

**Department of Technology**  
**Savitribai Phule Pune University**  
**(Formerly University of Pune)**  
**Board of Studies**  
**Aviation**  
**Curriculum Structure for B.Tech Program**



Sr. No.	Subject Code	Subject Name	Credits	Teaching Scheme (Theory)	Teaching Scheme (Lab)	Teaching Scheme (Tutorial)
<b>Semester -1</b>						
1.	BAV101	Aerodynamics	4	3		1
2.	BAV102	Mathematics	3	2		1
3.	BAV103	Avionics Technology Fundamentals	4	3	2	
4.	BAV104	Electrical & Instruments Fundamentals	4	3	2	
5.	BAV105	Radio & Radar Fundamentals	4	3	2	
		<b>Total</b>	<b>19</b>			
<b>Semester -2</b>						
6.	BAV201	Flight Dynamics	4	3		1
7.	BAV202	Meteorology-1	4	3	2	
8.	BAV203	Navigation	4	3		
9.	BAV204	AC Systems Mechanical	4	3		1
10.	BAV205	Propulsion	4	3		1
		<b>Total</b>	<b>20</b>			
<b>Semester -3</b>						
11.	BAV301	AC Systems-Electrical	4	3		1
12.	BAV302	Human Factors & Flight Safety	3	2		1
13.	BAV303	Aircraft Structures	2	2		
14.	BAV304	Meteorology-2	4	3	2	
15.	BAV305	Mass, Balance and CG Position	3			

16	BAV306	Flight and Monitoring	3			
		<b>Total</b>	<b>19</b>			
<b>Semester -4</b>						
16.	BAV401	PPL Flying Training	20			
		<b>Total</b>	<b>20</b>			
<b>Semester -5</b>						
17.	BAV501	CPL Flying Training	20			
		<b>Total</b>	<b>20</b>			
<b>Semester -6</b>						
18.	BAV601	Instrument Rating	20			
		<b>Total</b>	<b>20</b>			
<b>Semester -7</b>						
19.	BAV701	Civil Air Requirements	3	3		
20.	BAV702	Soft Skills	3	3		
21.	BAV703	DGCA Exams Preparation	12	12		
		<b>Total</b>	<b>18</b>			
<b>Semester -8</b>						
22.	BAVFinProj	Final Project	20			
		<b>Total</b>	<b>20</b>			
<b>Total Number of Credits for the course</b>			<b>156</b>			

## **Aerodynamics [L : 3; T:1; P: 0] (4 credits, Lectures) (Revised)**

### **Detailed contents:**

#### ***Module 1: (3 lectures)***

Heavier than air machine, History of Airplane development , Principle stated by Cayley, Gas Laws, Use of Coefficients in aerodynamics, Systems of units in Aviation, Anatomy of an airplane.

#### ***Module 2: (10 lectures)***

Atmosphere, composition, International standard atmosphere, Atmospheric layers and their characteristics. Variation of p, T and density with altitude, Pressure altitude, density altitude, Newton's Laws of motion, Application to gas flow, Velocity, Momentum, Energy Eqns, Bernoulli's equation, Compressibility and its effects introduction to trans sonic and supersonic flight regimes.

#### ***Module 3: (12 lectures)***

Airfoil, its geometry, flow over the airfoil, Pressure distribution, centre of pressure, generation of aerodynamic forces (AD), lift, drag and moment, angle of attack and its effect on AD forces, L vs angle of attack curve, movement of CP, aerodynamic centre, stall, wind and smoke tunnels.

#### ***Module 4: (10 lectures)***

D'Alembert's paradox, Drag, components of drag, Boundary layer theory (BL), Laminar and turbulent flows, BL profile in laminar and turbulent flow, creation of drag due to skin friction, transition of BL, flow separation, Streamlined and bluff bodies.

#### ***Module 5: (7 lectures)***

Two dimensional wings, three dimensional wings, Aspect ratio and its effects, Induced drag and its dependence on CL, Winglets, Qualitative study of Flow on 3D wings, Sweep back, Taper and twist to wing and wing setting angle, Wing body blending and interference.

#### ***Module 6: (3lectures)***

Measurement of airspeed, Pitot tube, its functioning, TAS, EAS, Effects of compressibility on Lift and drag, Introduction to Euler's eqn, High lift devices. Introduction to high speed aerodynamics, trans-sonic and supersonic airflows and their characteristics.

### **Suggested Reference Books**

- (i) Introduction to Flight, 6th edition. By John D Anderson
- (ii) Aerodynamics for Engineering Students. By Houghton and Brock
- (iii) Flight without Formulae, 5<sup>th</sup> edition. By AC Kermode
- (iv) Introduction to Aircraft Aerodynamics, By Cranfield College of Aeronautics
- (v) Handbook of Aeronautics. By Royal Aeronautical Society
- (vi) Principles of Flight. By Bert A Shield
- (vii) Manual of Flying (AP 129). By Air Ministry UK
- (viii) Aerodynamics for Naval Aviators. By H H Hurt, Jr. University of Southern California
- (ix) Principle of Flight. By Nordin, DGCA Recommended

**Course Outcomes: at the end of this course student will be able to know:**

- atmospheric variations in which aeroplane flies
- generation of forces on airplane and how angle of attack contributes significantly
- Important role of friction and compressibility which affects AD forces
- Airfoils, wings, wing shapes and how they contribute to lift and drag
- How airplane speeds are measured

**Mathematics [L : 2; T:1; P ](3 credits, Lectures) (Revised)**

**Detailed contents:**

*Module 1: (13 lectures)*

**Multivariable Calculus: Differentiation**

Limit, continuity and partial derivatives, total derivative; Tangent plane and normal line; Maxima, minima and saddle points.

*Module 2: (05 lectures)*

**Sequences and Series**

Convergence of sequence and series, tests for convergence, power series, Taylor's series.

*Module 3: (10 lectures)*

**Multivariable Calculus: Integration (7 hours)**

Change of variables (Cartesian to polar), Applications: areas and volumes by (double integration) Center of mass and Gravity (constant and variable densities)..

*Module 4: (8 hours)*

**First Order Ordinary Differential Equations (3 hours)**

Exact, linear and Bernoulli's equations, Euler's equations.

*Module 5: ( 7 lectures)*

**Ordinary Differential Equations of Higher Order (6 hours)**

Second order linear differential equations with variable coefficients, method of variation of Parameters.

**Suggested Reference Books**

**Text / References:**

1. G.B. Thomas and R.L. Finney, "Calculus and Analytic geometry", Pearson, 2002.
2. T. Veerarajan, "Engineering Mathematics", McGraw-Hill, New Delhi, 2008.
3. B. V. Ramana, "Higher Engineering Mathematics", McGraw Hill, New Delhi, 2010.

4. N.P. Bali and M. Goyal, "A text book of Engineering Mathematics", Laxmi Publications, 2010.
5. B.S. Grewal, "Higher Engineering Mathematics", Khanna Publishers, 2000.
6. E. Kreyszig, "Advanced Engineering Mathematics", John Wiley & Sons, 2006.
7. W. E. Boyce and R. C. DiPrima, "Elementary Differential Equations and Boundary Value Problems", Wiley India, 2009.
8. S. L. Ross, "Differential Equations", Wiley India, 1984.
10. E. L. Ince, "Ordinary Differential Equations", Dover Publications, 1958.

**Course Outcomes** At the end of the course students will be able to

- . Understand importance of calculus as language of Engineering
- . Understand the fundamental concepts of calculus
- . Able to apply calculus to solve engineering problems

## **Avionics Technology Fundamentals [L : 3; T:--; P 0: 2 (4 credits)] (Revised)**

### **Detailed contents:**

#### **Analog Electronics**

##### ***Module 1: (12 lectures)***

Semiconductor theory, Diodes, forward and reverse biasing of diode, application of diode Rectifier circuits and power supply

Bipolar Junction Transistors, Transistors Bias Circuits, CE, CB and CC configuration of transistor, Transistor operating region, Field Effect Transistors, Metal Oxide Semiconductor FETs.

Integrated Circuits

##### ***Module 2: ( 10 – Lectures)***

Introduction to Amplifiers, Single stage and Multistage Amplifiers, Amplifier Characteristics Feedbacks in Amplifiers, Introduction to sinusoidal Oscillators, Multivibrators (MVS), monostable, astable and bistable multivibrator circuits

Introduction to SCR(Silicon controlled rectifier), Power electronics, Thyristor, Light Activated SCR (LASCR), LED, photo diodes, photo-resistors, photo transmitters, Optoelectronics.

