Programme structure for B. Tech. Aeronautical Engineering Multi Disciplinary Minor

Track I: Minor in Avionics Engineering				
Minor	**Sr. No**	**Code**	**Title of the Course**	**Credits**
I	1.	U11MM011	Avionics Engineering	2
II	2.	U11MM012	Flight Instrumentation	2
III	3.	U11MM013	Control Engineering	2
IV	4.	U11MM014	Display Engineering	2
V	5.	U11MM015	Navigation Systems	2
VI	6.	U11MM016	UAV System	2

Track II: Minor in Space Technology				
Minor	**Sr. No**	**Code**	**Title of the Course**	**Credits**
I	1.	U11MM021	Elements of Satellite Technology	2
II	2.	U11MM022	Spacecraft Communication Systems	2
III	3.	U11MM023	Missile Guidance and Control	2
IV	4.	U11MM024	Missile Technology	2
V	5.	U11MM025	Aerospace Guidance and Control	2
VI	6.	U11MM026	Space Flight Dynamics	2

Track III: Minor in Drone Technology				
Minor	**Sr. No**	**Code**	**Title of the Course**	**Credits**
I	1.	U11MM031	Introduction to Drones	2
II	2.	U11MM032	Theory of Drones	2
III	3.	U11MM033	Engineering Materials for Drones	2
IV	4.	U11MM034	Drones Electronics	2
V	5.	U11MM035	Drones Manufacturing Processes	2
VI	6.	U11MM036	Drone metrology, assembly and maintenance	2

Track IV: Minor in Drone Technology				
Minor	**Sr. No**	**Code**	**Title of the Course**	**Credits**
I	1.	U11MM061	Introduction to Drones	2
II	1.	U11MM062	Theory of Drones	3
	2.	U11MM066	Basic Drones Lab	1
III	1.	U11MM063	Engineering Materials for Drones	3
	2.	U11MM067	Engineering Materials for Drones Lab	1
IV	1.	U11MM064	Drones Electronics	3
	2.	U11MM068	Drones Electronics Lab	1
V	1.	U11MM065	Drones Manufacturing Processes	3
	2.	U11MM069	Drones Manufacturing Processes Lab	1

- **Track I ,II,III for Technology, Track IV for Science, Arts & Management.**

Track I: Minor in Avionics Engineering				
Minor	**Sr. No**	**Code**	**Title of the Course**	**Credits**
I	1.	U11MM011	Avionics Engineering	2
II	2.	U11MM012	Flight Instrumentation	2
III	3.	U11MM013	Control Engineering	2
IV	4.	U11MM014	Display Engineering	2
V	5.	U11MM015	Navigation Systems	2
VI	6.	U11MM016	UAV System	2

Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U11MM011	Avionics Engineering	02	-	-	02	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					End Semester Exam (ESE)		
		T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
U11MM011	Avionics Engineering	-	10	5	15	40%	35	40%	50

Course Description

The course focuses on the electronic systems used in aircraft, including navigation, communication, and monitoring systems.

Pre-requisites: -

Course Objectives

- To introduce the basic of avionics and its need for civil and military aircrafts
- To impart knowledge about the avionic architecture and various avionics data buses
- To gain more knowledge on various avionics subsystems
- To understand the concepts of navigation systems.
- To gain knowledge on auto pilot system

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Explain**^{2} design considerations for avionic systems
- **CO2** **Explain**^{2} various display systems used in an aircraft
- **CO3** **Discuss**^{2} aircraft instruments that make the avionic system
- **CO4** **Explain**^{2} communication, navigation, and surveillance systems
- **CO5** **Apply**^{3} various Data Buses used in aircraft applications

Course Contents

Module	Unit	Description	Hours
1.0		**Design Considerations**	**6**
1	1.1	Importance and role of avionics, avionic environment, Regulatory and advisory agencies	
	1.2	Displays and man-machine interaction: Head -glass cockpit- Cathode Ray Tube (CRT), Active Matrix Liquid Crystal Display (AMLCD).	
2.0		**Display Systems**	**6**
2	2.1	Head Down Display (HDD), Head Up Display (HUD), Helmet Mounted Display (HMD), OLEDS, Night Vision Goggles, LASERS	
	2.2	Integrated Standby Instrument System (ISIS), data fusion, intelligent displays management, Displays technology, control and data entry, instrument placements	
3.0		**Aircraft Instruments**	**6**
3	3.1	Inertial reference systems, attitude derivation. RMI, HSI, ADI Magnetic Heading Reference System (MHRS.); Outside world sensor systems: Radar systems - Radar Sensing - Radar Altimeter (RADALT), Doppler Radar, Weather Radar, RADOME, infrared systems, awacs, aircraft lighting, runway lighting systems	
	3.2	Aerofoils, Mach number, Manoeuvres.	
4.0		**Navigation Systems**	**6**
4	4.1	Principles of navigation, Automatic Direction Finding, Very High Frequency Omni-Range (VOR), Distance Measuring Equipment (DME), landing aids (ILS & MLS),	
	4.2	Inertial Navigation, GPS-global positioning system, terrain reference navigation, RNAV, FMS, GPWS, TCAS, GNSS	
5.0		**Surveillance & Communications Systems**	**6**
5	5.1	HF, VHF, UHF, Microwaves Signals and Noise, Modulation and demodulation, Antennas, propagation, data links, Telemetry, Transponders,	
	5.2	Typical Systems in Aircrafts, Basic Radar Systems and types, ATC Electronic Warfare Basics	

Text Books

1. Cary R. Spitzer, The Avionics Handbook, 2nd Edition, CRC PressLLC, 2006
2. Ian Moir, Allan G. Seabridge, Military Avionics Systems, John Wiley& Sons, Ltd,2009

References

1. Ian Moir, Allan G. Seabridge, Aircraft Systems: Mechanical, Electrical, Avionics Subsystems Integration, 3rdEdition, ohn Wiley& Sons, Ltd 2008
2. Cary R. Spitzer., Digital Avionics Systems Principles and Practices, 2nd ed, McGraw-Hill, Inc,1993.
3. Brain Kendal, "Manual of Avionics", The English Book House, 3rdEdition, New Delhi, 1993.
4. Collinson RPG, Introduction to Avionics, Second Edition, Kluwer Academic Publishers, Chapman & Hall, 2003.
5. Don Middleton., Avionic Systems (Longman Aviation TechnologySeries),Longman, 1989.

Internal Assessment (T1, T2 and FET)

1. T2 should be based on First to Fourth modules, for 10 marks.
2. FET shall be assessed for 5 marks separately.

End Semester Examination

1. Question paper will be of 35 marks comprise of 5 questions, each carrying 7 marks
2. The duration of end semester examination shall be Two hours.
3. The students need to solve all questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U11MM012	Flight Instruments	02	-	-	02	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					End Semester Exam (ESE)		
		T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
U11MM012	Flight Instruments	-	10	5	15	40%	35	40%	50

Course Description

This course is designed for avionics technicians or apprentices who want to learn more about aircraft instrument systems and better understand their operation, installation considerations, and maintenance to become more effective trouble shooters.

Pre-requisites: -

Course Objectives

- To impart knowledge of the hydraulic and pneumatic systems components
- To Study the types of instruments and its operation including navigational instruments.
- Acquire the knowledge of essential systems of safe aircraft operation.
- To learn the concepts of display systems
- To study the various engine systems in aircraft

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Understand**[2] and apply the concept of measurement, classification of aircraft instrumentation, displays and layouts standards
- **CO2** **Explain**[1] about the various air data systems and synchronous data transmissions systems
- **CO3** **Apply**[2] the principle of gyroscope to various Advanced Aircraft Instruments
- **CO4** **Classify**[2] the aircraft magnetism, understand the Compass systems and FMS in 4D flight management in the Avionics domain requirements
- **CO5** **Explain**[1] the operation and importance of Power plant & engine instruments and flight data recorder.

Course Contents

Module	Unit	Description	Hours
1.0		**Measurement Science and Displays**	**6**
1	1.1	Instrumentation brief review - Concept of measurement - Functional elements of an instrument system- Transducers - classification of aircraft instruments-	
	1.2	Requirements and standards – Instrument Elements and Mechanism - Instrument displays panels and cockpit layout, Aircraft instruments Grouping - Electronic Flight Instrument System.	
2.0		**Air Data Instruments And Synchro Transmission Systems**	**6**
2	2.1	Earth's Atmosphere – Basic Air data system – Air Data instruments-airspeed, altitude, Vertical speed indicators - Probes – Posittion Error - Altitude alerting systems, Mach meter, Mach Warning system, Static Air temperature, Angle of attack measurement, Stall Warning system,Stick Shaker - Synchronous data transmission system – Synchros systems – Resolver synchros – Synchrotel.	
3.0		**Gyroscopic and Advanced Flight Instruments**	**6**
3	3.1	Gyroscope and its properties, gyro system, Gyro horizon, Erection systems for Gyro Horizons Direction gyro-direction indicator, Rate gyro-rate of turn and slip indicator, turn coordinator, acceleration and turning errors	
	3.2	Standby Attitude Director Indicator, Gyro stabilized Direction Indicating Systems, Advanced Direction Indicators, Horizontal Situation Indicator.	
4.0		**Aircraft Compass Systems & Flight Management System**	**6**
4	4.1	Aircraft magnetism - Direct reading compass, magnetic heading reference system-detector element, monitored gyroscope system, DGU, RMI, deviation compensator.	
	4.2	FMS- Flight planning flight path optimization-operational modes-4D flight management	

5.0		Power Plant Instruments & Flight Data Recording	6
5	5.1	Pressure measurement, temperature measurement, fuel quantity measurement, engine power and control instruments-measurement of RPM, manifold pressure, torque, exhaust gas temperature, EPR, Engine Fuel Indicators, engine vibration monitoring, Cockpit Voice Recorder and Flight Data Recorder.	

Text Books

1. Pallet, E.H.J. Aircraft Instruments & Integrated systems, Dorl.ing Kindersley (India) Pvt. Ltd,, 2011.
2. David Wyatt. 'Aircraft Flight Instruments and Guidance Systems', Routledge, Taylor & Francis Group, 2015.

References

1. Harry L. Stilz, Aerospace Telemetry, Vol I to IV, Prentice-Hall Space Technology Series, 1961
2. Sawhney A.K, ' Electronic Measurements and Instrumentation ' Dhanpat Rai & Co, 2017
3. Murthy, D.V.S., Transducers and Measurements, McGraw-Hill, 1995.

Internal Assessment (T1, T2 and FET)

1. T2 should be based on First to Fourth modules, for 10 marks.
2. FET shall be assessed for 5 marks separately.

End Semester Examination

1. Question paper will be of 35 marks comprise of 5 questions, each carrying 7 marks
2. The duration of end semester examination shall be Two hours.
3. The students need to solve all questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U11MM013	Control Engineering	02	-	-	02	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					End Semester Exam (ESE)		
		T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
U11MM013	Control Engineering	-	10	5	15	40%	35	40%	50

Course Description

This course is designed for avionics technicians or apprentices who want to learn more about aircraft instrument systems and better understand their operation, installation considerations, and maintenance to become more effective trouble shooters.

Pre-requisites: -

Course Objectives

- To introduce the mathematical modeling of systems, open loop and closed loop systems and analyses in time domain and frequency domain.
- To impart the knowledge on the concept of stability and various methods to analyze stability in both time and frequency domain.
- To introduce sampled data control system.
- To explain the concept of stability.
- To understand about digital controllers.

