# MATS UNIVERSITY

## Raipur (C.G.)

# Syllabus Scheme

**(5th Semester)**

**For**

**Bachelor of Engineering**

**In**

## AERONAUTICAL

## MATS School of Engineering & Technology

**ARANG, RAIPUR (C.G.)**

# MATS UNIVERSITY

**ARANG, RAIPUR**

## Subject Code for School of Engineering & Technology

## 5th Semester (AERONAUTICAL)

| S.No. | Subject Code | Subject Name |
|---|---|---|
| 1 | **BE550** | Aerodynamics-II |
| 2 | **BE551** | Propulsion-I |
| 3 | **BE552** | Control Engineering |
| 4 | **BE553** | Aircraft Performance |
| 5 | **BE554** | Civil Aviation Requirements |
| 6 | **BE555** | Aircraft Structures-II |
| 7 | **BE556** | Aircraft Structures-II Lab |
| 8 | **BE557** | Aircraft Structures Repair Lab |
| 9 | **BE558** | Propulsion-I Lab |
| 10 | **BE559** | CAD/CAM Lab |

# MATS UNIVERSITY

## ARANG, RAIPUR

### Scheme of Teaching & Examination

### B.E. V SEMESTER AERONAUTICAL ENGINEERING

| S.N. | code | Subject | Periods per week | | | Scheme of marks | | Total Marks |
|---|---|---|---|---|---|---|---|---|
| | | | L | T | P | ESE | IM | |
| 1. | BE550 | Aerodynamics-II | 4 | 1 | - | 70 | 30 | 100 |
| 2. | BE551 | Propulsion-I | 4 | 1 | - | 70 | 30 | 100 |
| 3. | BE552 | Control Engineering | 4 | 1 | - | 70 | 30 | 100 |
| 4. | BE553 | Aircraft Performance | 4 | 1 | - | 70 | 30 | 100 |
| 5. | BE554 | Civil Aviation Requirements | 4 | 1 | - | 70 | 30 | 100 |
| 6. | BE555 | Aircraft Structures-II | 4 | 1 | - | 70 | 30 | 100 |
| 7. | BE556 | Aircraft Structures-II Lab | - | | 3 | 20 | 30 | 50 |
| 8. | BE557 | Aircraft Structures Repair Lab | - | | 3 | 20 | 30 | 50 |
| 9. | BE558 | Propulsion-I Lab | - | | 3 | 20 | 30 | 50 |
| 10. | BE559 | CAD/CAM Lab | - | | 3 | 20 | 30 | 50 |
| | | Total | 24 | 6 | 12 | 500 | 300 | 800 |

L – Lecture, T – Tutorial, ESE – End Semester Examination,

P – Practical, IM – Internal Marks (Include Class Test & Teacher's Assessments)

**MATS UNIVERSITY, RAIPUR**

| | | |
|---|---|---|
| Semester | : | 5th BE Course |
| Branch | : | Aeronautical |
| Subject | : | Aerodynamics – II |
| Total Theory Periods | : | 45 |
| Total Tutorial Periods | : | 15 |
| Code | : | BE 550 |

**UNIT-I FUNDAMENTAL ASPECTS OF COMPRESSIBLE FLOW**

Compressibility, Continuity, Momentum and energy equation for steady one dimensional flow, compressible Bernoulli's equation, Calorically perfect gas, MachNumber, Speed of sound, Area – Mach number – Velocity relation, Mach cone, Machangle, One dimensional Isentropic flow through variable area duct, Static andStagnation properties, Critical conditions, Characteristic Mach number, Area-Machnumber relation, Maximum discharge velocity.

**UNIT-II SHOCK AND EXPANSION WAVES**

Normal shock relations, Prandtl's relation, Hugoniot equation, Raleigh Supersonic Pitot tube equation, Moving normal shock waves, Oblique shocks, $\Theta$-$\beta$-$M$ relation, Shock Polar, Reflection of oblique shocks, left running and rightrunning waves, Interaction of oblique shock waves, slip line, Rayleigh flow, Fanno flow, Expansion waves, Prandtl-Meyer expansion, Maximum turning angle, Simpleand non-simple regions, operating characteristics of Nozzles, under expansion, over expansion.