#### **Digital Electronics**

##### ***Module 3: (12 lectures)***

Digital Fundamentals: Binary Numbers, Signed-binary numbers, Decimal-to-Binary & Binary-to-Decimal Conversion, Binary Addition, Subtraction, Hexadecimal Number, Systems, Logic Gates, Boolean Algebra, De Morgan's Theorems, Laws of Boolean Algebra, combinational logic systems, Representation of logic function, Basics of Flip flops,

#### **Module 4: (12- lectures)**

Introduction to digital logic families and characteristics of digital IC's , TTL logic circuits, CMOS logic circuits, Registers, Counters, multiplexer, demultiplexers, Adder Half and full adder circuits.

Fundamentals of microprocessor: Introduction of microprocessor, Architecture of microprocessor, System Buses , Other units of microprocessor, ALU, Program counter, memory system, instruction set, and programming language.

#### **Suggested Reference Books**

(i) Grob's Basic Electronics. 11th edition. By Mitchel E Schultz

(ii) D. P. Kothari and I. J. Nagrath, "Basic Electrical Engineering", Tata McGraw Hill, 2010.

(iii) Instrumentation Aircraft General Knowledge. By Nordian

(iv) JAR ATPL(A) and CPL(A) Instruments. By Keith Williams

(v) Electron Flow Version. 9th edition. By Thomas L Floyd

**Course Outcomes:** At the end of this course students will be able to understand:

.Fundamentals of instrumentation, need for instruments, various types of working of instruments.

.Grouping of instrument in clusters, Arrangement of instruments for pilot to read them easily.

Display type for quick understanding.

.Instrument commonly used in the cockpit: airplane instruments, navigation instruments and engine instruments.

.Basic electricity fundamentals, circuits, system components, motors, generators, protections of circuit.

#### **Laboratory -**

Suggested list of experiments from the following:

1. To verify KCL and KVL
2. To study the V-I characteristics of an incandescent lamp.
3. To measure single phase power by using three ammeter method.
4. To measure the single phase power by using three voltmeter method.
5. To perform short circuit test on a single phase transformer.
6. To perform open circuit test on a single phase transformer.
7. To measure three phase power by using two wattmeter method.
8. To verify Superposition theorem.

## **Introduction to Electrical and Instrument Fundamentals (Revised)**

(L : 3, T: 0, P : 2 ( 4 Credits)

### **(Electromagnetism, Electrostatics, A.C fundamentals & circuits)**

(Unit 1 & Unit 2)

#### **Unit 1.**

(Total: 6 Hrs)

##### **(A) Electromagnetism:**

(4 Hrs)

Magnetic effect of an electric current, right hand grip rule and cork screw rule, nature of magnetic field of long straight conductor, solenoid and toroid. Concept of MMF, flux, flux density, reluctance, permeability and field strength, their units and relationships. Simple series and parallel magnetic circuits, comparison of electrical and magnetic circuit, force on current carrying conductors placed in magnetic field, Fleming's left hand and right hand rule. Faradays laws of electromagnetic induction, statically and dynamically induced emf, self and mutual inductance, energy stored in magnetic field. (No derivation).

##### **(B) Electrostatics:**

(2 Hrs)

Electrostatics field, electric flux density, electric field strength, absolute permittivity, relative permittivity, capacitance. Capacitors in series and parallel. Energy stored in capacitors, charging and discharging of capacitors and time constant (No derivation)

#### **Unit 2:**

##### **(A) A.C Fundamentals:**

Sinusoidal voltages and currents, their mathematical and graphical representation. Concept of instantaneous, peak(maximum), average and r.m.s. values, frequency , cycle, period, peak factor and form factor, phase difference ,lagging, leading and in phase quantities and phasor representation. Rectangular and polar representation of phasor.

(No any derivation)

(2 Hrs)

##### **(B) Single Phase AC Circuits:**

Study of series R-L, R-C, R-L-C circuit and corresponding Phasor diagrams and voltage-current-power waveforms. Concept of active, reactive and apparent power and power factor. Concept of Impedance and power triangle.

(2 Hrs)

##### **(C) Polyphase AC Circuits:**

Concept of three-phase supply and phase sequence. Voltages, currents and power relations in three phase balanced star-connected loads and delta-connected loads along with phasor diagrams.

(2 Hrs)

### **Section 2 (Electrical Machines)**

#### **Unit 3:**

##### **(A) Single Phase Transformers:**

Construction, principle of working, EMF equation, voltage and current ratios. Losses, efficiency, and voltage regulation of transformer. Determination of these by direct loading method. Descriptive treatment of autotransformers. (3Hrs)

**(B) D.C Machines:**

Construction of DC machines. Working principal of DC generators and motors. EMF equation, concept of back EMF. Types of DC machines. Losses and efficiency of DC machines. Power stages. Characteristics of DC Motors. Speed control methods. Necessity of Starters. Three point starter. Applications of DC motors. (3 Hrs)

**Unit 4:**

**(A) Three phase Induction Motors:** Construction, working principle and types of induction motors. Rotating magnetic field, synchronous speed, slip. Rotor circuit parameters (current, EMF, impedance, power). Torque of Induction motor. Condition for Max. torque. Torque ratios. Torque-slip and Torque-Speed characteristic. Losses and efficiency of induction motor. Power stages. Starting methods. Speed control methods. Applications. (4 Hrs)

**(B) Single Phase motors:** Construction and Working principle. Classifications. Split phase induction motors. Shaded pole motors. Applications. (Descriptive only) (2 Hrs)

**Section 3 (Flight and Navigation Instruments)**

**Unit 5: Transducers, Flight and Engine Instruments (6 Hrs)**

**Transducers.** Resistive Transducers-Thermistors, RTD, Thermocouples and Strain Gauges. Inductive Transducers- Linear variable differential transformer (LVDT). Capacitive Transducers.

**Flight instruments:** Artificial Horizon, Turn and Slip Indicator, Rate of climb/ descent indicator, altimeter, air speed indicator,

**Engine Instruments:** Engine rpm, Fuel flow meter, fuel pressure indicator, Turbine exit temperature, Oil pressure gauge, Cylinder head temperature, manifold pressure gauge.

**Unit 6: Navigation Instruments: (6 Hrs)**

Navigation Instruments: Gyro Compass and Heading Indicator gauge, VOR Course Deviation Indicator(CDI) Radio direction finder(RDF) and Automatic Direction Finder (ADF) indicator combined with NAV/COM radios set to the frequencies of VOR and ADF stations.[2], w:Horizontal Situation Indicator(HSI) up to Electronic Attitude Director Indicator (EADI), Electronic Flight Instrument System (EFIS), Dual VOR/ADF Course Deviation Indicator(CDI) (Nav1), (ILS) Localizer and Glide scope indicator.

**Laboratory -**

Term work shall consist of a record of minimum eight exercises and experiments suggested as below:



1. To verify KCL and KVL
2. To verify Superposition theorem
3. To perform open circuit and short circuit test on a single-phase transformer.
4. To perform direct load test on single-phase transformer.
5. To measure three phase power by using two-wattmeter method.
6. Study of R-L-C series circuit
7. Verification of voltage and current relations in three phase balanced star and delta connected loads.
8. Study of safety precautions while working on electric installations and necessity of earthing.
9. Introduction to energy conservation and simple techniques to achieve it.
10. Study of various wiring components (Wires, Switches, Fuses, Sockets, Plugs, lamps, holders etc)

### **Suggested Reference Books**

1. D. P. Kothari and I. J. Nagrath, “Basic Electrical Engineering”, Tata McGraw Hill, 2010.
2. C.R Dargan, “Electrical Technology” Dhanpatrai Publications
3. B.L Theraja “A textbook of Electrical Technology” S.chand and Company Ltd New Delhi
4. V.K.Mehta “Basic Electrical Engineering” S.chand and Company Ltd New Delhi.
5. A.K.Sawhney “A course in Electrical and Electronic Measurements and Instrumentation”  
Dhanpatrai and Company
6. G.Mandal, A.K. Datta “Electrical, Instruments & Radio” L.N.V.M. Society Group of Institutes, Dwarika, New Delhi.
7. Ian Moir Allan & Seabridge “Aircraft Systems-Mechanical, electrical, and avionics subsystems integration” John Wiley & Sons Ltd.

### **Course Outcomes:**

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

1. Understand and demonstrate the fundamentals of electromagnetism, electrostatics and A.C fundamentals.
2. Apply concept of electromagnetism for the working of single-phase transformers, A.C and D.C Machines.
3. Differentiate between electrical and magnetic circuits.
4. Draw phasor diagrams for single phase and three phase A.C circuits
5. Understand fundamentals of instrumentation and need for instruments.
6. Understand instrument commonly used in the cockpit: airplane instruments, navigation instruments and engine instruments.