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Apply**[2] mathematical knowledge to model the systems and analyse the frequency domain.
- **CO2** **Define**[1] the stability of the both time and frequency domain.
- **CO3** **Solve**[2] simple pneumatic, hydraulic and thermal systems, Mechanical and electrical component analogies-based problems.
- **CO4** **Solve**[1] the Block diagram representation of control systems, Reduction of block diagrams, Signal flow graph and problems based on it.
- **CO5** **Explain**[1] the digital control system, Digital Controllers and Digital PID Controllers.

Course Contents

Module	Unit	Description	Hours
1.0		**Introduction**	**6**
1	1.1	Historical review, Simple pneumatic, hydraulic and thermal systems, Series and parallel system.	
	1.2	Analogies, mechanical and electrical components, Development of flight control systems.	
2.0		**Open And Closed Loop Systems**	**6**
2	2.1	Feedback control systems – Control system components - Block diagram representation of control systems, Reduction of block diagrams, Signal flow graphs, Output to input ratios.	
	2.2		
3.0		**Characteristic Equation and Functions**	**6**
3	3.1	Laplace transformation, Response of systems to different inputs viz., Step impulse, pulse, parabolic and sinusoidal inputs,	
	3.2	Time response of first and second order systems, steady state errors and error constants of unity feedback circuit.	
4.0		**Concept Of Stability**	**6**
4	4.1	Necessary and sufficient conditions, Routh-Hurwitz criteria of stability, Root locus and Bode techniques, Concept and construction, frequency response.	
5.0		**Sampled Data Systems**	**6**
5	5.1	Z-Transforms Introduction to digital control system, Digital Controllers and Digital PID controllers	

Text Books

1. Azzo, J.J.D. and C.H. Houpis Feedback control system analysis and synthesis, McGraw-Hill international 3rs Edition, 1998.
2. OGATO, Modern Control Engineering, Prentice-Hall of India Pvt. Ltd., New Delhi, 1998.

References

1. Houpis, C.H. and Lamont, G.B. "Digital control Systems", McGraw Hill Book co., New York, U.S.A. 1995.
2. Kuo, B.C. "Automatic control systems", Prentice-Hall of India Pvt. Ltd., New Delhi, 1998.
3. Naresh K Sinha, "Control Systems", New Age International Publishers, New Delhi, 1998.

Internal Assessment (T1, T2 and FET)

1. T2 should be based on First to Fourth modules, for 10 marks.
2. FET shall be assessed for 5 marks separately.

End Semester Examination

1. Question paper will be of 35 marks comprise of 5 questions, each carrying 7 marks
2. The duration of end semester examination shall be Two hours.
3. The students need to solve all questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U11MM014	Display Engineering	02	-	-	02	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					End Semester Exam (ESE)		
		T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
U11MM014	Display Engineering	-	10	5	15	40%	35	40%	50

Course Description

This course deals with 2D and 3D display technologies (e.g. human visual system, color and depth perception, colour theory and metrology, and state-of-the-art display technologies), display performance evaluation and calibration, and display research frontiers

Pre-requisites: -

Course Objectives

- To gain exposure in the basics of the display systems
- To illustrate the current design practices of the display systems

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** Understand the material properties of display devices
- **CO2** Understand the projection technology of 3D display devices
- **CO3** Application of the acquired knowledge in practical design of a display system

Course Contents

Module	Unit	Description	Hours
1.0		**Introduction To Optics**	**6**
1	1.1	Properties of Light, Geometric Optics, Optical Modulation; Vision and Perception: Anatomy of Eye, Light Detection and Sensitivity, Spatial Vision and Pattern Perception, Binocular Vision and Depth Perception;	
	1.2	Driving Displays: Direct Drive, Multiplex and Passive Matrix, Active Matrix Driving, Panel Interfaces, Graphic Controllers.	
2.0		**Display Glasses**	**6**
2	2.1	Display Glasses, Inorganic Semiconductor TFT Technology, Organic TFT Technology; Transparent Conductors,	
	2.2	Patterning Processes: Photolithography for Thin Film LCD, Wet Etching, Dry Etching; Flexible Displays: Attributes, Technologies Compatible with Flexible Substrate and Applications, Touch Screen Technologies.	
3.0		**Display Devices**	**6**
3	3.1	Inorganic Phosphors, Cathode Ray Tubes, Vacuum Florescent Displays, Filed Emission Displays; Plasma Display Panels, LED Display Panels; Inorganic Electroluminescent Displays: Thin Film Electroluminescent Displays, AC Powder Electroluminescent Displays; Organic Electroluminescent Displays: OLEDs, Active Matrix for OLED Displays;	
	3.2	Liquid Crystal Displays: Fundamentals and Materials, Properties of Liquid Crystals, Optics and Modeling of Liquid Crystals; LCD Device Technology: Twisted Numeric and Super twisted Numeric Displays,	
4.0		**3-D Display Technology.**	**6**
4	4.1	Paper like and Low Power Displays: Colorant Transposition Displays, MEMs Based Displays, -D Displays, 3-D Cinema Technology, Autostereoscopic 3-D Technology,	

	4.2	Volumetric and 3DVolumetric Display Technology, Holographic 3-D Technology; Mobile Displays: Trans-reflective Displays for Mobile Devices, Liquid Crystal Optics for Mobile Displays, Energy Aspects of Mobile Display Technology.	
5.0		**Micro Display Technology**	**6**
5	5.1	Micro display Technologies: Liquid Crystals on Silicon Reflective Micro display, Transmissive Liquid Crystal Micro display, MEMs Microdisplay, DLP Projection Technology;	
	5.2	Micro display Applications: Projection Systems, Head Worn Displays; Electronic View Finders, Multi focal Displays, Occlusion Displays, Cognitive Engineering and Information Displays; Display Metrology, Standard Measurement Procedures,	

Text Books

1. Janglin Chen, Wayne Cranton, Mark Fihn , "Handbook of Visual Display Technology", Springer Publication.

References

1. Joseph A Castellano, "Hand book of Display Technology" , Elsevier, 1992.
2. Achintya K. Bhowmik, "Interactive Displays: Natural Human–Interface Technologies", Wiley SID Series, 2014.

Internal Assessment (T1, T2 and FET)

1. T2 should be based on First to Fourth modules, for 10 marks.
2. FET shall be assessed for 5 marks separately.

End Semester Examination

1. Question paper will be of 35 marks comprise of 5 questions, each carrying 7 marks
2. The duration of end semester examination shall be Two hours.
3. The students need to solve all questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U11MM015	Navigation Systems	02	-	-	02	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					End Semester Exam (ESE)		
		T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
U11MM015	Navigation Systems	-	10	5	15	40%	35	40%	50

Course Description

The course gives an overview of satellite-based radio navigation systems such as: GPS, GLONASS, GALILEO and BEIDOU, the basics of receiver design, wave propagation in the atmosphere, the geodetic fundamentals of navigation og positioning, reference- and coordinate systems and computational methods for navigation and

Pre-requisites: -

Course Objectives

- One of the primary objectives of navigation systems is to provide efficient routes for travelers, whether they are driving, walking, or using public transportation.
- This involves considering factors such as traffic conditions, road closures, construction, and real-time data to suggest the fastest or most convenient route.
- Safety: Navigation systems aim to enhance safety by guiding users through safe routes and providing real-time updates on hazards such as accidents, road closures, weather conditions, or other emergencies.
- **CO1** Explain the need for different axis systems and select the suitable system for the given Condition.
- **CO2** Derive the necessary mathematical knowledge that are needed in modelling the navigation process and methods
- **CO3** Analyze various Navigation systems such as Inertial Measurement systems, Radio Navigation Systems, Satellite Navigation – GPS; Landing aids
- **CO4** Understand the operation of various Automatic Landing systems
- **CO5** Explain the concepts of Satellite Navigation and Deploy these skills effectively in the analysis and understanding of hybrid navigation systems in an aircraft.

Course Contents

Module	Unit	Description	Hours
1.0		**Navigation Systems & Inertial Sensors**	**6**
1	1.1	Principles of navigation - Design Trade-offs – Evolution of Air navigation - Concept of latitude and longitude (Geodetic and Geostatic) - Different co-ordinate frames - Transformation Techniques – Euler Angles – Direction Cosine matrices – Quaternions – Dual Quaternions -	
	1.2	Introduction to Inertial Sensors -Accelerometers - Gyroscopes - Mechanical Gyro - Ring Laser gyro- Fiber optic gyro - MEMS system	
2.0		**Inertial Navigation Systems**	**6**
2	2.1	Navigation Equations - - Earth in inertial space - INS Mechanization Equations - Stable Platform and Strap down- INS components: transfer function and error analysis - Coriolis effect -	
	2.2	Rate corrections – Schuler Tuning - INS system block diagram - Initial calibration and Alignment Algorithms	
3.0		**Radio Navigation**	**6**
3	3.1	Different types of radio navigation – Non-directional Beacons - ADF, VOR, DME - Doppler - Hyperbolic Navigations -LORAN, DECCA and Omega - TACAN- VORTAC - Future trends	
4.0		**Landing Systems And Air Traffic Management**	**6**
4	4.1	Mechanic of Landing – Visual flight Rules – Categories of Landing - Instrument Landing System- Microwave Landing System- Satellite based Landing system – Ground controlled approach system- Surveillance systems-Airborne Collision Avoidance Systems	
5.0		**Satellite Navigation & Hybrid Navigation**	**6**
5	5.1	Introduction to GPS -system description - basic principles -position and velocity determination signal structure- Spread spectrum concepts- Errors – DGPS concepts: LAAS, WAAS - Estimation and mixed mode navigation -Integration of GPS and INS- Kalman Filter - Utilization of navigation systems in aircraft.	

Text Books

1. Myron Kyton, Walfred Fried, 'Avionics Navigation Systems', John Wiley & Sons, 2009

References

1. Collinson R.P.G, 'Introduction to Avionics Systems', Springer Publisher, 3rd Edition 2011
2. Nagaraja, N.S. Elements of Electronic Navigation‖, Tata McGraw-Hill Pub. Co., New Delhi, 2nd edition, 2017
   Paul. D. Groves. 'Principles of GNSS, Inertial, and Multi sensor Integrated Navigation Systems', Artech House, 2013.

Internal Assessment (T1, T2 and FET)

1. T2 should be based on First to Fourth modules, for 10 marks.
2. FET shall be assessed for 5 marks separately.

End Semester Examination

1. Question paper will be of 35 marks comprise of 5 questions, each carrying 7 marks
2. The duration of end semester examination shall be Two hours.
3. The students need to solve all questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U11MM016	UAV Systems	02	-	-	02	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					End Semester Exam (ESE)		
		T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
U11MM016	UAV Systems	-	10	5	15	40%	35	40%	50

Course Description

The course will cover modelling and dynamics of aerial vehicles, and common control strategies.

Pre-requisites: -

Course Objectives

- To expose students to concepts needed in modeling and analyzing an unmanned system.
- To expose students to the design and development of UAV.
- To expose students to the type of payloads used in UAV.
- To study path planning
- To understand the avionics hardware used in the UAV

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Design**[2] UAV system.
- **CO2** **Prepare**[1] preliminary design requirements for an unmanned aerial vehicle.
- **CO3** **Identify**[2] different hardware for UAV.
- **CO4** **Perform**[2] system testing for unmanned aerial vehicles.
- **CO5** **Design**[2] micro aerial vehicle systems by considering practical limitations.

