dimensionality reduction, Singular value decomposition, Principal Component Analysis, Basic principles, ideas and tools for of data visualization

Teaching hours: 10; RBT Levels: L1,L2,L3

Module-V: Managing Aeronautical Data

Aeronautical Information Services (AIS), AIS to AIM and System Wide Information Management (SWIM), Aeronautical standards on data-DO-200B and DO-276 of RTCA. Advice Circular AC-20-153B of FAA

Teaching hours: 10; RBT Levels: L1,L2,L3

Course Outcomes: Ability to

- To acquire skill sets needed to be a practitioner in the field of Data Science
- To apply appropriate methods for analyzing Aeronautical Data chains
- To identify suitable set of tools and techniques for analyzing the Data

Text Books:

3. Cathy O'Neil and Rachel Schutt., 'Doing Data Science, Straight Talk from the Frontline', O'Reilly Media 2014.
4. Jure Leskovek, etal., 'Mining of Massive Datasets', v2.1, Cambridge University Press. 2014

References:

4. Michael Burski., 'Global Information Management- RTCA overview', presented in ATC Global Conference at Beijing, Sept 2016
5. AC-20-153 B on Acceptance of Aeronautical Data, FAA, April 2016
6. Philippe MERLO., 'Managing Aeronautical Data', presented in ATC Global Conference at Beijing, Sept 2016

Avionics Lab-II

Sub Code:	17 MAV 26	IA Marks	20
No. of Lecture Hours /week	04	Exam Hours	03
Total No of Lecture Hours	50	Exam Marks	80
Practical work/Assignment, Hrs/wk	04	Fourth Semester	16 weeks
Credits: 02			

Course Objectives:
- To familiarize with responses of actuation systems and filters in time and frequency domain
- To demonstrate closed loop performance of actuation systems
- To analyze time response data of test output signals

LABORATORY WORK:

01 Generation of time responses using simplified linearized models for lateral dynamics of aircraft
02 Generation of time responses using simplified linearized models for longitudinal dynamics of aircraft
03 Generation of frequency response plots like Bode plots and Nichol charts for typical linear models including aircraft actuation systems used in AFCS and FMS
04 Generation of FFT for typical time response parameters
05 Generation of Navigational parameters using simulated Radio Nav Aid signals.
06 To simulate GPS Navigation computations for parameters relating to PVT

Note: The above activities could be simulated on PC Desk top environment using simulation tools like MATLAB and other similar tools.

Course Outcomes:
- To model and demonstrate response of actuation systems and filters
- To build virtual guidance cues in PFD etc
- To understand determining nav position from GPS data

References:

References:

1. Brian LS and Frank LL., ‘ Aircraft Control and Simulation’, Wiley India, 2910
2. Myron K and Walter RF., Avionics Navigation Systems’, Wiley India2010
3. User Manual on MATLAB
4. User Manual on Microsoft Flight Simulator / Flight Gear

Aircraft Propulsion, Utility Systems & Diagnostics

Sub Code:	17 MAV 41	IA Marks	20
No. of Lecture Hours /week	04	Exam Hours	03
Total No of Lecture Hours	50	Exam Marks	80
Practical work/Assignment, Hrs/wk	…	First Semester	16 weeks
Credits: 04			

Course Objectives:

- To understand propulsion principles
- To understand operation of sub systems of jet engine
- To understand principle of Cabin pressurization e aircraft utility systems
- To identify Engine condition monitoring requirements
- To understand principles of utility system operations

Module-I: Gas Turbine engine - Overview

Engine Theory, Classification of Propulsion System, Gas Turbine engine components and sub systems, Aircraft Fuel System and Engine Control system

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module-II: Gas Turbine Engine-Sub Systems

Compressors, Combustion chambers, Turbine & Exhaust Systems, Engine Starting and Ignition system

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module-III: Utility Systems

Aircraft Utility systems and Health Monitoring systems, Aircraft Electrical Systems, Aircraft Hydraulic and Pneumatic Systems, Aircraft Landing Gear Systems

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module –IV: Cabin Pressure Control

Aircraft Cabin Control System, Environmental Control System

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module-V: Monitoring and Maintenance

Aircraft and Engine condition monitoring, Aircraft Airworthiness Inspection and Maintenance