**UNIT-III TWO DIMENSIONAL COMPRESSIBLE FLOW**

Potential equation for 2-dimensional compressible flow, Linearisation of potential equation, perturbation potential, Linearised Pressure Coefficient, Linearised subsonic flow, Prandtl-Glauert rule, Linearised supersonic flow, Method of characteristics.

**UNIT-IV HIGH SPEED FLOW OVER AIRFOILS, WINGS AND AIRPLANE CONFIGURATION**

Critical Mach number, Drag divergence Mach number, Shock Stall, Supercritical Airfoil Sections, Transonic area rule, Swept wing, Airfoils for supersonic flows, Lift,drag, Pitching moment and Centre of pressure for supersonic profiles, Shock expansion theory, wave drag, supersonic wings, Design considerations for supersonic aircrafts.

**UNIT-V SPECIAL TOPICS**

Shock-Boundary layer interaction, Wind tunnels for transonic, Supersonic and hypersonic flows, shock tube, Gun tunnels, Supersonic flow visualization, Introduction to Hypersonic Flows, Numerical Analysis of one Dimensional flow.

**TEXT BOOKS**

1. Anderson, J. D, Modern Compressible Flow, McGraw-Hill & Co., 2002.
2. Rathakrishnan., E, Gas Dynamics, Prentice Hall of India, 2004.

**REFERENCES**

1. Shapiro, A. H., Dynamics and Thermodynamics of Compressible Fluid Flow, Ronald Press, 1982.
2. Zucrow, M. J. and Anderson, J. D., Elements of Gas Dynamics, McGraw- Hill &Co., 1989.
3. Oosthuizen,P.H., &Carscallen,W.E., Compressible Fluid Flow, McGraw- Hill &Co., 1997.

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| | | |
|---|---|---|
| Semester | : | 5th BE Course |
| Branch | : | Aeronautical |
| Subject | : | Propulsion – I |
| Total Theory Periods | : | 45 |
| Total Tutorial Periods | : | 15 |
| Code | : | BE 551 |

**UNIT-I FUNDAMENTALS OF GAS TURBINE ENGINES**

Illustration of working of gas turbine engine–The thrust equation–Factors affecting thrust– Effect of pressure, velocity and temperature changes of air entering compressor–Methods of thrust augmentation–Characteristics of turboprop, turbofan and turbojet–Performance characteristics.

**UNIT-II SUBSONIC AND SUPERSONIC INLETS FOR JET ENGINES**

Internal flow and Stall in subsonic inlets – Boundary layer separation – Major features of external flow near a subsonic inlet – Relation between minimum area ratio and eternal deceleration ratio – Diffuser performance – Supersonic inlets – Starting problem on supersonic inlets – Shock swallowing by area variation – External declaration – Models of inlet operation.

**UNIT-III COMBUSTION CHAMBERS**

Classification of combustion chambers–Important factors affecting combustion chamber design –Combustion process–Combustion chamber performance–Effect of operating variables on performance–Flame tube cooling–Flame stabilization–Use of flame holders–Numerical problems.

**UNIT-IV NOZZLES**

Theory of flow in isentropic nozzles–Convergent nozzles and nozzle choking–Nozzle throat conditions–Nozzle efficiency–Losses in nozzles–Over expanded and under–expanded nozzles–Ejector and variable area nozzles–Interaction of nozzle flow with adjacent surfaces–Thrust reversal.

**UNIT-V COMPRESSORS**

Principle of operation of centrifugal compressor–Work done & pressure rise–Velocity diagrams –Diffuser vane design considerations–Concept of pre whirl–Rotation stall–Elementary theory of axial flow compressor–Velocity triangles–degree of reaction–Three dimensional–Air angle distributions for free vortex and constant reaction designs–Compressor blade design–Centrifugal and Axial compressor performance characteristics.