## **Radio and Radar Fundamentals 10 [L : 3; T:1; P 0] (4 credits, Lectures)(Revised)**

### **Detailed contents:**

#### ***Module 1: (6 lectures)***

To present the basic concepts of telecommunication systems with focus on digital and wireless  
3 Basic Concepts: Signal Analog, Digital, Random, Sampling, Bandwidth, Spectrum, Noise, Interference, Channel Capacity, BER, Modulation, Multiplexing, Duplexing.  
Telecommunication Sign,

#### ***Module 2: (7 lectures)***

Basic Principle of operation, Signal Routing, Signal Timing, Ranging, Maximum Unambiguous Range,  
Antenna Gain, Antenna Aperture, Radar Cross Section. Transmitters, Power, MDS-Echo, Noise.

#### ***Module 3: (8 lectures)***

Radar Range Equation, Probability of Detection, Frequency-diversity .Classification of Radar Systems, Imaging Radar / Non-Imaging Radar, Primary Radar, Pulse Radar, Secondary Radar, Principle of operation, Continuous Wave Radar, Block Diagram of an CW-Radar,

#### ***Module 4: (6 Lectures)***

Air Traffic Control (ATC) Radars .En Route Radars, Air Surveillance Radar, Precision Approach Radar, Surface Movement Radar (SMR), Special Weather Radar Applications, Radar Frequency Bands.

#### ***Module 5: ( 8 lectures)***

Functions of an Antenna, Antenna Characteristics, Antenna Gain, Antenna Pattern, Polarization, Half-wave Antenna, Parabolic Antennae, Antennae with Coscant Squared Pattern, Phased Array Antenna, Principle of Operation

### **Suggested Reference Books**

- (i) Basic Radar Analysis. By Mervin C Budge, Shawn R German
- (ii) Fundamentals of Telecommunications. By International Centre for Theoretical Physics-
- (iii) [ebookpdf.com/basic-radar-books](http://ebookpdf.com/basic-radar-books)
- (iv) Radar Fundamentals. By Gershon J Wheeler

## **Introduction to Flight Dynamics [L : 3; T:1; P 0] (4 credits, Lectures)]( Revised)**

### **Detailed contents:**

#### ***Module 1: (8 lectures)***

Introduction, Airplane performance, Stability and Control, Meaning and need to study, Airplane parts, their function, Co-ordinate axis used, Possible motions, translational and rotational. Control surfaces responsible for each motion, pitch, roll and yaw. Pure and coupled motions. Drag, drag polar, components of drag. Lift dependent drag and other components, source of various components of drag, Factors affecting drag, Minimum drag condition. L by D ratio, Lift versus drag ratio.

#### ***Module 2: (8 lectures)***

Performance of a airplane, St and level flight, Thrust versus altitude, thrust versus forward speed, Thrust required and thrust available for piston engines. Thrust required and available for Jet engine airplane. Max velocity attainable for piston engine and jet engine. Effects of power required and available on piston engine airplane with altitude. Effects of thrust required and available with altitude. Rate of climb, max rate of climb. Gliding flight, range of gliding flight, max gliding distance. Service ceiling and absolute ceiling, time to climb, Range and endurance. Maximum range and max endurance.

#### ***Module 3: (8 lectures)***

Accelerated Flight, take-off and landing performance, both by graphical method. Turning flight, forces in turning flight, Load factor in turn, radius of turn, time to turn, Velocity versus load factor

#### ***Module 4: (8 lectures)***

Stability of an airplane, concept, stable and unstable airplanes, neutral stability, static and dynamic stability, Moments on the airplane, absolute angle of attack, moment balance, longitudinal static stability, criterion, qualitative discussion on longitudinal stability, contribution by main wing, fuselage and tail, Neutral point, static margin. CG calculation.

#### ***Module 5: (8 lectures)***

Control, concept of control, forces and moments, longitudinal control, control surfaces, control tabs. Trimming of airplane in longitudinal direction. Stability versus control dilemma. Directional and lateral stability, Directional and lateral control. Stick Force , Powered controls.

#### ***Module 6: (5 lectures)***

High lift devices,plane flaps, slots, multi slotted f flaps, fowler flaps, leading edge devices, their location and operation, stall warning, low drag airfoils, wing sweep and dihedral. BL control on wings of various shapes, vortex generators, BL trippers, their location.

### **Suggested Reference Books**

- (i) Introduction to Flight, 6th edition. By John D Anderson
- (ii) Flight without Formulae, 5th edition. By A C Kermode

- (iii) Fundamental of Flight ,2nd edition. By Richard S Shevell
- (iv) Flight Planning Flight Performance & Planning. By Nordian

### Course Outcomes

- . Understand what is performance of an airplane and understand straight and level flight, climb, glide, TO, Landing phases of flights
- . Max speed, max endurance and max range criterion
- Familiar with stability and control aspects of an airplane
- . Understand generation of moment on airplane and how it affects stability
- . Important role of position of CG and tail in stability
- . How an airplane is controlled and what are pilot interventions.

### Meteorology -1 [L : 3; T:0; P :2] (4credits, Lectures) ( No revision required)

#### Detailed contents:

#### **Module1:** (4 lectures)

An over view of aviation organisation and objective, structure and working of WMO, ICAO, CAeM, DGCA, IMD and AAI.

**Measurement of Time** - LMT, Universal time, Differences in LMT, Time zones, International Date Line.

**Elementary concepts of atmospheric sciences:** Our atmosphere and its composition, extent and vertical division. ICAO ISA and ISA deviation, JSA atmosphere, High Altitude and hypoxia.

#### **Module 2:** (8 lectures)

**Atmospheric pressure-** Definition, basic principle of Pressure measurement, Unit, kind of barometer, aneroid and mercury barometers, barograph measurement, Geo-potential meter. Atmospheric Pressure and its variation, reduction of pressure to mean sea level, QFF, QNH, QNE, QFE. Static pressure, dynamic pressure, pitot pressure.

**Altimetry** - Definitions. Principle of Altimeter. ICAN Altimeter and Radio Altimeter. Errors of Altimeter. Altimeter Setting Procedures. Correction to altimeter and D-Value. Pressure altitude, true altitude, height, altitude, flight level, Altimeter settings: QNH, QFE, 1013.25 hPa, effect of accelerated airflow due to topography. Terrain clearance, Minimum flight level.

**Air Density** and density altitude, effect of changes in pressure and temperature on air density, density variation with altitude and latitude, High density altitude, Low density altitude and aircraft operations.

#### **Module 3: (10 lectures)**

**Temperature-** Insolation, Unequal distribution of solar energy over the surface of the globe, Depletion of solar radiation, Variation of temperature with Altitude, Latitude, topography and seasonal. Effect of temperature on land and sea. Diurnal variation, Temperature scales. Dry bulb, wet bulb, maximum and minimum thermometer, Stevenson screen, Radiation balance, transfer of

heat- solar and terrestrial radiation, conduction, convection, condensation, advection. Lapse rate, stability and instability, development of inversions, types of inversions.

**Humidity** - Moisture in atmosphere and basic principle of measurement of humidity, relative humidity, humidity mixing ratio, variation of humidity- diurnal, latitudinal, seasonal. Instruments including Psychrometric measurements, Psychrometric tables, Errors, saturation of atmosphere, dew point temperature, wet-bulb temperature, dews and frost, effect of cooling in the atmosphere, formation of clouds, fog and precipitation, many phases of water, condensation nuclei, super cooled water.

**Wind** – Concept of wind circulation, Effective Forces and wind, PGF, Coriolis force, Frictional force, Geostrophic and gradient winds, cyclostrophic wind, cross-isobar wind flow, cyclonic and anticyclonic wind, Measurement of surface wind speed and direction. Local winds: land-sea breezes, mountain-valley breezes, katabatic-anabatic winds, jet-stream, thermal wind, veering and backing of winds, convergence and divergence of winds. Reporting procedure of wind direction and speed. Reporting procedure of variation of wind direction and speed.

**Precipitation** – kind of precipitations, rain and snow measurement, Rain gauges, Rain recorder – Self Recording (float type), Intensity of precipitation.

#### **Module 4: (10 lectures)**

**Cloud**- types of cloud, features and identification. Cloud Observation and Measurements - Estimation of amount, Height of the base, its measurements, Ceiling balloon, and Aircraft observations. Ceilometer & Ceilograph; principle and use.

**Atmospheric Stability** – Concept of air parcel, ELR, DALR, SALR, Equilibrium States, Parcel Method, Vertical Acceleration of the parcel and its application. Stability Analysis.

**Visibility Measurement for Aviation** – Definition of visibility, Prevailing visibility, Reporting Procedure of visibility, Directional variation in visibility, Landmarks. Runway Visual Range: Definition, landmarks. Transmissometer (Single base and Dual base), their installation, Reporting RVR practical aspects.