Course Contents

Module	Unit	Description	Hours
1.0		**Introduction To UAV**	**6**
1	1.1	History of UAV –classification – Introduction to Unmanned Aircraft Systems--models and prototypes – System Composition-applications	
2.0		**The Design Of UV Systems**	**6**
2	2.1	Introduction to Design and Selection of the System- Aerodynamics and Airframe Configurations- Characteristics of Aircraft Types**.**	
	2.2	Design Standards and Regulatory Aspects-UK,USA and Europe- Design for Stealth--control surfaces-specifications.	
3.0		**Avionics Hardware**	**6**
3	3.1	Autopilot – AGL-pressure sensors-servos-accelerometer –gyros-actuators- power supply-processor, integration, installation, configuration, and testing	
4.0		**Communication Payloads and Controls**	**6**
4	4.1	Payloads-Telemetry-tracking-Aerial photography-controls-PID feedback-radio control frequency range –modems-memory system-simulation-ground test-analysis-trouble shooting	
5.0		**The Development of UAV Systems**	**6**
5	5.1	Waypoints navigation-ground control software- System Ground Testing- System In-flight Testing- Future Prospects and Challenges-Case Studies – Mini and Micro UAVs.	

Text Books

1. Paul G Fahlstrom, Thomas J Gleason, "Introduction to UAV Systems", UAV Systems, Inc, 1998
2. Reg Austin "Unmanned Aircraft Systems UAV design, development and deployment", Wiley,2010.

References

1. Dr. Armand J. Chaput, "Design of Unmanned Air Vehicle Systems", Lockheed Martin Aeronautics Company, 2001
2. Kimon P. Valavanis, "Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy", Springer, 2007
3. Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 1998.

Internal Assessment (T1, T2 and FET)

1. T2 should be based on First to Fourth modules, for 10 marks.
2. FET shall be assessed for 5 marks separately.

End Semester Examination

1. Question paper will be of 35 marks comprise of 5 questions, each carrying 7 marks
2. The duration of end semester examination shall be Two hours.
3. The students need to solve all questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Track II: Minor in Space Technology				
Minor	**Sr. No**	**Code**	**Title of the Course**	**Credits**
I	1.	U11MM021	Elements of Satellite Technology	2
II	2.	U11MM022	Spacecraft Communication Systems	2
III	3.	U11MM023	Missile Guidance and Control	2
IV	4.	U11MM024	Missile Technology	2
V	5.	U11MM025	Aerospace Guidance and Control	2
VI	6.	U11MM026	Space Flight Dynamics	2

Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U11MM021	Elements of Satellite Technology	02	-	-	02	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					End Semester Exam (ESE)		
		T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
U11MM021	Elements of Satellite Technology	-	10	5	15	40%	35	40%	50

Course Description

This course provides an in-depth exploration of the fundamental elements comprising satellite technology, covering both theoretical concepts and practical applications.

Pre-requisites: -

Course Objectives

- Communication: Satellites are used for communication purposes, enabling long-distance transmission of voice, data, and video signals.
- The elements of communication satellite technology include transponders, antennas, ground stations, and modulation/demodulation techniques.
- Navigation: Navigation satellites are designed to provide accurate positioning, navigation, and timing (PNT) information to users worldwide. and military navigation, improving transportation efficiency, and enhancing location-based services.

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Understand**[1] the importance of Spacecraft missions and configurations
- **CO2** **Explain**[1] Spacecraft power system functions and importance
- **CO3** **Explain**[1] spacecraft Attitude and orbital control system design
- **CO4** **Understand**[1] satellite propulsion, thermal control and structure subsystems
- **CO5** **Analyse**[3] satellite telemetry and telecommand systems

Course Contents

Module	Unit	Description	Hours
1.0		**Satellite Mission And Configuration**	**6**
1	1.1	Mission Overview – Requirements for different missions – Space Environment, Spacecraft configuration-Spacecraft Bus–Payload–Requirements and constraints– Initial configuration decisions and Trade-offs–	
	2.1	Spacecraft configuration process– Subsystem layout–Types of Satellites– Types of Orbits-Applications.	
2.0		**Communication and Network systems**	**6**
2	2.1	Orbit and Description: A brief History of Satellite Communication, Satellite Frequency bands, Satellite Systems, Applications, Orbital Period and Velocity,	
	2.2	Effects of Orbital inclination, Azimuth and Elevation, Coverage and Slant range, Eclipse, Orbital perturbations, Placement of a Satellite in a Geo-Stationary Orbit.	
3.0		**Attitude And Orbit Control System**	**6**
3	3.1	Coordinate system –AOCS requirements–Environment effects – Attitude stabilization – Attitude sensors –Actuators–Orbit Control-Design of control algorithms	
4.0		**Propulsion Systems, Structures and Thermal Control**	**6**
4	4.1	Propulsion systems–Thermodynamic- Electrodynamic propellant systems – Design of Spacecraft structure– Structural elements–Material selection– Environmental Loads-guiding factors– Structural fabrication– Thermal control techniques– Active –Passive thermal control techniques-Heat balance equation	
5.0		**Telemetry Systems**	**6**
5	5.1	Base Band Telemetry system– Modulation– TT system–Telecommand system– Ground Control Systems	

Text Books

1. Space Mission Analysis and Design (Third Edition) by James R.Wertz and Wiley J.Larson – 1999.
2. James R.Wertz "Spacecraft Attitude Determination and Control", Kluwer Academic Publisher, 1988.

References

1. Marcel J.Sidi "Spacecraft Dynamics and Control", Cambridge University press, 1997.
2. Lecture notes on "Satellite Architecture", ISRO Satellite Centre Bangalore – 560 017

Internal Assessment (T1, T2 and FET)

1. T2 should be based on First to Fourth modules, for 10 marks.
2. FET shall be assessed for 5 marks separately.

End Semester Examination

1. Question paper will be of 35 marks comprise of 5 questions, each carrying 7 marks
2. The duration of end semester examination shall be Two hours.
3. The students need to solve all questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U11MM022	Spacecraft Communication Systems	02	-	-	02	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					End Semester Exam (ESE)		
		T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
U11MM022	Spacecraft Communication Systems	-	10	5	15	40%	35	40%	50

Course Description

Spacecraft Communication Systems is an advanced course that provides a comprehensive understanding of the principles, technologies, and methodologies behind communication systems used in spacecraft. Participants will explore the intricate design considerations,

Pre-requisites: -

Course Objectives

- Understanding Communication Requirements: Gain insight into the unique communication requirements of spacecraft missions, including data transmission, telemetry, telecommand, and payload operation.
- Recognize the challenges and constraints of communication in the space environment, such as long distances, limited power, and noise.
- Mastery of Communication Fundamentals: Grasp the fundamental concepts of electromagnetic wave propagation, modulation techniques, antenna principles, and link budget analysis.

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Understand**[1] the importance of Spacecraft missions and configurations
- **CO2** **Explain**[1] Spacecraft power system functions and importance
- **CO3** **Explain**[1] spacecraft Attitude and orbital control system design
- **CO4** **Understand**[1] satellite propulsion, thermal control and structure subsystems
- **CO5** **Analyse**[3] satellite telemetry and telecommand systems

Course Contents

Module	Unit	Description	Hours
1.0		**Elements Of Satellite Communications**	**6**
1	1.1	Satellite Systems, Orbital description and Orbital mechanics of LEO, MEO and GSO, Placement of a Satellite in a GSO, Satellite – description of different Communication subsystems, Bandwidth allocation.	
2.0		**Transmission, Multiplexing, Multiple Access and Coding**	**6**
2	2.1	Different modulation and Multiplexing Schemes, Multiple Access Techniques FDMA, TDMA, CDMA, and DAMA, Coding Schemes, Satellite Packet Communications.	
3.0		**Satellite Link Design**	**6**
3	3.1	Basic link analysis, Interference analysis, Rain induced attenuation and interference, Ionosphere characteristics, Link Design with and without frequency reuse.	
4.0		**Satellite Telemetry, Tracking and Telecommand**	**6**
4	4.1	Introduction to telemetry systems - Aerospace transducer - signal conditioning – multiplexing methods - Analog and digital telemetry - Command line and remote-control system	
	4.2	Application of telemetry in spacecraft systems - Base Band Telemetry system - Computer command & Data handling, Satellite command system-Issues.	
5.0		**Applications**	**6**
5	5.1	VSAT-VSAT Technologies, Networks MSS-AMSS, MMSS	

Text Books

1. Wilbur L. Pritchard and Joseph A.Sciulli, Satellite Communication Systems Engineering, Prentice Hall, New Jersey, 1986.
2. Timothy Pratt and Charles W.Bostain, Satellite Communications, John Wiley and Sons, 1986.
3. Tri T Ha, Digital Satellite Communication, Macmillan Publishing Company, 1986.

References

1. Kadish, Jules E, Satellite Communications Fundamentals, Artech House, Boston 2000
2. Lida, Takashi ed.,Satellite communications: System and its design technology, Ohmsha Tokyo 2000
3. Maral, Gerard,Satellite communications systems: Systems, techniques and technology, John Wiley, Newyork 2002.
4. Elbert, Bruce R, Satellite communication applications handbook, Artech house Boston 2004.

Internal Assessment (T1, T2 and FET)

1. T2 should be based on First to Fourth modules, for 10 marks.
2. FET shall be assessed for 5 marks separately.

End Semester Examination

1. Question paper will be of 35 marks comprise of 5 questions, each carrying 7 marks
2. The duration of end semester examination shall be Two hours.
3. The students need to solve all questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U11MM023	Missile Guidance and Control	02	-	-	02	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					End Semester Exam (ESE)		
		T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
U11MM023	Missile Guidance and Control	-	10	5	15	40%	35	40%	50

Course Description

Missile Guidance and Control is an advanced course designed to provide participants with a comprehensive understanding of the principles, technologies, and methodologies involved in guiding and controlling missiles.

Pre-requisites: -

Course Objectives

Gain insight into the fundamental principles of missile guidance, including navigation, target acquisition, tracking, and engagement.

Explore the different guidance laws and algorithms used to guide missiles toward their intended targets, such as proportional navigation, lead pursuit, and command guidance.

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Develop**[2] a generalized missile equations of motion and identify different components of a missile.
- **CO2** **Design**[2] a suitable control law by estimating the aerodynamic forces and moments for the given configuration.
- **CO3** **Compare**[3] different missile guidance laws and select a suitable law based on the type of threat.
- **CO4** **Compare**[3] strategic and conventional missiles and explain the concepts of ballistic and cruise missiles.
- **CO5** **Compare**[3] and select a suitable method of weapon delivery based on the requirements.

Course Contents

Module	Unit	Description	Hours
1.0		**Missile Systems Introduction**	**6**
1	1.1	History of guided missile for defence applications- Classification of missiles– The Generalized Missile Equations of Motion-	
	1.2	Coordinate Systems – Coordinate Transformation – Lagrange's Equations for Rotating Coordinate Systems-Rigid-Body Equations of Motion-missile system elements, missile ground systems.	
2.0		**Missile Airframes, Autopilots and Control**	**6**
2	2.1	Missile aerodynamics - Force Equations, Moment Equations, Phases of missile flight. Missile control configurations. Missile Mathematical Model. Autopilots — Definitions, Types of Autopilots, Example Applications.	
	2.2	Open-loop autopilots. Inertial instruments and feedback. Autopilot response, stability, and agility- Pitch Autopilot Design, Pitch-Yaw-Roll Autopilot Design.	
3.0		**Missile Guidance Laws**	**6**
3	3.1	Tactical Guidance Intercept Techniques, Derivation of the Fundamental Guidance Equations, explicit, Proportional Navigation, Augmented Proportional Navigation, beam riding, bank to turn missile guidance,	
	3.2	Three-Dimensional Proportional Navigation, comparison of guidance system performance, Application of Optimal Control of Linear Feedback Systems.	
4.0		**Strategic Missiles**	**6**
4	4.1	Introduction, The Two-Body Problem, Lambert's Theorem, First-Order Motion of a Ballistic MissileCorrelated Velocity and Velocity- to-Be-Gained Concepts,	
	4.2	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.	