**TEXT BOOKS**

1. Hill, P.G. & Peterson, C.R. "Mechanics & Thermodynamics of Propulsion" Addison–Wesley Longman INC, 1999.

**REFERENCES**

1. Cohen, H. Rogers, G.F.C. and Saravanamuttoo, H.I.H. "Gas Turbine Theory", Longman, 1989.
2. Oates, G.C., "Aero thermodynamics of Aircraft Engine Components", AIAA Education Series, New York, 1985.
3. "Rolls Royce Jet Engine" – Third Edition – 1983.
4. Mathur, M.L. and Sharma, R.P., "Gas Turbine, Jet and Rocket Propulsion", Standard Publishers & Distributors, Delhi, 1999.

**MATS UNIVERSITY, RAIPUR**

| | | |
|---|---|---|
| Semester | : | 5th BE Course |
| Branch | : | Aeronautical |
| Subject | : | Control Engineering |
| Total Theory Periods | : | 45 |
| Total Tutorial Periods | : | 15 |
| Code | : | BE 552 |

**UNIT-I INTRODUCTION**

Historical review, Simple pneumatic, hydraulic and thermal systems, Series and parallel system, Analogies, mechanical and electrical components, Development off light control systems.

**UNIT-II OPEN AND CLOSED LOOP SYSTEMS**

Feedback control systems Block diagram representation of control systems, Reduction of block diagrams, Output to input ratios.

**UNIT-III CHARACTERISTIC EQUATION AND FUNCTIONS**

Laplace transformation, Response of systems to different inputs viz., Step impulse, pulse, parabolic and sinusoidal inputs, Time response of first and second order systems, steady state errors and error constants of unity feedback circuit.

**UNIT-IV CONCEPT OF STABILITY**

Necessary and sufficient conditions, Routh-Hurwitz criteria of stability, Root locusand Bode techniques, Concept and construction, frequency response.

**UNIT-V SAMPLED DATA SYSTEMS**

Z-Transforms, Introduction to digital control system, Digital Controllers and Digital PID controllers

**TEXT BOOKS:**

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

**REFERENCES:**

1. Kuo, B.C. Automatic control systems, Prentice-Hall of India Pvt.Lted., New Delhi,1998.
2. Houpis, C.H. and Lamont, G.B. Digital control Systesm, McGraw Hill Book co.,New York, U.S.A. 1995.
3. Naresh K Sinha, Control Systems, New Age International Publishers, New Delhi, 98.

**MATS UNIVERSITY, RAIPUR**

| | | |
|---|---|---|
| Semester | : | 5th BE Course |
| Branch | : | Aeronautical |
| Subject | : | Aircraft Performance |
| Total Theory Periods | : | 45 |
| Total Tutorial Periods | : | 15 |
| Code | : | BE 553 |

**UNIT-I GENERAL CONCEPTS**

International Standard atmosphere, IAS, EAS, TAS, Propeller theory- Froude momentum and blade element theories, Propeller co-efficients, Use of propeller charts, Performance of fixed and variable pitch propellers, High lift devices, Thrust augmentation.

**UNIT-II DRAG OF BODIES**

Streamlined and bluff body, Types of drag, Effect of Reynold's number on skin friction and pressure drag, Drag reduction of airplanes, Drag polar, Effect of Mach number on drag polar.

**UNIT-III STEADY LEVEL FLIGHT**

Steady level flight, Thrust required and Power required, Thrust available and Power available for propeller driven and jet powered aircraft, Effect of altitude, maximum level flight speed, conditions for minimum drag and minimum power required, Effect of drag divergence on maximum velocity, Range and Endurance of Propeller and Jet airplanes.

**UNIT-IV GLIDING AND CLIMBING FLIGHT**

Shallow and steep angles of climb, Rate of climb, Climb hodograph, Maximum Climb angle and Maximum Rate of climb- Effect of design parameters for propeller and jet aircrafts, Absolute and service ceiling, Cruise climb, Gliding flight, Glide hodograph.

**UNIT-V ACCELERATD FLIGHT**

Estimation of take-off and landing distances, Methods of reducing landing distance, level turn, minimum turn radius, bank angle and load factor, Constraints on load factor, Pull up and pull down maneuvers, maximum turn rate, V-n diagram.