**IFR producers**- Common visibility reducers, Hydro, Litho, Electro and Photo meteors, Definition and description of smoke, dust, smoke, sand, volcanic ash. Radiation fog, advection fog, sea fog, steam fog, upslope fog, frontal fog, evaporation fog, ice fog, mist, shallow fog, dew, frost,

**Pressure systems**- Location of principle areas pressure, High and Low pressure, Anticyclones, type, general properties of cold and warm anticyclones, ridges and wedges, subsidence, Non-frontal low, depression, cold air pools, trough. Weather associated with pressure systems. Tropical revolving storms.

#### **Module 5: (6 lectures)**

**Indian Climatology** - Different seasons. Distribution of Means Sea level pressure/wind/temperature in different seasons. Wind circulation and temperature distribution over India in lower, middle and upper troposphere in different seasons. Indian rainfall in different seasons. Indian summer monsoon, onset, withdrawal, rainfall distribution, inter annual variability of monsoon. Main synoptic pressure systems causing weather over India in different seasons.

**Synoptic systems in different seasons. Winter** - Western disturbance, Rossby Waves, Westerly Jet Stream, Fog, Cold Wave etc.

**Summer** - Thunderstorms, Dust storms, Heat wave, Nor'westers, Andhi, Loo, Cyclonic disturbances in Indian region.

**Monsoon** - Onset, rainfall activity, Withdrawal, Breaks, Depressions, Easterly Jet Stream. Mid-tropospheric Cyclones, Component of monsoon season- heat low, TEJ, Mascarene high, Tibetan high, LLJ, monsoon trough.

**Post Monsoon** - Cyclones in the Indian Seas, N.E. Monsoon.

### **Module 6: (6 lectures + Practicles)**

**Station plot-** coding and decoding of weather elements on surface chart, TEMP message from RSRW, plotting of weather elements on surface level and upper level constant pressure charts and decode them.

**Aviation Weather Codes** – Metar/Speci, Meteorological Routine Report, Weather Symbols and RAREP, Conditions for issuing SPECI, Accuracy requirement for observation of weather elements in aviation.

### **List of Practicals :**

- **TYPE I :** Aviation Weather Codes Coding and De-Coding: Metar/Speci ;
  - Trend type Landing Forecast : Terminal Aerodrome Forecast.
- **TYPE II :** Exercises in issue of Local forecast, Terminal Aerodrome forecast
  - and Trend type landing forecast.
- **TYPE III :** Exercise in issue of Route forecast within the country / Ex –  
India.

### **Reference Books:**

1. Annex 3 - Meteorological Service for International Air Navigation- ICAO publication
2. Essential of Meteorology: An invitation to the atmosphere by C. Donald Ahrens
3. Aviation weather by Peter Lester
4. Meteorology and Flight : A pilot's guide to weather by Tom A. M. Bradbury
5. Weather analysis and forecasting Vol. 1 and 2 by Sverre Pettersson, MG Hills
6. An Introduction to Meteorology by S. Pettersen
7. The Monsoons by P.K. Das ( National Book Trust, India)
8. WMO Training Manuals for class I & II, WMO (Publications)
9. Aviation Weather: FAA AC 00-6A (FAA Handbooks)

***Navigation (BAV203)*** [L : 3; T:0; P 0] (4credits, Lectures) (Revised)

**Detailed contents:**

***Module 1: Basics of Navigation(5 lectures)***

Solar System, Seasonal and apparent movement of sun. The earth. Great circle, small circle, rhumb line, Convergency, Conversion angle. Latitude, difference of latitude. Longitude, difference of longitude. Use of Latitude and longitude and longitude co-ordinates to locate any specific position.

***Module 2: Time and Time conversion( 3 Lectures)***

Apparent time, UTC, LMT, Standard time, International date line. Directions: terrestrial magnetism, declination, deviation and compass variation. Magnetic poles, isogonals, relationship between true and magnetic heading. Distance: Units of distance and height used in navigation; nautical miles, statute miles, kilometers, meters, yards and feet, conversion between them. Relation between nautical miles and minutes of latitude.

***Module 3:Magnetism and Compass ( 6 Lectures)***

**General Principles:** terrestrial Magnetism, resolution of the earth's total magnetic force in to vertical and horizontal components. The effect of change of latitude on these components, directive force. Magnetic dip, variation. Aircraft Magnetism: hard iron and soft vertical soft iron, the resulting magnetic field, variation in directive force.

Change of deviation with change of latitude and in change with aircraft heading. Turning and acceleration errors, keeping magnetic material clear of compass. Knowledge of the principles, standby and landing or main compass and remote reading compasses. Detailed knowledge of the use of these compasses, serviceability test, advantage and disadvantage of remote reading compasses, adjustment and compensation of direct reading magnetic compass.

***Module 4: Charts (7 Lectures)***

General properties of miscellaneous types of projections: Mercator, Lambert Conformal Conic. Polar stereographic. The representation of meridians, parallels, great circles and rhumb lines. The use of current aeronautical charts: Plotting positions, Method of indicating scale and relief, , conventional signs, measuring tracks and distances, plotting bearings

***Module 5: Dead Reckoning Navigation (DR) ( 7 Lectures)***

Basics of DR: track, heading ( Compass, magnetic, true, grid), wind velocity, airspeed (IAS, TAS, CAS, Mach Number). Ground speed, ETA, drift and wind correction angle. DR position and fix.

Use of navigation computer: speed, time, distance, fuel consumption, conversions, heading, airspeed, wind velocity.

The triangle of velocities, method of solution for determination of: heading, ground speed, wind velocity, track and drift angle, track error, time and distance problems. Determination of DR position: need for DR, confirmation of flight progress (mental DR), lost procedure, heading and TAS vectors since last confirmed position. Application of wind velocity vector, last known track and ground speed vector, assessment of accuracy of DR position. Resolution of current DR problems by means of Mercator charts, Lambert Charts, polar stereographic projections. Measurements of Max range, Radius of action, point of safe return and point of equal time.

### ***Module 6: Inflight Navigation ( Lectures)***

Use of visual observations and application to inflight navigation. Navigation in climb and descent: average airspeed, average wind velocity, ground speed/ distance covered during climb and descent. Navigation in cruising flight: ground speed revision, off track corrections, ETA revisions. Flight log ( including navigation records)

### **Suggested Reference Books**

- (i) FAA-H-8083-18 Handbook of Navigation, 2011 edition. By Federal Aviation Administration.
- (ii) Air Pilot's Manual Vol 3 & 5. By Peter D Godwin
- (iii) Flight Performance & Planning. By AS Nordian
- (iv) General Navigation: ATPL JAR. By AS Nordian
- (v) GPS : Navigation. By Underdown
- (vi) GPP : Plotting & Flight Planning. By Underdown
- (vii) Radio Navigation ATPL JAR. By AS Nordian

**Course Outcomes:** At the end of the course the student will be able to know:

- . How to read and understand maps, earth's shape and size, co-ordinate system used
- . Relation between time, latitude, standard time. Units of measurement of distance.
- . Aeronautical charts and how to use them. How to use Aeronautical maps for planning flight near the airport and on way to destination.
- . Gyroscope and instruments based on Gyroscope. Different speeds and conversion to TAS.
- . Inertial Navigation, GPS and modern auto navigation systems.

### **Aircraft Systems - Mechanical [L : 3; T:1; P :0 -- (4 credits)] (9Revised)**

#### **Detailed contents:**

#### ***Module 1: (8 lectures)***

Hydraulic Systems (Hyd). Need for the system, requirements of Hyd system, Characteristics of Hyd System, Services provided by Hyd system in small and large airplanes. Typical layout of the Hyd systems for large and small airplanes. Important components, their function. Operating features of the system.

***Module 2: (8 lectures)*** Pneumatic Systems (Pnu) . Need for the system, requirements of the system, Characteristics of the System, Services provided by Pnu system in small and large



airplanes. Typical layout of the Pnu systems for large and small airplanes. Important components, their function. Operating features of the system.

***Module 3: (7 lectures)***

Air conditioning and Pressurisation Systems (P&AC). Need for the system, requirements of the system, Characteristics of the System, Services provided by P&AC system in small and large airplanes. Typical layout of the P&AC systems for large and small airplanes. Important components, their function. Operating features of the system.

***Module 4: (8 lectures)***

Flight Control Systems (FCS). Need for the system, requirements of the system, Characteristics of the System, Services provided by FCS system in small and large airplanes. Typical layout of the FCS systems for large and small airplanes. Important components, their function. Operating features of the system. Powered, Power assisted and manually operated sys, Artificial feel unit, Changes of control input with speed and altitude.

***Module 5: (6 lectures)***

Landing Gear Systems (UC). Need for the system, requirements of the system, Characteristics of the System, Services provided by UC system in small and large airplanes. Typical layout of the UC systems for small airplanes. Important components, their function. Operating features of the system.

***Module 6: (8 lectures)***

Airplane Fuel Systems (Fuel). Need for the systems, requirements of the system, Characteristics of the System, Services provided by Fuel system in small airplanes. Typical layout of the Fuel systems for small airplanes. Important components, their function. Operating features of the system. Refuelling and defueling, precautions, water content check.