5.0		Weapon Delivery Systems	6
5	5.1	Weapon Delivery Requirements, Factors Influencing Weapon Delivery Accuracy, Unguided Weapons, The Bombing Problem, Guided Weapons, Terminal Guidance	
	5.2	Integrated Flight Control in Weapon Delivery, Missile Launch Envelope, Mathematical Considerations Pertaining to the Accuracy of Weapon Delivery Computations	

Text Books

1. Blakelock, JH, "Automatic Control of Aircraft and Missiles", 2nd edition, John Wiley & Sons, 1991.
2. Siouris, GM, "Missile Guidance and control systems", Springer, 2004.
3. Fleeman, Eugene L, "Tactical Missile Design", 2nd edition, AIAA Education series, 2006.

References

1. Garnell, P, "Guided Weapon Control Systems", 2nd Edition, Pergamon Press, 1980.
2. Joseph Ben Asher and Isaac Yaesh, "Advances in Missile Guidance Theory" AIAA Education series, 1998.
3. Paul Zarchan, "Tactical and Strategic Missile Guidance", AIAA Education series,6th edition, 2013.

Internal Assessment (T1, T2 and FET)

1. T2 should be based on First to Fourth modules, for 10 marks.
2. FET shall be assessed for 5 marks separately.

End Semester Examination

1. Question paper will be of 35 marks comprise of 5 questions, each carrying 7 marks
2. The duration of end semester examination shall be Two hours.
3. The students need to solve all questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U11MM024	Missile Technology	02	-	-	02	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					End Semester Exam (ESE)		
		T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
U11MM024	Missile Technology	-	10	5	15	40%	35	40%	50

Course Description

Missile Guidance and Control is an advanced course designed to provide participants with a comprehensive understanding of the principles, technologies, and methodologies involved in guiding and controlling missiles.

Pre-requisites: -

Course Objectives

- Gain insight into the fundamental principles of missile guidance, including navigation, target acquisition, tracking, and engagement.
- Explore the different guidance laws and algorithms used to guide missiles toward their intended targets, such as proportional navigation, lead pursuit, and command guidance.

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Formulate**[1] the basic equations governing the rocket motion and compare different types of missiles.
- **CO2** **Compare**[2] and select a suitable method of estimating aerodynamic forces and moments acting on the missile
- **CO3** **Compare**[2] the different types of rocket propulsion and explain the importance of multistaging.
- **CO4** **Compare**[2] and select a suitable navigation, guidance and control scheme based on the requirements.
- **CO5** **Formulate**[1] the expressions related to rocket motion to calculate range and velocity for different conditions.

Course Contents

Module	Unit	Description	Hours
1.0		**Missile System**	**6**
1	1.1	Introduction - history - classification - missile system elements, missile ground systems - radars – launchers, coordinate frames –	
	1.2	Coordinate transformation, Equations of Motion – basics of trajectory dynamics.	
2.0		**Aerodynamics**	**6**
2	2.1	Missile aerodynamics- design methodology, aerodynamic prediction method, drag estimation – Aerodynamic loads & performance analysis, wind tunnel and flight testing of missile models and missile prototypes.	
3.0		**Propulsion**	**6**
3	3.1	Principles of jet propulsion and rocketry, nozzle theory and performance parameters of solid rockets and ramjet and compound jet engines	
	3.2	Evaluation of flight performance - forces acting on vehicle - basic relations of motion - multi stage vehicles	
4.0		**Navigation, Guidance & Control**	**6**
4	4.1	Navigation - types - Inertial - GPS - Radar based terrain mapping, Guidance - explicit - PN –APN - beam riding – CLOS – Q Guidance, control –	
	4.2	Autopilot, and Actuation Systems – hydraulic, pneumatic, electromechanical – RCS.	
5.0		**Missile Trajectory Calculations**	**6**
5	5.1	Vertical, inclined and gravity turn trajectories – determination of range and altitude- Two body problem - numerical computation of ballistic trajectories – Rocket dispersion	

Text Books

1. Cornelisse,JW, "Rocket Propulsion and Space Dynamics", J.W. Freeman & Co., Ltd., London, 1982.
2. Siouris, GM, "Missile Guidance and control systems", Springer, 2004
3. Chin, S.S. Missile Configuration Design, McGraw Hill, 1961. 4. Inc., 1963

References

1. Frederick White, J. Flight Performance Handbook for Powered Flight Operations, John Wiley & Sons,
2. Garnel, Guided Weapon Control Systems, 2nd Edition, Pergamon Press, 1980.
3. Merrill, G. Dictionary of Guided Missiles and Space Craft, D. Van Nostrand and Company, Inc,1959.
4. Paul Zarchan, "Tactical and Strategic Missile Guidance", AIAA Education series,6th edition, 2013.

Internal Assessment (T1, T2 and FET)

1. T2 should be based on First to Fourth modules, for 10 marks.
2. FET shall be assessed for 5 marks separately.

End Semester Examination

1. Question paper will be of 35 marks comprise of 5 questions, each carrying 7 marks
2. The duration of end semester examination shall be Two hours.
3. The students need to solve all questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U11MM025	Aerospace Guidance and Control	02	-	-	02	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					End Semester Exam (ESE)		
		T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
U11MM025	Aerospace Guidance and Control	-	10	5	15	40%	35	40%	50

Course Description

The Aerospace Guidance and Control course is designed to provide participants with a comprehensive understanding of the principles, methodologies, and technologies involved in guiding and controlling aerospace vehicles, including aircraft, spacecraft, and missiles.

Pre-requisites: -

Course Objectives

- Gain a solid understanding of the fundamental concepts, terminology, and objectives related to aerospace guidance and control.
- Develop a foundational knowledge of the principles of guidance, navigation, and control as they apply to aerospace vehicles.

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Explain**[1] the equations governing the aircraft dynamics and the process of linearizing them.
- **CO2** **Define**[1] the various guidance schemes and requirements for aircrafts and missiles.
- **CO3** **Apply**[1] the principle of stability and control augmentation systems
- **CO4** **Analyze**[3] the oscillatory modes and methods of suppressing them
- **CO5** **Design**[2] the controller for lateral, longitudinal and directional control of aircrafts.

Course Contents

Module	Unit	Description	Hours
1.0		**Introduction**	**6**
1	1.1	Introduction to Guidance and control - Definition, Historical background – Coordinate Frame -	
	1.2	Equations of motion – Linearization, Fundamentals of attitude estimation, using Euler's and Quaternion Technique.	
2.0		**Augmentation Systems**	**6**
2	2.1	Need for automatic flight control systems, First order system and second order system and its equation. Types of Feedback Technique, Control augmentation systems,	
	2.2	Design of Limited authority and Full Authority Augmentation systems - Effects of various feedback in longitudinal and later control system. Stability augmentation systems, Gain scheduling concepts.	
3.0		**Longitudinal Autopilot**	**6**
3	3.1	Displacement Autopilot -Pitch Orientation Control system, Pitch rate Control system Acceleration Control System, Importance of Pitch, roll and Yaw damper control system,	
	3.2	Velocity Control system, Mach control system, Altitude Control system, Angle of attack control system, Glide Slope Coupler and Automatic Flare Control and Flight path stabilization, Longitudinal control law design using root locus and Bode technique	
4.0		**Lateral Autopilot**	**6**
4	4.1	Damping of the Dutch Roll, Methods of Obtaining Coordination, Yaw Orientation Control system, turn compensation,	

	4.2	Automatic lateral Beam Guidance. Introduction to Fly-by-wire flight control systems, Lateral control law design using root locus and Bode technique	
5.0		**Missile and Launch Vehicle Guidance**	**6**
5	5.1	Operating principles and design of guidance laws, homing guidance laws- short range, Launch Vehicle- Operating environment Mission Design,	
	5.2	Implicit guidance schemes, Explicit guidance, Q guidance schemes, Trajectory design and Flight sequence, Navigation guidance and control aspects.	

Text Books

1. Blake Lock, J.H Automatic control of Aircraft and missiles, John Wiley Sons, New York, 1990.
2. Thomas R. Yechout, Steven L. Morris, David E. Bossert, Wayne F. Hallgren, James K. Hall— Introduction to Aircraft Flight Mechanics, AIAA Education series, 2014
3. Collinson R.P.G, 'Introduction to Avionics', Chapman and Hall, India, 1996.
4. Garnel. P. & East. D. J, 'Guided Weapon control systems', Pergamon Press, Oxford, 1977.

References

1. Michael V. Cook 'Flight Dynamics Principles: A Linear Systems Approach to Aircraft Stability and Control', Elsevier, 2013
2. Nelson R.C, 'Flight stability & Automatic Control', McGraw Hill, 1989.
3. Pierre T. Kabamba, Anouck R. Girard. 'Fundamentals of Aerospace Navigation and Guidance', Cambridge university press, 2014
4. Stevens B.L & Lewis F.L, 'Aircraft control & simulation', John Wiley Sons, New York, 1992
5. B.N Suresh & K.Sivan, Integrated design for space transportation system', springer 2015.

Internal Assessment (T1, T2 and FET)

1. T2 should be based on First to Fourth modules, for 10 marks.
2. FET shall be assessed for 5 marks separately.

End Semester Examination

1. Question paper will be of 35 marks comprise of 5 questions, each carrying 7 marks
2. The duration of end semester examination shall be Two hours.
3. The students need to solve all questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U11MM026	Space Flight Dynamics	02	-	-	02	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					End Semester Exam (ESE)		
		T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
U11MM026	Space Flight Dynamics	-	10	5	15	40%	35	40%	50

Course Description

This course provides an in-depth exploration of the dynamics of space flight, focusing on the mathematical principles and computational techniques used to model and analyze the motion of spacecraft in various celestial environments. Topics covered include orbital mechanics, spacecraft trajectory design, attitude dynamics, orbital maneuvers, gravitational forces, perturbation theory, mission planning, and interplanetary navigation..

Pre-requisites: -

Course Objectives

- Gain a deep understanding of the laws governing the motion of objects in space, including Kepler's laws, Newton's laws of motion, and the gravitational forces acting on spacecraft.
- Learn how to analyze spacecraft trajectories in various celestial environments, including circular, elliptical, and interplanetary orbits, using mathematical models and computational tools.