Teaching Hours: 10; RBT Levels: L1,L2,L3

Course Outcomes: After completing the course, the students will be able…
• To understand jet engine operation principles • To Understand engine control system • To analyze combustion principles of jet engine • To understand operation of various aircraft utility systems • To understand and identify health monitoring and maintenance requirements of engine and various utility systems

Text Books:

1. The Jet Engine, 5th Edition, Rolls Royce, Wiley, June 2015, ISBN: 978-1-119-06599-9.
2. Irwin E. Treager, Aircraft Gas Turbine Engine Technology, Third Edition 1997,Tata McGraw-Hill Publishing Company Limited

References:

3. Jeppesen, A&P Technician Airframe, Textbook

Fault Tolerant Systems

Sub Code:	17 MAV 421	IA Marks	20
No. of Lecture Hours /week	04	Exam Hours	03
Total No of Lecture Hours	50	Exam Marks	80
Practical work/Assignment, Hrs/wk	…	First Semester	16 weeks
Credits: 04			

Course Objectives:

- To understand and analyze system safety requirements
- To understand and analyze methods for redundancy
- To explain Built In Test and Vehicle health monitoring
- To understand methods for development of fault tolerant SW

Module-I: Fault Tolerance & Health Monitoring-Introduction

Defining System Flight Safety, Dependability and Attributes, Classification of Faults and their Categorization; System Health Status– Representation; Design for Dependability: Approach, Options, Design Elements and philosophies on Fault Tolerance. Evolution of BITE, BIT and Centralized Fault Display Systems in aircraft; Overview of Central Maintenance Computing Systems, Aircraft Condition Monitoring Functions; Overview of Prognostics, Physics of Failure based Modeling, Vehicle Health Management (VHM) and Integrated VHM

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module-II: Failure rates, Reliability & Availability

Defining Failure Rates and prediction using Part Count method and in service data, Accelerated Stress Test, Determining Reliability and availability using conventional methods and Semi Markov Chains.

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module-III: Mechanisms & Techniques

Fault Tolerance for Dependability of System, Fault Tolerant Mechanisms, Design Paradigms, Various Redundancy mechanisms including TMR, Dual-Dualetc. Types of Voting methods, Error Detection and Correction Techniques; MAFT, SAFEbus

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module-IV: IHRS, Safety Regulations and Requirements

Top level Safety requirements of FAR 25.1309 and FAA Advisory Circular AC.1309, Objectives and Design Principles, Acceptable Techniques for Compliance with examples, Step by Step Guidance for Compliance, Severities of Failure Conditions, Comparison with JAR.25 and Mil.Std 882, Safety of Precedence (SOP) for Airspace by FAA. Defining Hazard, Hazard Analysis; Overview of Integrated System Hazard Analysis, Adverse Event Scenarios and Adverse Event modeling of FAA and typical examples

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module-V: Software Fault Tolerance

Problem of Software Faults and Application of Fault Tolerance, Types of Software Fault Tolerance, Fault Tolerance of Single Version Programming including SW Structure Architectural aspects, Error Detection and recovery techniques; Fault Tolerance of N version Programming including Design Diversity, Recovery Blocks, NSCP etc.,

Teaching Hours: 10; RBT Levels: L1,L2,L3

Course Outcomes:

- To analyze system safety requirements and evolve Fault tolerant architectures
- To analyze message formats and data records of various Flight Data Recorders…
- To build adverse event models and evolve effective controls
- To apply Markov modeling for prediction of reliability and availability

Text Books:

1. Ellis F Hitt, Dennis Mulcare, 'Fault Tolerant Avionics', in Avionics Handbook, CRC press, 2007
2. Parad K Lala.,'Fault Tolerant and Fault Testable Hardware Design', BS Publications, 2014.