**TEXT BOOKS:**

1. Houghton, E.L. and Carruthers, N.B. Aerodynamics for engineering students, Edward Amold Publishers, 1988.
2. Anderson, Jr., J.D. Aircraft Performance and Design, McGraw-Hill International Edition, 1999.

**REFERENCES:**

1. Kuethe, A.M. and Chow, C.Y., Foundations of Aerodynamics, John Wiley & Sons, 1982.
2. J.J.Bertin, Aerodynamics for Engineers, Prentice-Hall, 1988.
3. L.J. Clancey, Aerodynamics, Pitman, 1986
4. Anderson, Jr., J.D. Introduction to Flight, McGraw-Hill International Edition, 1999.

**MATS UNIVERSITY, RAIPUR**

| | | |
|---|---|---|
| Semester | : | 5th BE Course |
| Branch | : | Aeronautical |
| Subject | : | Civil Aviation Requirements |
| Total Theory Periods | : | 40 |
| Total Tutorial Periods | : | 15 |
| Code | : | BE 554 |

**UNIT-I C.A.R. SERIES 'A' AND 'B'**

**C.A.R. SERIES 'A' – Procedure for Civil Air Worthiness Requirements and Responsibility Operators Vis-À-Vis Air Worthiness Directorate**

Responsibilities of operators / owners-Procedure of CAR issue, amendments etc., Objectives and targets of airworthiness directorate; Airworthiness regulations & safety oversight of engineering activities of operators.

**C.A.R. SERIES 'B' – Issue Approval of Cockpit Check List, MEL, CDL:**

Deficiency list (MEL & CDL); Preparation and use of cockpit checklist and emergency list.

**UNIT-II C.A.R. SERIES 'C' AND 'D'**

**C.A.R. SERIES 'C' – Defect Recording, Monitoring, Investigation and Reporting**

Defect recording, reporting, investigation, rectification and analysis; Flight report; Reporting and rectification of defects observed on aircraft; Analytical study of in-flight readings & recordings; Maintenance control by reliability Method.

**C.A.R. SERIES 'D' – and aircraft maintenance programmes**

Reliability Programmes (Engines); Aircraft maintenance programme & their approval; On condition maintenance of reciprocating engines; TBO–Revision programme; Maintenance of fuel and oil uplift and consumption records – Light aircraft engines; Fixing routine maintenance periods and component TBOs – Initial & revisions.

**UNIT-III C.A.R. SERIES 'E' AND 'F'**

**C.A.R. SERIES 'E' – Approval of Organisations**

Approval of organizations in categories A, B, C, D, E, F, & G - Requirements of infrastructure at stations other than parent base.

**C.A.R. SERIES 'F' – Air Worthiness and Continued Air Worthiness:**

Procedure relating to registration of aircraft; Procedure for issue/revalidation of Type Certificate of aircraft & its engines/propeller; Issue/revalidation of Certificate of Airworthiness; Requirements for renewal of Certificate of Airworthiness.

**UNIT-IV C.A.R. SERIES 'L'&'M'**

Issue of AME License, its classification and experience requirements, Mandatory Modifications /Inspections.

**UNIT-V C.A.R. SERIES 'T'&'X'**

Flight testing of (Series) aircraft for issue of C of A; Flight testing of aircraft for which C of A had been previously issued. Registration Markings of aircraft; Weight and balance control of an aircraft; Provision of first aid kits & Physician's kit in an aircraft; Use furnishing materials in an aircraft; Concessions; Aircraft log books; Document to be carried on board on Indian registered aircraft; Procedure for issue of tax permit; Procedure for issue of type approval of aircraft components and equipment including instruments.

**TEXT BOOKS**

1. "Civil Aviation Requirements with latest Amendment (Section 2 Airworthiness)" –Published by DGCA, The English Book Store, 17-1, Connaught Circus, New Delhi 2000.
2. Aeronautical Information Circulars (relating to Airworthiness) from DGCA 2000.