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Explain**^{2} basics of astronomy and space time systems.
- **CO2** **Analyze**^{4}different orbits using two body orbital mechanics
- **CO3** **Apply**^{3} concept of Orbital Maneuver and mechanics to solve the problems associated with them.
- **CO4** **Discuss**^{2}the significance of orbital perturbations in different calculations.
- **CO5** **Apply**^{3} principle of trajectories and their types with mission planning perspective

Course Contents

Module	Unit	Description	Hours
1.0		**Introduction to Astronomy**	**6**
1	1.1	Solar system, comets and meteors, Kepler's laws and Newton's law of gravitation, concept of celestial sphere, vernal equinox, ecliptic.	
	1.2	Coordinate systems, ECI system, geographic coordinate system, azimuth elevation coordinate system, ecliptic system, Time systems-sidereal time, mean solar time, universal time, ephemeris time. Effect of orbital altitude on satellite lifetimes.	
2.0		**Two Body Orbital Mechanics**	**6**
2	2.1	N-body problem, two-body problem-simplifying assumptions. Equations of relative motion. Constants of the motion-conservation of angular momentum.	
3.0		**Trajectory Motion**	**6**
3	3.1	Trajectory equation, elliptical orbit-Geometry of the ellipse, period of an elliptical orbit, circular orbit, parabolic orbit, hyperbolic orbit. Geometry of the hyperbola, hyperbolic excess speed, Basic Problems associated with two-body problem.	
4.0		**Basic Orbital Manoeuvre**	**6**
4	4.1	Low altitude earth orbits, effect of orbital altitude on satellite lifetimes, direct ascent to orbit. High altitude earth orbits, the synchronous satellite, launching a high-altitude satellite. between circular orbits.	
5.0		**Orbital Perturbations**	**6**
5	5.1	General overview of orbit perturbations, Earth Gravity Harmonics, Luni, solar Gravitational attractions, Solar Radiation Pressure Effects,	
	5.2	Atmospheric drag effects, Tidal friction effects and Mutual Gravitational attraction. Earth's Oblations (J2) effects, Critical Inclination. Sun- synchronous orbits, J3 effects and frozen orbit.	

Text Books

1. Bate,R.R.,Mueller,D.D.andWhite,J.E., FundamentalsofAstrodynamics, DoverPublications

References

1. Wiesel, W.E.,SpaceflightDynamics,2nd Edition, McGraw- Hill,NewYork,1995.
2. Hale,F.J., Introduction to Space Flight, PrenticeHall, 1994.

Internal Assessment (T1, T2 and FET)

1. T2 should be based on First to Fourth modules, for 10 marks.
2. FET shall be assessed for 5 marks separately.

End Semester Examination

1. Question paper will be of 35 marks comprise of 5 questions, each carrying 7 marks
2. The duration of end semester examination shall be Two hours.
3. The students need to solve all questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

Track III: Minor in Drone Technology				
Minor	**Sr. No**	**Code**	**Title of the Course**	**Credits**
I	1.	U11MM031	Introduction to Drones	2
II	2.	U11MM032	Theory of Drones	2
III	3.	U11MM033	Engineering Materials for Drones	2
IV	4.	U11MM034	Drones Electronics	2
V	5.	U11MM035	Drones Manufacturing Processes	2
VI	6.	U11MM036	Drone metrology, assembly and maintenance	2

Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U11MM031	Introduction to Drones	02	-	-	02	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					End Semester Exam (ESE)		
		T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
U11MM031	Introduction to Drones	-	10	5	15	40%	35	40%	50

Course Description

This Course involved primarily in designing aircraft and propulsion systems and in studying the aerodynamic performance of aircraft and construction materials.

Pre-requisites: -

Course Objectives

- To expose students to concepts needed in modelling and analyzing an unmanned system.
- To expose students to the design and development of UAV.
- To expose students to the type of payloads used in UAV.
- To study path planning
- To understand the avionics hardware used in the UAV

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Design**[2] UAV system
- **CO2** **Prepare**[2] preliminary design requirements for an unmanned aerial vehicle.
- **CO3** **Identify**[3] different hardware for UAV
- **CO4** **Perform**[3] system testing for unmanned aerial vehicles
- **CO5** **Design**[2] micro aerial vehicle systems by considering practical limitations.

Course Contents

Module	Unit	Description	Hours
1.0		**Introduction to UAV**	**6**
1	1.1	History of UAV –classification – Introduction to Unmanned Aircraft Systems--models and prototypes – System Composition-applications	
2.0		**The Design of UAV Systems**	**6**
2	2.1	Introduction to Design and Selection of the System- Aerodynamics and Airframe Configurations Characteristics of Aircraft Types	
	2.2	Design Standards and Regulatory Aspects-UK,USA and Europe Design for Stealth--control surfaces-specifications.	
3.0		**Avionics Hardware**	**6**
3	3.1	Autopilot – AGL-pressure sensors-servos-accelerometer –gyros-actuators	
	3.2	Power supply processor, integration, installation, configuration, and testing.	
4.0		**Communication Payloads and Controls**	**6**
4	4.1	Payloads-Telemetry-tracking-Aerial photography-controls-PID feedback-radio control frequency range	
	4.2	Modems-memory system-simulation-ground test-analysis-trouble shooting.	
5.0		**The Development of UAV Systems**	**6**
5	5.1	Waypoints navigation-ground control software- System Ground Testing- System In-flight Testing	
	5.2	Future Prospects and Challenges-Case Studies – Mini and Micro UAVs.	

Text Books

1. Paul G Fahlstrom, Thomas J Gleason, "Introduction to UAV Systems", UAV Systems, Inc, 1998
2. Reg Austin "Unmanned Aircraft Systems UAV design, development and deployment", Wiley, 2010.
3. Stephen.A. Brandt, Introduction to aeronautics: A design perspective, 2nd edition, AIAA Education Series, 2004.

References

1. Dr. Armand J. Chaput, "Design of Unmanned Air Vehicle Systems", Lockheed Martin Aeronautics Company, 2001
2. Kimon P. Valavanis, "Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy", Springer, 2007
3. Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 1998.

Internal Assessment (T1, T2 and FET)

1. T2 should be based on First to Fourth modules, for 10 marks.
2. FET shall be assessed for 5 marks separately.

End Semester Examination

1. Question paper will be of 35 marks comprise of 5 questions, each carrying 7 marks
2. The duration of end semester examination shall be Two hours.
3. The students need to solve all questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U11MM032	Theory of Drones	02	-	-	02	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					End Semester Exam (ESE)		
		T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
U11MM032	Theory of Drones	-	10	5	15	40%	35	40%	50

Course Description

This course provides an in-depth exploration of the theory, principles, and applications of drones (Unmanned Aerial Vehicles - UAVs). Drones have revolutionized various industries, including agriculture, filmmaking, surveillance, and delivery services, and understanding their underlying principles is essential for professionals and enthusiasts alike.

Pre-requisites:

Course Objectives

- The objective of this subject is to teach the students fundamental mechanical engineering concepts, applied to drone engineering.

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Identify**[1] the principles of drones.
- **CO2** **Discuss**[3] centre of gravity of drones
- **CO3** **Explain**[3] forces in drones
- **CO4** **Discuss**[3] stability of the drones
- **CO5** **Explain**[3] dynamic conditions of drones.

Course Contents

Module	Unit	Description	Hours
1.0		**Drone Mechanics**	**5**
1	1.1	Drone Mechanics: -concepts of engineering mechanics, definition of mechanics, statics, dynamics, applications of engineering mechanics in practical fields. Free body diagrams types of loads, of a force system, equilibrium of coplanar force systems.	
	1.2	Principles and concept of moments and its applications, Methods for finding resultant	
2.0		**Centre of Gravity**	**7**
2	2.1	Centre of gravity:-concepts, definition of centroid of plane figures and centre of gravity of symmetrical solid bodies,	
	2.2	Determination of centroid of plane and composite lamina using first principle, centroid of areas with removed portions .CG of solid bodies like cone, cylinder, hemisphere and sphere, bodies with removed portions.	
3.0		**Force Analysis in Drones**	**7**
3	3.1	Force analysis in drones: - force analysis in drones, forces and force systems during drone operations,	
	3.2	Aerodynamics of drones-dynamics of aerial systems, forces of flight, principle axes and rotation of aerial systems.	
4.0		**Stability and Control**	**5**
4	4.1	Stability and control of drones:-stability and control of drones, force balancing of rotating masses.	
	4.2	Flywheels:-Principles and applications of flywheels.	
5.0		**Dynamics of Machines**	**6**
5	5.1	Dynamics of machines:-static and dynamic force analysis, gyroscopic action in machines,	
	5.2	Gyroscopic motions and their variations, concept of gyroscopic couple.	

Text Books

1. D.R. Malhotra & Nitin Kr. Malhotra. The Theory of Machines. 2016th Edition - 1 January 1988
2. R.S.Khurmi Engineering Mechanics, S Chand Publishing 22ED 1 January 2018.
3. R.K.Rajput, Applied Mechnaics, Laxmi Publications, 3rd ED, 2016

Internal Assessment (T1, T2 and FET)

1. T2 should be based on First to Fourth modules, for 10 marks.
2. FET shall be assessed for 5 marks separately.

End Semester Examination

1. Question paper will be of 35 marks comprise of 5 questions, each carrying 7 marks
2. The duration of end semester examination shall be Two hours.
3. The students need to solve all questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U11MM033	Engineering Materials for Drones	02	-	-	02	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					End Semester Exam (ESE)		
		T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
U11MM033	Engineering Materials for Drones	-	10	5	15	40%	35	40%	50

Course Description

The "Materials for Drones" course offers a comprehensive study of the materials science and engineering principles essential for the design, fabrication, and maintenance of drones (Unmanned Aerial Vehicles - UAVs). Understanding the properties and characteristics of materials used in drone construction is critical for optimizing performance, durability, and efficiency.

Pre-requisites:

Course Objectives

- The objective of this course is to train the students about conventional & advanced engineering materials specially pertaining to drones.

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Understand**[1] the engineering materials and their properties
- **CO2** **Learn**[1] the history of material origin for unmanned aerial vehicles
- **CO3** **Understand**[1] various issues of usage of the materials
- **CO4** **Gain**[1] knowledge of the conventional and advanced drone materials
- **CO5** **Gain**[1] expertise in drone frame material selection

Course Contents

Module	Unit	Description	Hours
1.0		**Introduction**	**5**
1	1.1	Introduction, history of material origin, scope of material science, overview of various engineering materials and their applications,	
	1.2	Classification of materials and their mechanical, thermal, chemical and electrical properties, present and future needs of materials, various issues of material usage-economical, environmental and social.	
2.0		**Plastics , Composites and Ceramics**	**5**
2	2.1	Plastics-classification, applications and uses of thermoplastic.	
	2.2	Composites-classification and importance of composites, phases of composite materials primary and secondary phase, introduction to fiber, particle, flake, laminar and filled composites.	
	2.3	Ceramics-Adhesives – Classification, properties and applications, Smart materials - Properties and applications.	
3.0		**Advanced materials**	**6**
3	3.1	Advanced material-Basic material characteristics, relative ranking of characteristic material properties,	
	3.2	Top materials used in drones-carbon fiber, carbon reinforced composites, thermoplastics, aluminium and its alloys, titanium alloys.	
4.0		**Drone frame Materials**	**7**
4	4.1	Drone frame materials-properties of balsa wood, PLA/ABS, aluminum and carbo fibbers,	
	4.2	Advantages and limitations of above materials and idea of cost estimation	
5.0		**Materials for propellers**	**7**
5	5.1	Materials for propellers and guide materials-properties, uses, merits and demerits of polycarbonates, nylon carbon composites and thermoplastics.	

Text Books

1. George F. titter Ton. Aircraft materials and processes, 5thedn, Himalayan books
2. Jones R.M. Mechanics of composite materials, McGraw-hill, Kogakusha Ltd., Tokyo
3. Van Vlack.L.H., Materials Science for Engineers, Addison Wesley, 1985.