**Suggested Reference Books**

- (i) FAA Handbook of Hydraulic Systems. By Federal Aviation Administration
- (ii) Aircraft Hydraulic System. By William A Leese
- (iii) Handbook of Aeronautics. By Royal Aeronautical Society
- (iv) Aircraft Hydraulic System. By William L Green
- (V) The Air Pilot's Manual 4-The Aeroplane-Technical. By Airline Publishing Company

**Course Outcomes: At the end of the course the student will be able to know;**

- . Need for different airplane operating systems
- . Characteristics of different systems
- . Services provided by the different systems
- . Typical layouts of different systems for big and small airplanes
- . Peculiarities of some of the systems

## **Propulsion [L : 3; T:1; P : 0 (4 credits)](Revision Not Required)**

### **Pre-requisites:**

High-school education with 10+2 with Science and Mathematics or diploma in relevant engineering branch

### **Detailed contents:**

#### ***Module 1: (7 lectures)***

Introduction, thermodynamic system, properties and state of a system, point and path functions, Thermodynamic processes – reversible and irreversible, Thermodynamic processes – isothermal, adiabatic, isobaric, isochoric, etc., First law of thermodynamics, perpetual motion machine, high grade and low grade energies, Work and Energy, Second law of thermodynamics, Enthalpy and Entropy, Efficiency, Ideal Gas Laws – Boyle's law, Charles's law, Combined gas laws, thermodynamic cycles.

#### ***Module 2: (7 lectures)***

Carnot cycle – work, energy and efficiency, Otto cycle - work, energy and efficiency, Brayton cycle - work, energy and efficiency

Basics of Heat Transfer: Conduction – mechanism of heat transfer, Law of conduction, Conductors and insulators, Convection – mechanism of heat transfer , Natural and Forced convection, rate of heat transfer, Radiation – mechanism of heat transfer, black body, relation with temperature, Stephan Boltzmann constant

#### ***Module 3: (8 lectures)***

The spark ignition engine, Engine construction and main components, Multi cylinder engine and Engine classification, Theoretical 4 – strokes: suction/induction, compression, power, exhaust, Practical cycle – valve timing and ignition timing, Engine power – Indicated power, Brake Power, Engine Efficiency – thermal, mechanical, volumetric, Specific Fuel Consumption, Effect of change in ambient conditions on the engine performance,

Power Augmentation – supercharger and turbocharger

#### ***Module 4: (7 lectures)***

Auxiliary systems:

Lubrication system – construction and working, types - dry sump and wet sump

Engine cooling system – working and control

Starting and Ignition system – components and working

Fuel system – carburettor and direct injection

Fuel – mixture, detonation, pre-ignition, octane rating, fuel additives

Fuel quality, fuel quality control

**Module 5: (6 lectures)**

Propellers: Fixed pitch and variable pitch, alpha and beta range, single acting propeller, constant speed propeller, constant speed unit, propeller control unit, feathering and unfeathering, beta range operations, reduction gearing, torque meter, checks

**Module 6: (10 lectures)**

Jet Engine introduction, principle of working and working cycle, equation of thrust, propulsive efficiency, bypass ratio, types of jet engines – turbojet, turbofan, turboprop, turboshaft, spools, limiting temperature, afterburner, study of construction and working of main components – air intake, compressor, combustion chamber, turbine, nozzle/exhaust system, thrust, TSFC & BSFC, change of thrust with change in ambient conditions, thrust augmentation, bleed air, gear boxes, Ignition system, APU, Engine starting, Gas Turbine Fuel and Fuel system.

**Suggested Reference Books**

- (i) JAA Powerplant Manual – Oxford Aviation Services
- (ii) The Jet Engine – Rolls Royce
- (iii) Engineering Thermodynamics – P K Nag, McGraw Hill
- (iv) Aircraft General Knowledge: Powerplant – Nordian (DGCA recommended for CPL/ATPL exam)

**Course Outcomes**

On successful completion of the course, the student will be able to –

1. Understand and apply the principles of thermodynamics and heat transfer to analyse simple thermal systems
2. Understand the construction and working of piston engines
3. Understand the working and control of the propeller used on aircrafts
4. Understand the construction and working of piston engines

**Course Contents:**

**Section-1**  
**(Electromagnetism, Electrostatics, A.C fundamentals & circuits)**  
(Unit 1 & Unit 2)

**Unit 1.**

(Total: 6 Hrs)

**(C) Electromagnetism:**

(4 Hrs)

Magnetic effect of an electric current, right hand grip rule and cork screw rule, nature of magnetic field of long straight conductor, solenoid and toroid. Concept of MMF, flux, flux density, reluctance, permeability and field strength, their units and relationships. Simple series and parallel magnetic circuits, comparison of electrical and magnetic circuit, force on current carrying conductors placed in magnetic field, Fleming's left hand and right hand rule. Faradays laws of electromagnetic induction, statically and dynamically induced emf, self and mutual inductance, energy stored in magnetic field. (No derivation).

**(D) Electrostatics:**

(2 Hrs)

Electrostatics field, electric flux density, electric field strength, absolute permittivity, relative permittivity, capacitance. Capacitors in series and parallel. Energy stored in capacitors, charging and discharging of capacitors and time constant (No derivation)

**Unit 2:**

**(D) A.C Fundamentals:**

Sinusoidal voltages and currents, their mathematical and graphical representation. Concept of instantaneous, peak(maximum), average and r.m.s. values, frequency, cycle, period, peak factor and form factor, phase difference, lagging, leading and in phase quantities and phasor representation. Rectangular and polar representation of phasor.

(No any derivation)

(2 Hrs)

**(E) Single Phase AC Circuits:**

Study of series R-L, R-C, R-L-C circuit and corresponding Phasor diagrams and voltage-current-power waveforms. Concept of active, reactive and apparent power and power factor. Concept of Impedance and power triangle.

(2 Hrs)

**(F) Polyphase AC Circuits:**

Concept of three-phase supply and phase sequence. Voltages, currents and power relations in three phase balanced star-connected loads and delta-connected loads along with phasor diagrams.

(2 Hrs)

## Section 2 (Electrical Machines)

### Unit 3:

#### (C) Single Phase Transformers:

Construction, principle of working, EMF equation, voltage and current ratios. Losses, efficiency, and voltage regulation of transformer. Determination of these by direct loading method. Descriptive treatment of autotransformers. (3Hrs)

#### (D) D.C Machines:

Construction of DC machines. Working principal of DC generators and motors. EMF equation, concept of back EMF. Types of DC machines. Losses and efficiency of DC machines. Power stages. Characteristics of DC Motors. Speed control methods. Necessity of Starters. Three point starter. Applications of DC motors. (3 Hrs)

### Unit 4:

(C) **Three phase Induction Motors:** Construction, working principle and types of induction motors. Rotating magnetic field, synchronous speed, slip. Rotor circuit parameters (current, EMF, impedance, power). Torque of Induction motor. Condition for Max. torque. Torque ratios. Torque-slip and Torque-Speed characteristic. Losses and efficiency of induction motor. Power stages. Starting methods. Speed control methods. Applications. (4 Hrs)

(D) **Single Phase motors:** Construction and Working principle. Classifications. Split phase induction motors. Shaded pole motors. Applications. (Descriptive only) (2 Hrs)

## Section 3 (Flight and Navigation Instruments)

### Unit 5: Transducers, Flight and Engine Instruments (6 Hrs)

**Transducers.** Resistive Transducers-Thermistors, RTD, Thermocouples and Strain Gauges. Inductive Transducers- Linear variable differential transformer (LVDT). Capacitive Transducers.

**Flight instruments:** Artificial Horizon, Turn and Slip Indicator, Rate of climb/ descent indicator, altimeter, air speed indicator,

**Engine Instruments:** Engine rpm, Fuel flow meter, fuel pressure indicator, Turbine exit temperature, Oil pressure gauge, Cylinder head temperature, manifold pressure gauge.

### Unit 6: Navigation Instruments: (6Hrs)

Navigation Instruments: Gyro Compass and Heading Indicator gauge, VOR Course Deviation Indicator (CDI) Radio direction finder (RDF) and Automatic Direction Finder (ADF) indicator combined with NAV/COM radios set to the frequencies of VOR and ADF stations. [2], w: Horizontal Situation Indicator (HSI) up to Electronic Attitude Director

Indicator (EADI), Electronic Flight Instrument System (EFIS), Dual VOR/ADF Course Deviation Indicator(CDI) (Nav1), (ILS) Localizer and Glide scope indicator.