**REFERENCES**

1. "Aircraft Manual (India) Volume" – Latest Edition, the English Book Store, 17-1, Connaught Circus, New Delhi.
2. Advisory Circulars from DGCA 2003.

**MATS UNIVERSITY, RAIPUR**

| | | |
|---|---|---|
| Semester | : | 5th BE Course |
| Branch | : | Aeronautical |
| Subject | : | Aircraft Structures –II |
| Total Theory Periods | : | 40 |
| Total Tutorial Periods | : | 15 |
| Code | : | BE 555 |

**UNIT-I UNSYMMETRICAL BENDING**

Bending of symmetric beams subject to skew loads - bending stresses in beams of unsymmetrical sections – generalized 'k' method, neutral axis method, principal axis method.

**UNIT-II SHEAR FLOW IN OPEN SECTIONS**

Thin walled beams – concept of shear flow – the shear centre and its determination– shear flow distribution in symmetrical and unsymmetrical thin-walled sections –structural idealization – shear flow variation in idealized sections.

**UNIT-III SHEAR FLOW IN CLOSED SECTIONS**

Bredt -Batho theory – single-cell and multi-cell tubes subject to torsion – shear flowdistribution in thin-walled single & multi-cell structures subject to combined bending torsion – with walls effective and ineffective in bending – shear centre of closed sections.

**UNIT-IV BUCKLING OF PLATES**

Bending of thin plates – rectangular sheets under compression - local buckling stress of thin walled sections – crippling strength estimation – thin-walled column strength – load carrying capacity of sheet stiffener panels – effective width.

**UNIT-V STRESS ANALYSIS OF WING AND FUSELAGE**

Loads on an aircraft – the V-n diagram – shear force and bending moment distribution over the aircraft wing and fuselage –shear flow in thin-webbed beamswith parallel and non-parallel flanges – complete tension field beams– semi-tension field beam theory.

**TEXT BOOK**

1. Megson T M G, 'Aircraft Structures for Engineering Students', Edward Arnold, 1995.
2. Bruhn. E.H., 'Analysis and Design of Flight Vehicles Structures', Tri-state off-set company, USA, 1985.
3. Howard D Curtis, 'Fundamentals of Aircraft Structural Analysis', WCB-McGrawHill, 1997

**REFEENCES**

1. Rivello, R.M., Theory and Analysis of Flight Structures, McGraw Hill, 1993.
2. Peery, D.J., and Azar, J.J., Aircraft Structures, 2nd edition, McGraw – Hill, N.Y., 1999.

**MATS UNIVERSITY, RAIPUR**

Semester : 5th BE Course
Branch : Aeronautical
Subject : Aircraft Structures-II Lab
Code : BE 556

## LIST OF EXPERIMENTS

1. Generation of lift and tip vortices.
2. Flow visualization in water flow channel
3. Flow visualization in smoke tunnel
4. Plot of RPM Vs test section velocity in a subsonic wind tunnel.
5. Pressure distribution over circular cylinder.
6. Pressure distribution over airfoil and estimation of CL and CD.
7. Force measurement using wind tunnel balance.
8. Mach number distribution in nozzle of supersonic wind tunnel.
9. Use of Schlieren system to visualize shock.
10. Use of Shadow graph system to visualize shock.

## LIST OF EQUIPMENTS

(For a batch of 30 students)

| S. No. | Details of Equipments | Qty Req. | Expt. No. |
|---|---|---|---|
| 1 | Blower, Balance, and small aspect ratio model | 1 | 1 |
| 2 | Water flow channel & models | 1 set | 2 |
| 3 | Subsonic wind tunnel | 1 | 3, 4,5,6,7 |
| 4 | Smoke apparatus and rake | 1 | 3 |
| 5 | Manometer, Pitot-Static tube | 1 | 4,5,6 |
| 6 | Circular cylinder and Aerofoil pressure distribution models | 1 | 5,6 |
| 7 | Wind tunnel strain gauge balance | 1 | 7 |
| 8 | Supersonic wind tunnel, Mercury manometer | 1 | 8,9,10 |
| 9 | Schlieren system and Shadow graph system | 1 | 9,10 |
| 10 | Sharp nosed and Blunt nosed models | 1 | 9,10 |