References

1. Van Vlack.L.H., Materials Science for Engineers, Addison Wesley, 1985.

Internal Assessment (T1, T2 and FET)

1. T2 should be based on First to Fourth modules, for 10 marks.
2. FET shall be assessed for 5 marks separately.

End Semester Examination

1. Question paper will be of 35 marks comprise of 5 questions, each carrying 7 marks
2. The duration of end semester examination shall be Two hours.
3. The students need to solve all questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U11MM064	Drones Electronics	03	-	-	03	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					End Semester Exam (ESE)		
		T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
U11MM064	Drones Electronics	-	10	5	15	40%	35	40%	50

Course Description

Drone electronics is a specialized field of electronics engineering focused on the design, development, and integration of electronic systems and components essential for the operation of drones (Unmanned Aerial Vehicles - UAVs). These electronic systems play a crucial role in controlling, navigating, and powering drones, enabling them to perform a wide range of tasks across various industries and applications.

Pre-requisites: Basic Knowledge in Electronics, Voltage etc.

Course Objectives

- Understanding Basic Electronic Components
- Comprehending Circuit Design and Analysis

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Identify**[1] the battery to be used for UAV application.
- **CO2** **Understand**[1] working of motor that can be used in UAV.
- **CO3** **Explain**[1] the basic concept of communication system.
- **CO4** **Find**[1] out best communication device for given project.
- **CO5** **Understand**[1] different types of sensors used in drone technology.

Course Contents

Module	Unit	Description	Hours
1.0		**Battery and its management**	**9**
1	1.1	Introduction of Battery, Description of Li-Po Battery, Charging / Discharging of Battery. Back up, Ratings, Shelf Life, Maintenance and safety of Battery. Selection criteria of Battery for Drone application.	
2.0		**Motors**	**9**
2	2.1	Difference between AC and DC motors and steeper motor, Brushed and Brushless motors, brief idea of motor capabilities for a drone build.	
	2.2	Selection criterion of motor for drone application. Working and application of BLDC motor.	
3.0		**Sensors**	**9**
3	3.1	Wi fi devices, RADAR and range finder, GPS receiver, Gyro sensor, Speed and Distance sensor, Image sensor, TOF sensor, Chemical sensor.	
	3.2	Cameras in drones and selection criteria of camera for different range. Barometers, Accelerometer, Magnetometer, remote control for drone.	
4.0		**Radio Control System**	**9**
4	4.1	Introduction of radio control system, Controllers, Transmitter and Receiver, Flight Controllers, Electronic Speed Controller, SIMONK & BLHelifirmware software, ,Battery Eliminator Circuit, Universal Battery Eliminator Circuit , OPTO Coupler.	
5.0		**Connections and Interfaces of Devices in Drone and Drone Programming**	9
5	5.1	Brief introduction of RS232, RS422, RS485, UART ports. Different types of connectors and their specifications. Microcontroller interfacing techniques.	
	5.2	Introduction to programming language used in drone : C and Python. Installation of cards. Auto Pilot software i.e. Ardupilot, Openpilot.	

Text Books

1. Robert L. Boylestad / Louis Nashelsky"Electronic Devices and Circuit Theory", Latest Edition, Pearson Education.
2. D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill.
3. J.B. Gupta, Basic Electrical Engineering, Kataria& Sons.

References

1. An Introduction to Analog and Digital Communication by Simon Haykin, Wiley Student Edition.
2. Electronics Communication System by Kennedy, Tata McGraw Hill Education Pvt Ltd, New Delhi.

Internal Assessment (T1, T2 and FET)

1. T2 should be based on First to Fourth modules, for 10 marks.
2. FET shall be assessed for 5 marks separately.

End Semester Examination

1. Question paper will be of 35 marks comprise of 5 questions, each carrying 7 marks
2. The duration of end semester examination shall be Two hours.
3. The students need to solve all questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U11MM035	Drones Manufacturing Processes	02	-	-	02	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					End Semester Exam (ESE)		
		T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
U11MM035	Drones Manufacturing Processes	-	10	5	15	40%	35	40%	50

Course Description

This course imparts knowledge of drone parts and components and the principles of flying applied to the drone technology. It takes the technician through the process of understanding the setting up of drone parameters through the use of a simulator

Pre-requisites: Basic workshop knowledge

Course Objectives

- Gain practical proficiency with hands-on flying, and learn about flight weather data interpretation, flight planning, airspace, map reading, and use of platforms to perform video and mapping tasks.
- The course is intended for people who want to become more proficient pilots, flying safely and legally.

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Define**[1] deep and real-world knowledge of manufacturing limitations of drones.
- **CO2** **Perform**[3] turning, step turning, taper turning, threading and knurling operation on lathe machine.
- **CO3** **Explain**[2] uses of lathe accessories and different types of lathes.
- **CO4** **Perform**[1] drilling, reaming, counter boring, counter sinking and tapping operations on drilling machine.
- **CO5** **Define**[1] milling machine accessories and attachments.

Course Contents

Module	Unit	Description	Hours
1.0		**Drone structure making**	**9**
1	1.1	Name and use of raw materials used in carpentry shop: wood &alternative materials, Names, uses, care and maintenance of hand tools such as different types of Saws, C-Clamp, Chisels, Mallets, Carpenter's vices, marking gauges,	
	1.2	Try-squares, Rulers and other commonly used tools and materials used in Carpentry shop by segregating as cutting tools, supporting tools, holding tools, measuring tools etc., Different types of Timbers, their properties, uses & defects. Seasoning of wood.	
2.0		**Painting and polishing shop**	**9**
2	2.1	Introduction of paints, varnishes, Reason for surface preparation.	
	2.2	Advantages of Painting, other method of surface coating ie. Electro-plating etc.	
3.0		**Electrical shop**	**9**
3	3.1	Study, demonstration and identification of common electrical materials with standard ratings and specifications such as wires, cables, switches, fuses, cleats, clamps and allied items, tools and accessories	
4.0		**Metal cutting**	**9**
4	4.1	Principle of lathe operations like turning, drilling, shaping, threading, milling, grinding, introduction to cutting fluids and lubricants, brief introduction to single point cutting tools and multi point cutting tools.	
5.0		**Metal joining**	9
5	5.1	Introduction, types and importance of welding as compared to other material joining processes, welding joints and welding positions, materials to be welded.	

Text Books

1. S.K. Hajra Choudhury, Workshop technology, Media Promoters & Publishers Pvt Ltd.
2. K.Venkat reddy, Manual of workshop practice, 9788178003078
3. B.S.Raghuvanshi, Workshop technology, Dhanpatrai and company limited

References

1. H.S.Bawa ,Workshop technology,TMH publishers.

Internal Assessment (T1, T2 and FET)

1. T2 should be based on First to Fourth modules, for 10 marks.
2. FET shall be assessed for 5 marks separately.

End Semester Examination

1. Question paper will be of 35 marks comprise of 5 questions, each carrying 7 marks
2. The duration of end semester examination shall be Two hours.
3. The students need to solve all questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U11MM036	Drone metrology, assembly and maintenance	02	-	-	02	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					End Semester Exam (ESE)		
		T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
U11MM036	Drone metrology, assembly and maintenance	-	10	5	15	40%	35	40%	50

Course Description

This course provides in-depth training on the critical aspects of drone technology, focusing specifically on metrology, assembly, and maintenance. Students will gain practical skills and knowledge essential for ensuring the accurate operation, proper assembly, and effective maintenance of drones across various industries.

Pre-requisites: Basic Drone Knowledge

Course Objectives

- Understand the principles of drone metrology and its importance in ensuring accurate data collection and measurement.
- Learn the process of drone assembly, including component selection, integration, and quality control measures.
- Develop proficiency in conducting routine maintenance tasks to prolong the lifespan and optimize the performance of drones.

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Define**[1] and exercise various measuring devices and metrological aspects in drone engineering
- **CO2** **Perform**[2] assembly practice of micro and nano drones.
- **CO3** **Define**[1] chronological and technological development of drone sensors
- **CO4** **Understand**[2] basic rules and instruments in mechanical measurements
- **CO5** **Perform**[2] drone maintenance and understand its challenges

Course Contents

Module	Unit	Description	Hours
1.0		**Introduction to Metrology**	**6**
1	1.1	Introduction and scope of metrology in drone technology: - basic concepts of metrology, classifications of measurements, need of measurements in drone technology,	
	1.2	Types of measuring instruments, their accuracy and precision parameters.	
2.0		**Development of Drone**	**6**
2	2.1	Development and need of drone sensors: -micro electro mechanical systems (MEMS) based sensors like accelerometer, barometer, gyro sensors and magneto meter, stabilization of drones using above sensors.	
3.0		**Drone sensors**	**5**
3	3.1	Special purpose drone sensors: -need and application of distance sensors, brief introduction to light-pulse distance sensing (laser), radio detection and ranging, sonar pulse distance sensing (ultrasonic), time of flight (TOF) sensors, thermal and chemical sensors.	
4.0		**Assembly of drones**	**6**
4	4.1	Assembly of drones:-concept of interchangeability, principles of gauging and their applicability in drone assembly, parameters and profile measurements of standard propellers, limits, fits and tolerances. Concepts of drones' assembly using three dimensional modelling.	
5.0		**Metal joining**	**7**
5	5.1	Drone maintenance: -need and scope of drone maintenance, types of maintenance, routine drone maintenance and its checklist-introduction, recording basic details,	
	5.2	Structural inspections, battery check, software/firmware (description not required). Finishing upforward maintenance report, maintenance challenges in small UAVs.	

Text Books

1. Dr. E. V. Raghava Rao, Dr. S A Rahim , Advance Methods and Techniques in Drone Surveying Book | Simplified Method of Constructing, Handling, and Maintaining a Drone, Prashas Research Consulting Pvt.

References

1. Sachi Nandan Mohanty, J.V.R. Ravindra, G. Surya Narayana, Chinmaya Ranjan Pattnaik, Y. Mohamed Sirajudeen,Drone Technology: Future Trends and Practical Applications, 22 May 2023

Internal Assessment (T1, T2 and FET)

1. T2 should be based on First to Fourth modules, for 10 marks.
2. FET shall be assessed for 5 marks separately.

End Semester Examination

1. Question paper will be of 35 marks comprise of 5 questions, each carrying 7 marks
2. The duration of end semester examination shall be Two hours.
3. The students need to solve all questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Track IV: Minor in Drone Technology				
Minor	**Sr. No**	**Code**	**Title of the Course**	**Credits**
I	1.	U11MM061	Introduction to Drones	2
II	1.	U11MM062	Theory of Drones	3
	2.	U11MM066	Basic Drones Lab	1
III	1.	U11MM063	Engineering Materials for Drones	3
	2.	U11MM067	Engineering Materials for Drones Lab	1
IV	1.	U11MM064	Drones Electronics	3
	2.	U11MM068	Drones Electronics Lab	1
V	1.	U11MM065	Drones Manufacturing Processes	3
	2.	U11MM069	Drones Manufacturing Processes Lab	1

Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U11MM061	Introduction to Drones	02	-	-	02	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					End Semester Exam (ESE)		
		T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
U11MM061	Introduction to Drones	-	10	5	15	40%	35	40%	50

Course Description

This Course involved primarily in designing aircraft and propulsion systems and in studying the aerodynamic performance of aircraft and construction materials.