### **Laboratory -**

Term work shall consist of a record of minimum eight exercises and experiments suggested as below:

11. To verify KCL and KVL
12. To verify Superposition theorem
13. To perform open circuit and short circuit test on a single-phase transformer.
14. To perform direct load test on single-phase transformer.
15. To measure three phase power by using two-wattmeter method.
16. Study of R-L-C series circuit
17. Verification of voltage and current relations in three phase balanced star and delta connected loads.
18. Study of safety precautions while working on electric installations and necessity of earthing.
19. Introduction to energy conservation and simple techniques to achieve it.
20. Study of various wiring components (Wires, Switches, Fuses, Sockets, Plugs, lamps, holders etc)

### **Suggested Reference Books**

1. D. P. Kothari and I. J. Nagrath, “Basic Electrical Engineering”, Tata McGraw Hill,2010.
2. C.R Dargan, “Electrical Technology” Dhanpatrai Publications
3. B.L Theraja “A textbook of Electrical Technology” S.chand and Company Ltd New Delhi
4. V.K.Mehta “Basic Electrical Engineering” S.chand and Company Ltd New Delhi.
5. A.K.Sawhney “A course in Electrical and Electronic Measurements and Instrumentation” Dhanpatrai and Company
6. G.Mandal, A.K. Datta “Electrical, Instruments& Radio” L.N.V.M. Society Group of Institutes, Dwarika,New Delhi.
7. IanMoir Allan & Seabridge “Aircraft Systems-Mechanical, electrical, and avionics subsystems integration” John Wiley & Sons Ltd.

## **Human Factors and Flight Safety [L : 2; T:1; P 0: -- (3 credits)]**

### **Detailed contents:**

#### ***Module 1: (8 lectures)***

Human Behaviour: Definitions of Human Behavior, Personality Types, Instructor and Student Relationship , Human Needs and Motivation, Human Needs That Must Be Met To Encourage Learning, Physiological, Security, Belonging, Esteem, Cognitive and Aesthetic, Self-Actualization.

***Module 2: (8 lectures)***

Human Nature and Motivation, Human Factors That Inhibit Learning, Defense Mechanisms, Repression, Denial, compensation, Projection, Rationalization, Reaction Formation, Fantasy, Displacement, Student Emotional Reactions, Anxiety, Normal Reactions to Stress, Abnormal Reactions to Stress.

***Module 3: (10 lectures)***

The Learning Process: The First Flight, The Check Ride, Discussion of First Flight and Check Ride, What Is Learning? The Framework for Learning, Learning Theory, Behaviorism, Cognitive Theory, Information Processing Theory, Constructivism, Perceptions, Factors That Affect Perception, Physical Organism, Goals and Values, Self-Concept, Time and Opportunity, Element of Threat, Insight, Acquiring Knowledge, Memorization, Understanding, Concept Learning, exercise, Primacy, Intensity, Recency.

***Module 4: (12 lectures)***

Domains of Learning, cognitive, Affective, Psychomotor. Characteristics of Learning, Learning Styles, Right Brain/Left Brain, Holistic/Serialist, Visual, Auditory, Kinesthetic Learners (VAK), Skill Knowledge, Skill Acquisition, Cognitive and Associative Stage, How To Develop Skills, Types of Practice, Deliberate Practice, Blocked Practice, Random Practice, Learning To Multitask, Distractions and Interruptions, Fixation and Inattention, How To Identify Fixation or Inattention

The Learning Route to Problem-Solving Tactics, Awareness of Existence of Unknowns, Errors : Kinds of Error, Slip, Mistake, Reducing Error, Learning and Practicing, Taking Time, Checking for Errors, Using Reminders, Developing Routines, Raising Awareness, Error Recovery, Learning From Error, Motivation, Where Does the Motivation To Learn Come From, Maintaining Motivation, Rewarding Success, Presenting New Challenges, Drops in Motivation, Short-Term Memory (STM), Long-Term Memory (LTM), Remembering What Has Been Learned, How Usage Affects Memory, Forgetting, Retrieval Failure, Fading, Interference, Retention of Learning, Transfer of Learning, Habit Formation,

***Module 5: (4 lectures)***

Effective Communication :Basic Elements of Communication, Source, Symbols, Receiver, Barriers to Effective Communication, Lack of Common Experience, Confusion Between the Symbol and the Symbolized Object. Developing Communication Skills, Role Playing, Instructional Communication, Listening, Questioning, Instructional Enhancement.

***Module 6: (3 lectures)***

Risk Management, Defining Risk Management, Principles of Risk Management, Accept No Unnecessary Risk, Make Risk Decisions at the Appropriate Level, Accept Risk When Benefits Outweigh the Costs

Integrate Risk Management Into Planning at All Level, Risk Management Process, Implementing the Risk Management Process, Level of Risk, Assessing Risk, Likelihood of an Event, Severity of an Event, Mitigating Risk.

### **Suggested Reference Books**

(i) FAA-h\_8083-9A Aviation Instructor's Handbook. By Federal Aviation Administration  
(ii) Aviation Psychology and Human Factors. By Monica Martinussen and David R. Hunter

(iii) Principles and Practice of Aviation Psychology by Pamela S. Tsang and Michael A. Vidulich

(iv) Aircraft Safety Accident investigations, Analyses and Applications. By Shari Stamford Krause.

**Course Outcomes:** At the end of the course students will be able to know:

- . Basics of human personality, needs, motivation, esteem. Basic human traits.
- . Human ability and method of learning. Factors which inhibit learning.
- . Ways of learning, different styles of learning, errors and how they occur, Multi-tasking.
- . communication skills and risk assessment and risk mitigation.

### **Aircraft Structures L : 2; T:0; P 0: -- (2 credits)]**

Students are made aware of construction of aircraft and structural limitations on flying and manoeuvring. Basics of strength of materials are covered. Aircraft construction of various components and loads experienced are covered. Common failures are explained.

Topics covered are:

Introduction to loads, free body diagram, stress and strain, Hooke's law.

Material properties and relation between stress and strain.

Tension, compression and shear. Axial loads and stresses in differently oriented planes.

Torsion.

Beams.

V-n Diagram

Fatigue and creep, Fatigue testing, Case study of Comet airplane.

Reference Books:

Elements of Strength of Material by Timoshenko and Young

Stability and Control by Perkins and Hage



## **Meteorology -2** [L : 3; T:0; P :2 -- (4credits)]

### **Module 1: (6 lectures)**

**Atmospheric thermodynamics:** Equation of state for dry and moist air, Adiabatic and Isothermal Processes, Humidity Parameters, Virtual Temperature, Standard Atmosphere, Laws of thermodynamics, Entropy, Potential Temperature, Pseudo- adiabatic Process, Equivalent Temperature, Equivalent Potential Temperature, Clausius – Clapeyron Equation, Stability and Instability, Parcel Method and Slice Method, Entrainment in Cb clouds, Thermodynamic Diagram: p,α–diagram, Emagram, T -Øgram, Uses of thermodynamic diagrams, Precipitable Water Vapour, Rate of Precipitation, Stability indices, Role of Convective Available Potential Energy (CAPE) and Convective Inhibition Energy (CINE) in thunderstorm development

### **Module 2: (8 lectures)**

**Thunderstorm:** Basic requirements, Development mechanism, Life cycle of a thunderstorm cell, Movement of thunderstorm, Air-mass, Steady state thunderstorms, Ordinary Cell, Multi-cell Cluster, Super cell Thunderstorms.

**Jet Stream** - Definition, Classification of Jet Stream, Characteristics of Jet Stream, Jet Stream over Indian region and Seasonal Variation, Jet Stream and associated Aviation Weather Hazards.

**Cloud Physics** - General aspects of cloud and precipitation formation. Condensation Nuclei. Growth of water droplets. Microphysical properties of clouds. Bowen's Model. Growth by Condensation and Coalescence. Ice phase Nucleation, Ice Nuclei, Diffusion growth on Ice Nuclei, further growth by Accretion and Aggregation. Different types of precipitation processes including Bergeron Process and weather modification.

**Atmospheric Electricity** - Fair Weather Electric field of the atmosphere. Ions and Ionizing radiation, Conduction current, diurnal variation of electric field and conductivity. Thunderstorm electrification, its observation and theoretical aspects. Thunderstorm detection systems at airfields. Thunderstorm as a mechanism for maintaining the fair weather electric field.

### **Module 3: (4 lectures)**

**Tropical cyclones:** Classification of tropical disturbances, Global Distribution of Tropical Cyclones, Origin, Season and Frequency, Necessary conditions for tropical cyclone formation, intensity and land fall. Structure of tropical cyclone, The Eye, The Eye-Wall, Rain-bands, Name of cyclones, associated weather-gale wind, storm surge, heavy rainfall.

**General Circulation:** Energy Balance, Transport Process, Three Cell Model, ITCZ, Sub tropical highs, Trade winds, Westerlies, Polar easterlies. Monsoon Condition- active and weak monsoon. EL-Nino, La-Nina, ENSO, Walker circulation and their effect on Indian monsoon.