References:

1. Wilfredo Torres-Pomales, Software Fault Tolerance – A Tutorial, NASA/ TM 2000-210616, 2000
2. FAA System Safety Handbook, December 30, 2000
3. T. Anderson and P. A. Lee, Fault Tolerance: Principles and Practice, ISBN 0-13-308254-7, 2003;

Mission Avionics

Sub Code:	17 MAV 422	IA Marks	20
No. of Lecture Hours /week	04	Exam Hours	03
Total No of Lecture Hours	42	Exam Marks	80
Practical work/Assignment, Hrs/wk	…	Sixth Semester	16 weeks
Credits: 03			

Course Objectives:

- To understand and analyze IR based systems for airborne applications
- To understand Laser and LIDAR based airborne systems
- To understand and analyze various guidance systems towards targets
- To analyze imaging techniques using SAR

Module-I: Infrared System Fundamentals

Thermal Radiation Laws. Radiometric terminology and computation. Infrared (IR) spectral and atmospheric transmission. IR detectors and characteristics. Charged-Coupled Devices (CCD) and Focal Plane Arrays (FPA), IR Search, Detection and Track Systems – analysis and description. Signal Processing aspects.

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module II: IR detection and Imaging

IR Detection – Analysis and description, Signal Processing aspects, IR Line Scanner (IRLS) and Forward Looking IR (FLIR) imaging systems, Image quality and resolution requirements

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module III: Laser Systems

Types of Lasers , Characteristics , elements of Laser source and operation. Laser Range Finder (LRF) and Laser Designator (LD) Systems, High Power lasers and applications, LiDAR (Light Detection And Ranging) systems and Applications

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module IV: Target Acquisition, Tracking and Guidance Systems

Active and Semi-active guidance of weapons. Target Acquisition, Tracking and Pointing (ATP) and sight-line steering and stabilization concepts, Warning Systems.

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module V: Advanced Radar Systems

Overview of Advanced Radar Systems, Principle of Synthetic Aperture Radar, Range and Azimuth Resolution, Signal Processing Chain of SAR, Inverse SAR and typical applications of SAR.

Teaching Hours: 10; RBT Levels: L1,L2,L3

Course Outcomes:

- To apply IR principles for target detection and tracking
- To analyze performance of Synthetic Aperture Radars for imaging applications
- To analyze Laser based systems for airborne applications

Text Books:

1. Richard D Hudson. Jr, 'Infrared System Engineering', John Wiley & sons, New York 2006, ISBN: 978-0-470-09935-3
2. Ian Moir and Allan Seabridge, 'Military Avionics Systems', John Wiley & Sons Ltd, 2006

References:

1. Merril I Skolnik., 'Radar Handbook', McGraw Hill, 1990, ISBN 0-07-057913-X
2. Infrared Technology Fundamentals , second edition, Monroe Schlesinger. Marcel Dekker, Inc. N.Y.
3. Stephen B. Campana., 'The Infrared & Electro-optical Handbook – Vol 5 & 6', SPIE Optical Engineering press.
4. Eugene Hecht., 'Optics, Pearson Education, 2008, ISBN-10: 8131718077
5. A.R. Jha., Infrared Technology., Applications to Electrooptics, Photonics Devices, and Sensors. John Wiley & Sons, INC.

Flight Testing of Avionics Systems

Sub Code:	17 MAV 423	IA Marks	20
No. of Lecture Hours /week	04	Exam Hours	03
Total No of Lecture Hours	50	Exam Marks	80
Practical work/Assignment, Hrs/wk	…	Sixth Semester	16 weeks
Credits: 03			
Course Objectives: • To understand testing of various RF avionics systems in flight • To understand instrumentation and telemetry requirements • To understand various data recording methods for analysis and investigation • To understand methods for test data analysis			

Module-I: Flight Test – Instrumentation and Telemetry

Introduction, Methodology, Purpose and Scope of Flight Testing, Planning and Procedures, Instrumentation, Telemetry – Transmit and Receive Systems, Antenna Sub Systems, Link Analysis, System Sensitivity, Dynamic Range,

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module-II: Test Data Analysis

Flight Test data generation, Certification Standards and Regulations, Flight Test Data analysis- Data Scatter and Errors, Correlation Functions and LSE methods. Confidence Interval estimation- Normal Standard variate and Student Test analysis methods

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module-III: Flight Data Recorders:

Incident Analysis-Process, Critical Flight parameters for recording and incident investigations, Flight Data Recorders, CDR, DFDR and CVR, Crash worthiness Requirements, Trends towards Video, DLC and Combined Recorders

Teaching hours: 10; RBT Levels: L1,L2,L3

Module IV: Flight Testing of Airdata Systems

Position and Instrument Errors and their characterization, Pacer Aircraft method, Trailing Cone Method, Ground Course Method, Tower Fly By Method, GPS methods.