**MATS UNIVERSITY, RAIPUR**

Semester : 5th BE Course
Branch : Aeronautical
Subject : Aircraft Structures Repair Lab
Code : BE 557

## LIST OF EXPERIMENTS

1. Patch repair welding using TIG.
2. Patch repair welding using MIG.
3. Patch repair welding using Plasma Arc.
4. Exercise on pipe bending.
5. Exercise on Riveted joints & repair work.
6. Exercise on composites & repair work.
7. Repair of Sandwich panels.
8. Exercise on Sheet metal forming.
9. Exercise on cable swaging.

## LIST OF EQUIPMENTS

(For a batch of 30 students)

| S. No. | Details of Equipments | Qty Req. | Expt. No. |
|---|---|---|---|
| 1 | Shear cutter pedestal type | 1 | 6,8 |
| 2 | Drilling Machine | 1 set | 5,6,8 |
| 3 | Bench Vices | 1 | 5,6,8 |
| 4 | Radius Bend bars | 1 | 4 |
| 5 | Pipe Flaring Tools / Pipe Bending Tools | 1 | 9 |
| 6 | Carbide Gas Plant | 1 | 4 |
| 7 | MIG Weld Plant | 1 | 2 |
| 8 | TIG Weld Plant | 1 | 1 |
| 9 | Plasma welding setup | 1 | 3 |
| 10 | Cable And Swaging Block | 1 | 9 |
| 11 | Sandwich / Composite Panels | 5 | 6,7 |

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Semester : 5th BE Course
Branch : Aeronautical
Subject : Propulsion-I Lab
Code : BE 558

## LIST OF EXPERIMENTS

1. Study of an aircraft piston engine -assembly of sub systems.
2. Study of an aircraft piston engine -various components, their functions and operating principles
3. Study of an aircraft jet engine - assembly of sub systems,
4. Study of an aircraft jet engine - various components, their functions and operating principles
5. Study of forced convective heat transfer.
6. Study of free convective heat transfer.

## LIST OF EQUIPMENTS

(For a batch of 30 students)

| S. No. | Details of Equipments | Qty Req. | Expt. No. |
|---|---|---|---|
| 1 | Piston engines | 2 | 1 |
| 2 | Jet Engine /Engine model | 1 | 2 |
| 3 | Forced Convective apparatus | 1 | 3 |
| 4 | Free Convective apparatus | 1 | 4 |

**MATS UNIVERSITY, RAIPUR**

| | | |
|---|---|---|
| Semester | : | 5th BE Course |
| Branch | : | Aeronautical |
| Subject | : | CAD/CAM Lab |
| Code | : | BE 559 |

## LIST OF EXPERIMENTS

1. Study of CRT monitors.
2. Draw simple line on computer screen translate, rotate reflect 2-D object about any axis.
3. Draw 2-Dimensional object.
4. Draw 3-D object and show scaling, rotation & translation of that object about any particular axis.
5. Test the painter's algorithm by showing general filled polygons with different interior styles.
6. For given part to be machined, prepare a CNC part program to machine the holes on vertical axis CNC machining center using the ISO standard G-codes. You may choose Program Zero (Axes) to be used for the component. Show the axes chosen and write the program.
7. For a given component to be machined, prepare a CNC part program to machine the part contour on any vertical axis. Shown machining center using the ISO standard G-codes. Show the axis chosen and write the program using the initial tool position.
8. Prepare a CNC part program for a component to be machined on any turning center using the ISO standard G-codes. Write the program using the initial tool position.
9. Develop a CNC milling part program in a post processor version to machine the given Component.

## LIST OF EQUIPMENTS

(For a batch of 30 students)

| S. No. | Details of Equipments | Qty Req. | Expt. No. |
|---|---|---|---|
| 1 | Computer | 30 | 1 to 9 |
| 2 | CNC Machine | 1 | 6,7,8,9 |