### **Module 4: (4 lectures)**

**Radar Meteorology** - Application of Radar in Meteorology, characteristics of Radar Echoes, Doppler Radar, Radar Network and introduction to MST radar.

**Satellite Meteorology-** Polar orbiting and Geostationary satellites, Satellite systems: IRS and INSAT , Meteorological Images Multi-channel sensing, measurements of atmospheric

temperature, humidity, CO, Ozone, Clouds, Soil temperature and moisture, sea surface temperature, sea waves, ocean bed topography, future prospects.

### **Module 5: (6 lectures)**

**Aviation Weather Hazards** – Definitions: Thunder Storm, Thundery Conditions, tornado, water spout, funnel cloud, Dust Storm, Dust Raising Winds, Smoke, Gust, Gustnadoes, gust-front, Gale, Squall, squall lines, Icing, hail, ceiling and low cloud turbulence, down burst-microburst and macroburst, water ingestion, precipitation static.

**Mid-Latitude Meteorology** – Air Masses- definition and classification, Air mass modification, Stability of air mass, Fronts- definition- Types of fronts, Cold, Warm, Stationary and Occluded front, Frontal waves, frontal cyclone and occlusion, Warm front and Cold front occlusion, frontolysis and frontogenesis, Dryline. Extra-tropical cyclone and its comparison with tropical cyclone, Western Disturbances -their formation, movement and associated weather. Induced low, their formation, movement and associated weather.

### **Module 6: (2 lectures)**

Icing - Super-cooled water droplets, effect of icing on aircraft, structural icing- glaze, rime, mixed, pack, rain, hoar frost, freezing level, icing intensities. Induction and instrument icing, icing in clouds and ground icing.

### **Module 7: (4 lectures)**

**Global Climatology** - Global distribution of pressure and temperature at m.s.l. in winter and summer, distribution of annual rainfall and its variability, distribution of moisture and clouds. Vertical distribution of temperature. General circulation of atmosphere. Development of monsoons. Major categories of world climates.

**Aeronautical Climatology** - Airfield Weather Summary. Route Weather Summary (Indian). Route Weather Summary (Foreign).

### **Module 8: (14 lectures)**

**Aircraft Observations and Reporting:** Obligation of States, Aircraft observations, Routine Aircraft observations, Special Aircraft Observations and Reporting of Air reports.

**Aviation Forecast** – Forecast for Take-off and Landing. Trend type landing Forecast, Local Forecast, Area Forecast, ROFOR, WAFS, TAFs, GAMET, Reliability and accuracy of forecast.

**Warnings** - Cautionary Reports, Weather Warnings and Gale warnings, Storm Warnings, Aerodrome Warnings; SIGMET, AIRMET, SNOWTAM and Wind Shear Warnings.

**Flight Briefings and advices** - Pre-flight information. Information at the time of briefing. In-flight Weather information. Post flight Weather information and Debriefs. VIP/VVIP Flight briefings. NOTAMs and SNOTAMs  
Documentation including Chart form of documentation and WAFS and products from WAFS.

**Operations of Aircraft** - Meteorological requirements for different types of Aircraft and Air operations: Effect of Air density, Humidity, Turbulence and Winds on aircraft performance. Meteorology and Flight Safety.

**Special Weather Phenomena** - Jet streams. Clear Air Turbulence. Mountain waves. Icing Contrails. Dust haze/Dust raising winds. Fog/Mist/Haze. Definition: features and their effects on aviation.

### **Communication Network for exchange of aeronautical data.**

ROBEX, VOLMET, D-VOLMET, ATIS, ACARs, AMDAR, Direct Reception System, internet use for meteorological briefing.

### **List of Practicals :**

- **TYPE I : Nowcasting technique.**
- **TYPE II : Place Specific Objective forecasting techniques** – for
  - important Aviation Weather Hazards like Thunderstorm Dust
  - Storm, Squall, Poor Visibility (Fog, Mist,).
- **TYPE III : Area Forecast:** Preparation of enroute weather forecast for a
  - flight.
- **TYPE IV :** Exercises in issue of Weather warning; Cautionary Met report;
  - Gale warning; SIGMET; Aerodrome warning.

### **Reference Books:**

1. WMO Tech Notes on CAT, Mountain Waves, Icing, etc.
2. WMO Tech Note No 95 on Aeronautical Met.
3. Manual of Aeronautical Meteorological Practice by ICAO Doc 8896.
4. Meteorological Service for International Air Navigation by WMO- No.49 Volume II.
5. Essential of Meteorology: An invitation to the atmosphere by C. Donald Ahrens
6. Aviation weather by Peter Lester
7. Meteorology and Flight : A pilot's guide to weather by Tom A. M. Bradbury
8. Meteorology for pilot by Mike Wickson

### **Outcome after learning the course ( Meteorology-1 and Meteorology-2):**

1. Students will be highly skilled professional aviators who understand the International and national airspace system and can be utilized with all aspect of the air traffic control system used by Director General of Civil Aviation, Airport Authority of India and Airlines. Students will be able to plan a cross country flight with current data, print the developed flight log and demonstrate satisfactory knowledge about the elements of such a flight.

2. Students will develop communication skills and proficiency and will be able to apply these skills in the aviation environment. Students will be appointed in teams of two or four such that they will develop an oral presentation given to the class on an assigned weather chapter out of the textbook.

3. Students will recognize their responsibility to continue professional and personal development with an emphasis on diversity, ethics and teamwork. The assigned project to team members will be evaluated by classmates and the instructor and each team member will evaluate each other based on individual effort and teamwork performed within the team project.

4. Students will use appropriate aeronautical decision making based on meteorological conditions, human factors and safety.

## **(BAV305) Mass, Balance, Loading and CG[L : 3; T:0; P 0] (4credits, Lectures) (Revised)**

### ***Module 1: Mass and Balance of Airplanes ( Lectures)***

Introduction to Mass and Balance: Centre of Gravity, Definition, Importance in regard to aircraft stability, , Mass and Balance, Consult airplane manual CG limits for takeoff, landing and cruise configuration. Maximum floor load, max ramp and taxi mass.

Mass and balance document factors determining permissible mass: structural limitations, performance limitations such as runway available for takeoff and landing, weather conditions (temperature, pressure, wind, precipitation), rate of climb and altitude requirements for obstacle clearance, engine out performance requirements.

### ***Module 2: CG Location ( Lectures)***

Factors determining CG limits: aircraft stability, ability of flight controls and surfaces to overcome mass and lift pitching moments under all flight conditions, changes in CG location during flight due to consumption of fuel, raising lowering of undercarriage and intentional relocation of passengers or cargo, transfer of fuel, movement of centre of lift because of changes in position of wing flaps.

### ***Module 3: Loading. ( Lectures)***

Terminology: empty mass, dry operating mass, zero fuel mass, standard mass- crew, passengers and baggage, fuel, oil, water ( volume/ mass conversion factors), carry-on luggage, useful load (traffic load,+ useful fuel).

Effects of overloading: high takeoff and safety speeds, longer takeoff and landing distance, lower rate of climb, effect on range and endurance, decreased engine-out performance, possible structural damage in extreme cases.

### ***Module 4: Centre of Gravity (CG) Movement ( Lectures)***

Basics of CG calculations (load and balance document). Datum- explanation of term, location, use in CG calculation. Moment arm: explanation of term, determining of algebraic signs, use. Moment: explanation, moment = mass X moment arm, Expression in % of mean aerodynamic chord (% MAC) Calculation of CG: Effects of load shift, Movement of CG , possible out of limits. Possible damage due to inertia of a moving load, effects of acceleration of the aircraft load.

### **Suggested Reference Books**

- (i) FAA-H-8083-18 Handbook of Navigation, 2011 edition. By Federal Aviation Administration.
- (ii) Air Pilot's Manual Vol 3 & 5. By Peter D Godwin
- (iii) Flight Performance & Planning. By AS Nordian
- (iv) General Navigation: ATPL JAR. By AS Nordian
- (v) GPS : Navigation. By Underdown
- (vi) GPP : Plotting & Flight Planning. By Underdown
- (vii) Radio Navigation ATPL JAR. By AS Nordian

Flight Plans for cross country Flights

***Module 1: Navigation Plan ( Lectures)***

Navigation Plan: selection of routes, speeds, heights (altitudes), alternate airfields/ landing sights. Terrain and obstacle clearance, cruising level appropriate for direction of flight, Navigation check points: visual and radio. Measurements of tracks and distances, obtaining wind velocity forecast for each leg, computations of headings, ground speeds and time-enroute from tracks, true airspeed and wind velocities, completion of pre-flight portion of navigation flight log.