Teaching hours: 10; RBT Levels: L1,L2,L3

Module V: Flight Testing of Radio and Navigation Systems

Flight Test Approach for Radio Navigation Systems and Communication Systems, Antenna Radiation Pattern measurement, Flight Testing of Marker Beacon, ADF, VOR and DME.

Teaching Hours: 10; RBT Levels: L1,L2,L3

Course Outcomes:

- To analyze errors in flight test data and to estimate confidence intervals
- To analyze test data and message frames various FDR systems
- To calibrate airdata systems and to evaluate avionics navigation systems

Text Books:

3. Ralph D Kimberlin, Flight Testing of Fixed Wing Aircraft, AIAA Education Series, 2003, ISBN: 978-1-56347-564-1 .
4. Harry L Stilz., ‘ Aerospace Telemetry’, Vol I to IV, Prentice Hall Space technology series.

References:

1. Flight Test Instrumentation and Methods, FTI-RTO-AG-160-V21-02, 2008
2. Flight Test Guide for certification - Advisory Circular - Part-23, FAA, 2011
3. Stoliker, F. (2005). "Introduction to Flight Test Engineering". NATO Research and Technology Organisation (RTO) – Systems Concepts and Integration Panel (SCI). Flight Test Techniques Series, AGARDograph (AG-300), Volume 14
4. Federal Register-12542-CVR and FDR, 2008

Fuzzy Logic and Neural Networks

Sub Code:	17 MAV 424	IA Marks	20
No. of Lecture Hours /week	04	Exam Hours	03
Total No of Lecture Hours	50	Exam Marks	80
Practical work/Assignment, Hrs/wk	…	Sixth Semester	16 weeks
Credits: 03			

Course Objectives:

- To understand basics of Neural Networks and Fuzzy sets
- To understand single and multilayer feed forward networks
- To familiarize with various application methods

Module –I: Introduction to Neural Networks

Introduction, Biological and Artificial Neuron Models, Characteristics of ANN, McCulloch-Pitts Model, Historical Developments, Artificial Neuron Model, Types of ANN Architectures, Classification Taxonomy of ANN – Connectivity, Neural Dynamics - Activation and Synaptic.

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module –II: Fuzzy Sets & Logic

Introduction to classical sets - properties, Operations and relations; Fuzzy sets, Membership, Uncertainty, Operations, properties, fuzzy relations, cardinalities, membership functions. Fuzzification, Membership value assignment, development of rule base and decision making system, Defuzzification to crisp sets, Defuzzification methods.

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module -III: Single Layer Feed Forward Neural Networks

Introduction, Perceptron Models: Discrete, Continuous and Multi-Category, Training Algorithms: Discrete and Continuous Perceptron Networks, Perceptron Convergence theorem, Limitations of the Perceptron Model, Applications.

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module -IV: Multilayer Feed forward Neural Networks and associative memories

Credit Assignment Problem, Generalized Delta Rule, Derivation of Backpropagation (BP) Training, Summary of Backpropagation Algorithm, Kolmogorov Theorem, Learning Difficulties and Improvements. Paradigms of Associative Memory, Architecture of Hopfield Network: Discrete and Continuous versions

Teaching Hours: 10; RBT Levels: L1,L2,L3

Module - V: Applications
Neural network applications: Process identification, control, fault diagnosis and load forecasting. Fuzzy logic applications: Fuzzy logic control and Fuzzy classification.

Teaching Hours: 10; RBT Levels: L1,L2,L3

Course Outcomes:

- To analyze errors in flight test data and to estimate confidence intervals
- To analyze test data and message frames various FDR systems
- To calibrate airdata systems and to evaluate avionics navigation systems

TEXT BOOK:

1. Neural Networks, Fuzzy logic, Genetic algorithms: synthesis and applications by Rajasekharan and Rai – PHI Publication.
2. Introduction to Neural Networks using MATLAB 6.0 - S.N.Sivanandam, S.Sumathi, S.N.Deepa, TMH, 2006

REFERENCE BOOKS:

1. Neural Networks – James A Freeman and Davis Skapura, Pearson Education, 2002.
2. Neural Networks – Simon Hakins , Pearson Education
3. Neural Engineering by C.Eliasmith and CH.Anderson, PHI
4. Neural Networks and Fuzzy Logic System by Bart Kosko, PHI Publications.