Pre-requisites: -

Course Objectives

- To expose students to concepts needed in modelling and analyzing an unmanned system.
- To expose students to the design and development of UAV.
- To expose students to the type of payloads used in UAV.
- To study path planning
- To understand the avionics hardware used in the UAV

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Design**[2] UAV system
- **CO2** **Prepare**[2] preliminary design requirements for an unmanned aerial vehicle.
- **CO3** **Identify**[3] different hardware for UAV
- **CO4** **Perform**[3] system testing for unmanned aerial vehicles
- **CO5** **Design**[2] micro aerial vehicle systems by considering practical limitations.

Course Contents

Module	Unit	Description	Hours
1.0		**Introduction to UAV**	**6**
1	1.1	History of UAV –classification – Introduction to Unmanned Aircraft Systems--models and prototypes – System Composition-applications	
2.0		**The Design of UAV Systems**	**6**
2	2.1	Introduction to Design and Selection of the System- Aerodynamics and Airframe Configurations Characteristics of Aircraft Types	
	2.2	Design Standards and Regulatory Aspects-UK,USA and Europe Design for Stealth--control surfaces-specifications.	
3.0		**Avionics Hardware**	**6**
3	3.1	Autopilot – AGL-pressure sensors-servos-accelerometer –gyros-actuators	
	3.2	Power supply processor, integration, installation, configuration, and testing.	
4.0		**Communication Payloads and Controls**	**6**
4	4.1	Payloads-Telemetry-tracking-Aerial photography-controls-PID feedback-radio control frequency range	
	4.2	Modems-memory system-simulation-ground test-analysis-trouble shooting.	
5.0		**The Development of UAV Systems**	**6**
5	5.1	Waypoints navigation-ground control software- System Ground Testing- System In-flight Testing	
	5.2	Future Prospects and Challenges-Case Studies – Mini and Micro UAVs.	

Text Books

1. Paul G Fahlstrom, Thomas J Gleason, “Introduction to UAV Systems”, UAV Systems, Inc, 1998
2. Reg Austin “Unmanned Aircraft Systems UAV design, development and deployment”, Wiley, 2010.
3. Stephen.A. Brandt, Introduction to aeronautics: A design perspective, 2nd edition, AIAA Education Series, 2004.

References

1. Dr. Armand J. Chaput, “Design of Unmanned Air Vehicle Systems”, Lockheed Martin Aeronautics Company, 2001
2. Kimon P. Valavanis, “Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy”, Springer, 2007
3. Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 1998.

Internal Assessment (T1, T2 and FET)

1. T2 should be based on First to Fourth modules, for 10 marks.
2. FET shall be assessed for 5 marks separately.

End Semester Examination

1. Question paper will be of 35 marks comprise of 5 questions, each carrying 7 marks
2. The duration of end semester examination shall be Two hours.
3. The students need to solve all questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U11MM062	Theory of Drones	03	-	-	03	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					End Semester Exam (ESE)		
		T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
U11MM062	Theory of Drones	10	10	5	25	40%	50	40%	75

Course Description

This course provides an in-depth exploration of the theory, principles, and applications of drones (Unmanned Aerial Vehicles - UAVs). Drones have revolutionized various industries, including agriculture, filmmaking, surveillance, and delivery services, and understanding their underlying principles is essential for professionals and enthusiasts alike.

Pre-requisites:

Course Objectives

- The objective of this subject is to teach the students fundamental mechanical engineering concepts, applied to drone engineering.

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Identify**[1] the principles of drones.
- **CO2** **Discuss**[3] centre of gravity of drones
- **CO3** **Explain**[3] forces in drones
- **CO4** **Discuss**[3] stability of the drones
- **CO5** **Explain**[3] dynamic conditions of drones.

Course Contents

Module	Unit	Description	Hours
1.0		**Drone Mechanics**	**9**
1	1.1	Drone Mechanics:-concepts of engineering mechanics, definition of mechanics, statics, dynamics, applications of engineering mechanics in practical fields. Free body diagrams types of loads, of a force system, equilibrium of coplanar force systems.	
	1.2	Principles and concept of moments and its applications, Methods for finding resultant	
2.0		**Centre of Gravity**	**9**
2	2.1	Centre of gravity:-concepts, definition of centroid of plane figures and centre of gravity of symmetrical solid bodies,	
	2.2	Determination of centroid of plane and composite lamina using first principle, centroid of areas with removed portions .CG of solid bodies like cone, cylinder, hemisphere and sphere, bodies with removed portions.	
3.0		**Force Analysis in Drones**	**9**
3	3.1	Force analysis in drones: - force analysis in drones, forces and force systems during drone operations,	
	3.2	Aerodynamics of drones-dynamics of aerial systems, forces of flight, principle axes and rotation of aerial systems.	
4.0		**Stability and Control**	**9**
4	4.1	Stability and control of drones:-stability and control of drones, force balancing of rotating masses.	
	4.2	Flywheels:-Principles and applications of flywheels.	
5.0		**Dynamics of Machines**	9
5	5.1	Dynamics of machines:-static and dynamic force analysis, gyroscopic action in machines,	
	5.2	Gyroscopic motions and their variations, concept of gyroscopic couple.	

Text Books

1. D.R. Malhotra & Nitin Kr. Malhotra. The Theory of Machines. 2016th Edition - 1 January 1988
2. R.S.Khurmi Engineering Mechanics, S Chand Publishing 22ED 1 January 2018.
3. R.K.Rajput, Applied Mechnaics, Laxmi Publications, 3rd ED, 2016

Internal Assessment (T1, T2 and FET)

1. T1 (Test 1) should be based on first two modules and T2 (Test 2) should be based on next two modules, for 10 marks each.
2. FET shall be assessed for 5 marks separately.

End Semester Examination

1. Question paper will be of 50 marks comprise of 5 questions, each carrying 10 marks.
2. The duration of end semester examination shall be Two hours.
3. The students need to solve all 5 questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U11MM066	Basic Drones Lab	-	02	-	-	01	-

Evaluation Scheme

Course Code	Course Name	In Semester Evaluation		End Semester Exam (OE/POE)		
		Term work	Min pass	Marks	Min pass	Total (Marks)
U11MM066	Basic Drones Lab	25	40%	-	-	25

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Gain**[2] practical exposure of relevant drone sciences.
- **CO2** **Discuss**[3] Drones concept

List of Experiments

All the experiments will be based on the course content of **Theory of Drones, U11MM062**

Ex.No	Experiment Name
1	To verify polygon law of forces using Gravesend apparatus.
2	To find out center of gravity of regular lamina
3	To find out centre of gravity of irregular lamina
4	To balance the rotating masses by using single counter mass.
5	To observe gyroscopic motions qualitatively
6	To study the operation and working of rim type flywheel.
7	To study and sketch various frame structure viz. quadcopter frame (plus shape, cross shape and H-shape),hex copter frame (hexa+ and hexa S).
8	Study the components of aircraft Jet engine

Text Books

1. D.R. Malhotra & Nitin Kr. Malhotra. The Theory of Machines. 2016th Edition - 1 January 1988
2. R.S.Khurmi Engineering Mechanics, S Chand Publishing 22ED 1 January 2018.
3. R.K.Rajput, Applied Mechnaics, Laxmi Publications, 3rd ED, 2016

Evaluation Scheme

1. TERM WORK assessment shall be based on the overall performance of the student with every assignment graded from time to time.
2. The grades will be converted to marks as per 'credit and grading system' manual and should be added and averaged.
3. Based on above scheme grading and TERM WORK assessment should be done.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U11MM063	Engineering Materials for Drones	03	-	-	03	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					End Semester Exam (ESE)		
		T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
U11MM063	Engineering Materials for Drones	10	10	5	25	40%	50	40%	75

Course Description

The "Materials for Drones" course offers a comprehensive study of the materials science and engineering principles essential for the design, fabrication, and maintenance of drones (Unmanned Aerial Vehicles - UAVs). Understanding the properties and characteristics of materials used in drone construction is critical for optimizing performance, durability, and efficiency.

Pre-requisites:

Course Objectives

- The objective of this course is to train the students about conventional & advanced engineering materials specially pertaining to drones.

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Understand**[1] the engineering materials and their properties
- **CO2** **Learn**[1] the history of material origin for unmanned aerial vehicles
- **CO3** **Understand**[1] various issues of usage of the materials
- **CO4** **Gain**[1] knowledge of the conventional and advanced drone materials
- **CO5** **Gain**[1] expertise in drone frame material selection

Course Contents

Module	Unit	Description	Hours
1.0		**Introduction**	**9**
1	1.1	Introduction, history of material origin, scope of material science, overview of various engineering materials and their applications,	
	1.2	Classification of materials and their mechanical, thermal, chemical and electrical properties, present and future needs of materials, various issues of material usage-economical, environmental and social.	
2.0		**Plastics , Composites and Ceramics**	**9**
2	2.1	Plastics-classification, applications and uses of thermoplastic.	
	2.2	Composites-classification and importance of composites, phases of composite materials primary and secondary phase, introduction to fiber, particle, flake, laminar and filled composites.	
	2.3	Ceramics-Adhesives – Classification, properties and applications, Smart materials - Properties and applications.	
3.0		**Advanced materials**	**9**
3	3.1	Advanced material-Basic material characteristics, relative ranking of characteristic material properties,	
	3.2	Top materials used in drones-carbon fiber, carbon reinforced composites, thermoplastics, aluminium and its alloys, titanium alloys.	
4.0		**Drone frame Materials**	**9**
4	4.1	Drone frame materials-properties of balsa wood, PLA/ABS, aluminum and carbo fibbers,	
	4.2	Advantages and limitations of above materials and idea of cost estimation	
5.0		**Materials for propellers**	9
5	5.1	Materials for propellers and guide materials-properties, uses, merits and demerits of polycarbonates, nylon carbon composites and thermoplastics.	

Text Books

1. George F. titter Ton. Aircraft materials and processes, 5thedn, Himalayan books
2. Jones R.M. Mechanics of composite materials, McGraw-hill, Kogakusha Ltd., Tokyo
3. Van Vlack.L.H., Materials Science for Engineers, Addison Wesley, 1985.

References

1. Van Vlack.L.H., Materials Science for Engineers, Addison Wesley, 1985.

Internal Assessment (T1, T2 and FET)

1. T1 (Test 1) should be based on first two modules and T2 (Test 2) should be based on next two modules, for 10 marks each.
2. FET shall be assessed for 5 marks separately.

End Semester Examination

1. Question paper will be of 50 marks comprise of 5 questions, each carrying 10 marks.
2. The duration of end semester examination shall be Two hours.
3. The students need to solve all 5 questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U11MM067	Engineering Materials for Drones Lab	-	02	-	-	01	-

Evaluation Scheme

Course Code	Course Name	In Semester Evaluation		End Semester Exam (OE/POE)		
		Term work	Min pass	Marks	Min pass	Total (Marks)
U11MM067	Engineering Materials for Drones Lab	25	40%	-	-	25

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Explain**[2] various materials for drone frames, propellers and guides.
- **CO2** **Discuss**[3] the properties of plastics/ceramics.

List of Experiments

All the experiments will be based on the course content of **Engineering Materials for Drones, U11MM063**

Ex.No	Experiment Name
1	To study and visual inspection of various materials for drone frames, propellers and guides.
2	To study the micro structures of different materials used in drones.
3	To determine the strength of various materials used in drones
4	To study the various properties of plastics/ceramics.
5	To study the various properties of composite materials.
6	To study the different heat treatment processes
7	Practices on various drone assembly materials.

Text Books

1. George F. titter Ton. Aircraft materials and processes, 5thedn, Himalayan books
2. Jones R.M. Mechanics of composite materials, McGraw-hill, Kogakusha Ltd., Tokyo
3. Van Vlack.L.H., Materials Science for Engineers, Addison Wesley, 1985.