***Module 2: Fuel Plan ( Lectures)***

Fuel Plan: Computation of planned fuel usage for each leg and total fuel usage for the flight. Flight manual figures for fuel flow during climb, en-route and descent. Navigation plan for times en-route. Fuel for holding and diversion to alternate airfield, reserves, , total fuel requirement for the flight. Completion of pre-flight portion of fuel log.

***Module 3: Flight Monitoring ( Lectures)***

Flight monitoring and in-flight re-planning: In-flight fuel computations, recording of fuel quantities remaining at navigational check points, Calculation of actual fuel consumption rate. Comparison of actual and planned fuel consumption and fuel state. Revision of fuel reserve estimates, in-flight re-planning in case of problems, selection of cruise altitude and power setting for new destination, time to new destination, fuel state, fuel requirements, fuel reserves.

***Module 4: Radio and Navigation ( Lectures)***

Radio Communication and Navigation Aids: Communication frequencies, call signs for appropriate control agencies and inflight service facilities as weather stations. Radio navigation and approach aids, if appropriate type, frequency and identification.

***Module 5: ICAO Flight Plan ( Lectures)***

ICAO ATC Flight Plan: Types of flight plan, ICAO flight plan format, completing the flight plan, filling the flight plan, procedure for filling, agency responsible for processing the flight plan, adherence to flight plan.

***Module 6: Practical Flight Plan ( Lectures)***

Practical Flight Planning: Chart preparation, plot tracks and measure directions and distances. Navigation plans: completing the navigation plan using Tracks and distances from prepared charts, wind velocities as provided, , true airspeed as appropriate. Simple fuel plans: preparation of fuel logs showing planned values for : fuel used on each leg, fuel remaining at end of each leg, endurance based on fuel remaining and planned consumption rate at end of each leg. Radio Planning Practice: Communications, frequencies and call signs of Air Traffic Control agencies and facilities and for in-flight services such as weather information.

### **Module 7: Completion of Flight Plan ( Lectures)**

Practical completion of Flight Plan. Extraction of data: navigation data, meteorological data, performance data, completion of navigation flight plan. completion of fuel plan: time and fuel to top of climb, cruise sector times and fuel used, total time and fuel used, total time and fuel required to destination, fuel required for missed approach, climb en-route altitude and cruise alternate, reserve fuel. Completion of air traffic flight plan.

### **Suggested Reference Books**

- (i) FAA-H-8083-18 Handbook of Navigation, 2011 edition. By Federal Aviation Administration.
- (ii) Air Pilot's Manual Vol 3 & 5. By Peter D Godwin
- (iii) Flight Performance & Planning. By AS Nordian
- (iv) General Navigation: ATPL JAR. By AS Nordian
- (v) GPS : Navigation. By Underdown
- (vi) GPP : Plotting & Flight Planning. By Underdown
- (vii) Radio Navigation ATPL JAR. By AS Nordian

**Course Outcomes:** At the end of the course the student will be able to know:

- .How to read and understand maps, earth's shape and size, co-ordinate system used
- .Relation between time, latitude, standard time. Units of measurement of distance.
- .Aeronautical charts and how to use them. How to use Aeronautical maps for planning flight near the airport and on way to destination.

## **Civil Air Requirements**

### **Module 1: (15 Lectures)**

#### **Indian Aircraft Act 1934**

Rules 1, 2, 8, 10, 11 & 12

#### **Indian Aircraft Rules 1937**

Part I – Extent & Definitions

Part II – General Flying Conditions

Rules – 4 to 20

Part III – General Safety Conditions

Rules – 21, 24, 24A, 24C

Part IV – Registration and marking of Aircraft Change in ownership

Rules – 33 & 34

Part V – Personnel of Aircraft

Rules – 38, 38 A(1) (a), 38 A(5), 38 A(6), 38 A(7), 42 A & 47.

### **Module 2: ( 15 lectures)**

Part VI – Airworthiness

Rules 52, 53 & 55

Part VII – Radio Telegraphic Apparatus

Rule 63

Schedule I – Prohibited Areas

Schedule II – Private Pilots Licence, Validity, Renewal & Privileges,  
General Requirements

Schedule III – Instrument Rating – Validity, Renewal & Privileges,  
General Requirements

**Module 3: ( 15 lectures)**

Schedule IV – Rules of the Air (Excluding water operations & Sea Planes)

Relevant Contents of Aeronautical Information publication

Relevant notices to Airmen

Aeronautical Information circular

Civil Aviation Requirements

**REFERENCE BOOKS**

**TITLE PUBLISHER**

1. Aviation Act 1934 Ministry of Civil Aviation
2. Indian Aircraft Rules Ministry of Civil Aviation
3. Aeronautical Information Publication Ministry of Civil Aviation
4. Aircraft Manual India

**Soft Skills** [L : 3; T:--; P 2: -- (4 credits)]

**Detailed contents:**

**Module 1: (5 lectures)**

What are soft skills, why are they important. Examples of soft skills, Examples of soft skills with videos.

**Module 2: (15 lectures)**

Knowing self, Knowing what others think about you. Understanding others, Johari Windows, Interpersonal skills, Team work, empathy, Emotional Quotient, giving and taking feedback.

**Module 3: (20 lectures)**

Communication Skills, Spoken and Written, Body language. Presentation Skills, how to prepare for a presentation, How to deliver an effective presentation, practical presentation.

**Module 4: (10 lectures)**

Written skills, Deciding on the objective, how to plan the report, how to research a topic, how to find important points, how to write effectively. How to quote references, Index, Bibliography.

**Module 5: ( 5lectures)**

Time and stress management.

## Suggested Reference Books

1. Effective Communication by Keith Coleman
2. Writing without bullshit by Josh Burnoff
3. Assertiveness by Michael Hudson

**Course Outcomes** after the course the students will be able

- . Understand their own personality
- . Understand how to manage interpersonal relations effectively.
- . Develop skills to deliver talks and presentations effectively.
- . Develop written skills to write reports.

### **Laboratory - [ L : 0; T:0 ; P :2 -- (1 credits)]**

Suggested list of experiments from the following:

- Give a talk for 5 minutes extempore
- Give a long, prepared presentation
- Write and submit an essay.

### **Simulator Flying [L : 3; T:1-; P 4: -- (6 credits)]**

**Detailed contents:** Following topics are covered during the simulator to familiarise students with airplane systems used by pilots. After familiarisation the students are trained to fly the airplane using the simulator. The airplane is flown, controlled and navigated.

#### ***Module 1: (5 lectures)***

Aircraft Control Systems: basic ac structure, shape, parts, function.

Flight Controls: Primary and secondary controls, trimmers.

Control Systems: Electrical, Hydraulic and pneumatic.

#### ***Module 2: (15 lectures)***

Navigation: Airnavigation systems, Nav-aids, and operations. Maps, charts, Velocities, winds, track, bearing, distance, speeds, time, situational awareness, CDMVT, magnetic compass.

Radio Nav Instruments: NDB, ADF, VOR, DME, ILS, Radar (primary and secondary).

#### ***Module 3: (20 lectures)***

Flight Instruments: Analogue and Digital. Control, performance. Indicators and displays.

Pressure Instruments: Alt, ASI, VSI, Mach meter

Gyro Instruments: Attitude Indicators, TSI, DG

Magnetic Instruments: Compass

Combined Gyro Magnetic Instrument: DG

#### ***Module 4: (10 Lectures and Practicals)***

Electronic Flight Instruments System: EFIS: Digital Display for Flight Crew.



ADC feeds, CRT / LED screens, PFD, ND, MFD, EICAS, APIFD, FG

***Module 5: ( 10 Lectures and Practicals )***

Radio Communication: VHF, HF Long range, SELCAL, ACARSs, ADS

***Module 6 (10 Lectures and Practicals )***

Engine Instruments: Propeller-piston, Propeller- turboprop, Turbo Jet. Engine performance and control. Power display Instruments: RPM, Torque, EPR, N1. Control Instruments: CHT, EGT, Vibration detection.

***Module7: (4 Lectures and Practicals )***

Failure Warning and Alerting Systems: Warning for Failures, Fire, Stall, Over/under speed etc. Indications: Audio, Video, Tactile, Textual.

***Module 8: (4 Lectures and Practicals )***

TCAS, GPWS, Weather Radar etc..

***Module 9: ( 6 Lectures and Practicals )***

Related topics: Airport Layout, Air routes, Instrument flying procedures.

***Module 10: ( 6 Lectures and Practicals )***

Aviation Safety,,: avoidance of incidents and accidents, Continuous Training, Adherence to Rules and SOPs.

**Suggested Reference Books**

- . Manual of Jeet Aerospace

**Course Outcomes:** after the course the students will be able to

- . Familiarise airplane parts, configurations, parts etc
- . Know cockpit layout and its instrument and operating controls
- . Know navigation, communication and control of airplane
- . Know airfield layout, flight planning, procedures etc
- . Know importance of SOPs, Rules and Training.