References

1. Van Vlack.L.H., Materials Science for Engineers, Addison Wesley, 1985.

Evaluation Scheme

1. TERM WORK assessment shall be based on the overall performance of the student with every assignment graded from time to time.
2. The grades will be converted to marks as per 'credit and grading system' manual and should be added and averaged.
3. Based on above scheme grading and TERM WORK assessment should be done.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U11MM064	Drones Electronics	03	-	-	03	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					End Semester Exam (ESE)		
		T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
U11MM064	Drones Electronics	10	10	5	25	40%	50	40%	75

Course Description

Drone electronics is a specialized field of electronics engineering focused on the design, development, and integration of electronic systems and components essential for the operation of drones (Unmanned Aerial Vehicles - UAVs). These electronic systems play a crucial role in controlling, navigating, and powering drones, enabling them to perform a wide range of tasks across various industries and applications.

Pre-requisites: Basic Knowledge in Electronics, Voltage etc.

Course Objectives

- Understanding Basic Electronic Components
- Comprehending Circuit Design and Analysis

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Identify**[1] the battery to be used for UAV application.
- **CO2** **Understand**[1] working of motor that can be used in UAV.
- **CO3** **Explain**[1] the basic concept of communication system.
- **CO4** **Find**[1] out best communication device for given project .
- **CO5** **Understand**[1] different types of sensors used in drone technology.

Course Contents

Module	Unit	Description	Hours
1.0		**Battery and its management**	**9**
1	1.1	Introduction of Battery, Description of Li-Po Battery, Charging / Discharging of Battery. Back up, Ratings, Shelf Life, Maintenance and safety of Battery. Selection criteria of Battery for Drone application.	
2.0		**Motors**	**9**
2	2.1	Difference between AC and DC motors and steeper motor, Brushed and Brushless motors, brief idea of motor capabilities for a drone build.	
	2.2	Selection criterion of motor for drone application. Working and application of BLDC motor.	
3.0		**Sensors**	**9**
3	3.1	Wi fi devices, RADAR and range finder, GPS receiver, Gyro sensor, Speed and Distance sensor, Image sensor, TOF sensor, Chemical sensor.	
	3.2	Cameras in drones and selection criteria of camera for different range. Barometers, Accelerometer, Magnetometer, remote control for drone.	
4.0		**Radio Control System**	**9**
4	4.1	Introduction of radio control system, Controllers, Transmitter and Receiver, Flight Controllers, Electronic Speed Controller, SIMONK & BLHelifirmware software, ,Battery Eliminator Circuit, Universal Battery Eliminator Circuit , OPTO Coupler.	
5.0		**Connections and Interfaces of Devices in Drone and Drone Programming**	9
5	5.1	Brief introduction of RS232, RS422, RS485, UART ports. Different types of connectors and their specifications. Microcontroller interfacing techniques.	
	5.2	Introduction to programming language used in drone : C and Python. Installation of cards. Auto Pilot software i.e. Ardupilot, Openpilot.	

Text Books

1. Robert L. Boylestad / Louis Nashelsky"Electronic Devices and Circuit Theory", Latest Edition, Pearson Education.
2. D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill.
3. J.B. Gupta, Basic Electrical Engineering, Kataria& Sons.

References

1. An Introduction to Analog and Digital Communication by Simon Haykin, Wiley Student Edition.
2. Electronics Communication System by Kennedy, Tata McGraw Hill Education Pvt Ltd, New Delhi.

Internal Assessment (T1, T2 and FET)

1. T1 (Test 1) should be based on first two modules and T2 (Test 2) should be based on next two modules, for 10 marks each.
2. FET shall be assessed for 5 marks separately.

End Semester Examination

1. Question paper will be of 50 marks comprise of 5 questions, each carrying 10 marks.
2. The duration of end semester examination shall be Two hours.
3. The students need to solve all 5 questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U11MM068	Drones Electronics Lab	-	02	-	-	01	-

Evaluation Scheme

Course Code	Course Name	In Semester Evaluation		End Semester Exam (OE/POE)		
		Term work	Min pass	Marks	Min pass	Total (Marks)
U11MM068	Drones Electronics Lab	25	40%	-	-	25

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Explain**[2] the different drone motors ESC and Trans -Receivers.
- **CO2** **Discuss**[3] the payload and imbalanced payload effect on drone flight.

List of Experiments

All the experiments will be based on the course content of **U11MM064 Drones Electronics.**

, U11PC301

Ex.No	Experiment Name
1	To Study the basic electronic components
2	To Study the different Drone motors.
3	To Study the ESC, Trans-receivers etc.
4	To Study the different types of Flight controllers
5	To Study payload mechanisms of drones.
6	To Study the different payload effects on drone flight.
7	To Study the effect of imbalanced payload conditions.

Text Books

1. John Baichta, Building Your Own Drones, QUE, 4 September 2015
2. Charles Platt Make: Electronics: Learn by Discovery, Maker Media Inc 1st Edition
3. Randal W. Beard and Timothy W. McLain, Small Unmanned Aircraft: Theory and Practice, , Princeton University Press February 2012

References

1. John M. Glover and James L. Shoemaker, Drone University

Evaluation Scheme

1. TERM WORK assessment shall be based on the overall performance of the student with every assignment graded from time to time.
2. The grades will be converted to marks as per ‘credit and grading system’ manual and should be added and averaged.
3. Based on above scheme grading and TERM WORK assessment should be done.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U11MM065	Drones Manufacturing Processes	03	-	-	03	-	-

Evaluation Scheme

Course Code	Course Name	Evaluation Scheme (In Semester)					End Semester Exam (ESE)		
		T1	T2	FET	Total	Min pass	Marks	Min pass	Total (Marks)
U11MM065	Drones Manufacturing Processes	10	10	5	25	40%	50	40%	75

Course Description

This course imparts knowledge of drone parts and components and the principles of flying applied to the drone technology. It takes the technician through the process of understanding the setting up of drone parameters through the use of a simulator

Pre-requisites: 11th and 12th standard Physics and mathematics.

Course Objectives

- Gain practical proficiency with hands-on flying, and learn about flight weather data interpretation, flight planning, airspace, map reading, and use of platforms to perform video and mapping tasks.
- The course is intended for people who want to become more proficient pilots, flying safely and legally.

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Define**[1] deep and real world knowledge of manufacturing limitations of drones.
- **CO2** **Perform**[3] turning, step turning, taper turning, threading and knurling operation on lathe machine.
- **CO3** **Explain**[2] uses of lathe accessories and different types of lathes.
- **CO4** **Perform**[1] drilling, reaming, counter boring, counter sinking and tapping operations on drilling machine.
- **CO5** **Define**[1] milling machine accessories and attachments.

Course Contents

Module	Unit	Description	Hours
1.0		**Drone structure making**	**9**
1	1.1	Name and use of raw materials used in carpentry shop: wood &alternative materials, Names, uses, care and maintenance of hand tools such as different types of Saws, C-Clamp, Chisels, Mallets, Carpenter's vices, marking gauges,	
	1.2	Try-squares, Rulers and other commonly used tools and materials used in Carpentry shop by segregating as cutting tools, supporting tools, holding tools, measuring tools etc., Different types of Timbers, their properties, uses & defects. Seasoning of wood.	
2.0		**Painting and polishing shop**	**9**
2	2.1	Introduction of paints, varnishes, Reason for surface preparation.	
	2.2	Advantages of Painting, other method of surface coating ie. Electro-plating etc.	
3.0		**Electrical shop**	**9**
3	3.1	Study, demonstration and identification of common electrical materials with standard ratings and specifications such as wires, cables, switches, fuses, cleats, clamps and allied items, tools and accessories	
4.0		**Metal cutting**	**9**
4	4.1	Principle of lathe operations like turning, drilling, shaping, threading, milling, grinding, introduction to cutting fluids and lubricants, brief introduction to single point cutting tools and multi point cutting tools.	
5.0		**Metal joining**	9
5	5.1	Introduction, types and importance of welding as compared to other material joining processes, welding joints and welding positions, materials to be welded.	

Text Books

1. S.K. Hajra Choudhury, Workshop technology, Media Promoters & Publishers Pvt Ltd.
2. K.Venkat reddy, Manual of workshop practice, 9788178003078
3. B.S.Raghuvanshi, Workshop technology, Dhanpatrai and company limited

References

1. H.S.Bawa ,Workshop technology,TMH publishers.

Internal Assessment (T1, T2 and FET)

1. T1 (Test 1) should be based on first two modules and T2 (Test 2) should be based on next two modules, for 10 marks each.
2. FET shall be assessed for 5 marks separately.

End Semester Examination

1. Question paper will be of 50 marks comprise of 5 questions, each carrying 10 marks.
2. The duration of end semester examination shall be Two hours.
3. The students need to solve all 5 questions.
4. Question No.1 will be compulsory and based on entire syllabus.
5. Remaining question (Q.2 to Q.5) will be selected from all the modules.

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Course Code	Course Name	Teaching Scheme (Hr/week)			Credits Assigned		
		Theory	Practical	Tutorial	Theory	Practical	Tutorial
U11MM069	Drones Manufacturing Processes Lab	-	02	-	-	01	-

Evaluation Scheme

Course Code	Course Name	In Semester Evaluation		End Semester Exam (OE/POE)		
		Term work	Min pass	Marks	Min pass	Total (Marks)
U11MM069	Drones Manufacturing Processes Lab	25	40%	-	-	25

Course Outcomes: After the successful completion of the course students will able to:

- **CO1** **Perform**[1] milling machine operations on vertical and horizontal milling machine.
- **CO2** **Understand**[1] theory, raw materials and tools/equipment's in carpentry shop, painting and polishing shop, electrical shop and smithy shop.

List of Experiments

All the experiments will be based on the course content of **Drones Manufacturing Processes, U11MM065**

Ex.No	Experiment Name
1	**Drone structuring practice** • To practice marking, sawing, planning and chiseling. • To prepare half lap joint (cross, l or t – any one) • To prepare mortise and tenon joint
2	**Painting and polishing practice** • To prepare metal surface for painting, apply primer and paint the same. • To prepare a metal surface for spray painting, first spray primer and paint the same by spray painting gun and compressor system.
3	**Electrical components' practice** • To install battery and connecting two or three batteries in series and parallel. • To charge a battery and testing with hydrometer and cell tester
4	**Metal cutting practice** • To practice plain, turning, knurling, drilling, boring, reaming and tapping. • To study and sketch of planning/shaping machine and to plane a rectangle of cast iron.

	• To practice boring with the help of boring bar. • To study the different grinding and abrasive machining process.
5	**Metal joining practice** • To prepare t-joint using arc welding. • To prepare lap joint using gas welding. • To practice spot welding / seam welding.

References

1. Ghosh A and Mallik A K. Manufacturing science, Ellis Horwood.
2. Schey J., Introduction to manufacturing processes, McGraw-Hill, 1987
3. Dhar, Manufacturing processes., Asian Books Private Limited, 2010
4. Singh K Hiraniya, Manufacturing engineering, I.K. International Publishing House Pvt. Limited, 2013

Evaluation Scheme

1. TERM WORK assessment shall be based on the overall performance of the student with every assignment graded from time to time.
2. The grades will be converted to marks as per 'credit and grading system' manual and should be added and averaged.
3. Based on above scheme grading and TERM WORK assessment should be done.

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