**ANNA UNIVERSITY, CHENNAI**

**NON- AUTONOMOUS COLLEGES AFFILIATED TO ANNA UNIVERSITY**

**M.E. AERONAUTICAL ENGINEERING**

**REGULATIONS 2021**

**CHOICE BASED CREDIT SYSTEM**

**I TO IV SEMESTERS CURRICULA AND I SEMESTER SYLLABUS**

**I SEMESTER**

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | MA4153 | Advanced Mathematical Methods | FC | 4 | 0 | 0 | 4 | 4 |
| 2. | AO4101 | Aerospace Propulsion | PCC | 3 | 0 | 0 | 3 | 3 |
| 3. | AO4102 | Aircraft Structural Mechanics | PCC | 3 | 1 | 0 | 4 | 4 |
| 4. | AO4103 | Flight Vehicle Aerodynamics | PCC | 4 | 0 | 0 | 4 | 4 |
| 5. | RM4151 | Research Methodology and IPR | RMC | 2 | 0 | 0 | 2 | 2 |
| 6. | | Professional Elective - I | PEC | 3 | 0 | 0 | 3 | 3 |
| 7. | | Audit Course – I* | AC | 2 | 0 | 0 | 2 | 0 |
| **PRACTICAL** | | | | | | | | |
| 8. | AO4111 | Low Speed and High Speed Aerodynamics Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| 9. | AO4112 | Jet Propulsion Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| | | | **TOTAL** | **21** | **1** | **8** | **30** | **24** |

* Audit Course is optional.

## II SEMESTER

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | AO4201 | Advanced Flight Dynamics | PCC | 3 | 0 | 0 | 3 | 3 |
| 2. | AO4202 | CFD for Aerospace Applications | PCC | 3 | 0 | 0 | 3 | 3 |
| 3. | AO4251 | Analysis of Composite Structures | PCC | 3 | 0 | 0 | 3 | 3 |
| 4. | AO4252 | Finite Element Analysis | PCC | 3 | 0 | 0 | 3 | 3 |
| 5. | | Professional Elective-II | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | | Professional Elective-III | PEC | 3 | 0 | 0 | 3 | 3 |
| 7. | | Audit Course – II* | AC | 2 | 0 | 0 | 2 | 0 |
| **PRACTICAL** | | | | | | | | |
| 8. | AO4211 | Structures Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| 9. | AO4261 | Computation Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| 10. | AO4212 | Mini Project with Seminar | EEC | 0 | 0 | 4 | 4 | 2 |
| | | | **TOTAL** | **20** | **0** | **12** | **32** | **24** |

* Audit Course is optional.



## III SEMESTER

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | | Professional Elective-IV | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | | Professional Elective-V | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | | Open Elective | OEC | 3 | 0 | 0 | 3 | 3 |
| **PRACTICAL** | | | | | | | | |
| 4. | AO4311 | Project Work I | EEC | 0 | 0 | 12 | 12 | 6 |
| | | | **TOTAL** | **9** | **0** | **12** | **21** | **15** |

## IV SEMESTER

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **PRACTICAL** | | | | | | | | |
| 1. | AO4411 | Project Work II | EEC | 0 | 0 | 24 | 24 | 12 |
| | | | **TOTAL** | **0** | **0** | **24** | **24** | **12** |

**TOTAL CREDITS TO BE EARNED FOR THE AWARD OF THE DEGREE: 75**

## PROFESSIONAL ELECTIVE COURSES (PEC)

### SEMESTER I , ELECTIVE – I

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | AO4077 | Theory of Vibrations | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | AO4001 | Rocketry and Space Mechanics | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | AS4072 | Computational Heat Transfer | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | AO4002 | Theory of Elasticity | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | AO4003 | Experimental Aerodynamics | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | AO4004 | Control Engineering | PEC | 3 | 0 | 0 | 3 | 3 |

### SEMESTER II, ELECTIVE – II

| SL. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODSPE RWEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | AO4005 | Structural Dynamics | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | AS4251 | Hypersonic Aerodynamics | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | AO4006 | Advanced Propulsion Systems | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | AS4071 | Aerospace Materials | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | AO4007 | Airworthiness and Air Regulations | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | AO4008 | Experimental Methods of Stress Analysis | PEC | 3 | 0 | 0 | 3 | 3 |

### SEMESTER II, ELECTIVE – III

| SL. NO. | COURSE CODE | COURSETITLE | CATE GORY | PERIODSPE RWEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | AO4009 | Aeroelasticity | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | AO4076 | Theory of Boundary Layers | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | AO4010 | Combustion in Jet and Rocket Engines | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | AO4011 | Gas Dynamics | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | AO4072 | Fatigue and Fracture Mechanics | PEC | 3 | 0 | 0 | 3 | 3 |

**SEMESTER III , ELECTIVE – IV**

| SL. NO. | COURSE CODE | COURSETITLE | CATE GORY | PERIODSPE RWEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | AO4078 | Vibration Isolation and Control | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | AO4074 | Non-Destructive Evaluation | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | AO4012 | Component Design of Aircraft Engines | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | AO4013 | Aircraft Systems Engineering | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | AO4014 | Aircraft Design | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | AO4015 | Composite Product Processing Methods | PEC | 3 | 0 | 0 | 3 | 3 |

**SEMESTER III, ELECTIVE – V**

| SL. NO. | COURSE CODE | COURSETITLE | CATE GORY | PERIODSPE RWEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| 1. | AO4016 | Helicopter Aerodynamics | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | AO4073 | High Speed Jet Flows | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | AO4075 | Smart Materials and Structural Health Monitoring | PEC | 3 | 0 | 0 | 3 | 3 |
| 4. | AO4071 | Artificial Intelligence and Machine Learning | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | AO4017 | Aircraft Guidance and Control | PEC | 3 | 0 | 0 | 3 | 3 |



**AUDIT COURSES (AC)**
**Registration for any of these courses is optional to students**

| SL. NO | COURSE CODE | COURSE TITLE | PERIODS PER WEEK | | | CREDITS |
|---|---|---|---|---|---|---|
| | | | L | T | P | |
| 1. | AX4091 | English for Research Paper Writing | 2 | 0 | 0 | 0 |
| 2. | AX4092 | Disaster Management | 2 | 0 | 0 | 0 |
| 3. | AX4093 | Constitution of India | 2 | 0 | 0 | 0 |
| 4. | AX4094 | நற்றமிழ் இலக்கியம் | 2 | 0 | 0 | 0 |

**MA4153 ADVANCED MATHEMATICAL METHODS**

| L | T | P | C |
|---|---|---|---|
| 4 | 0 | 0 | 4 |

**COURSE OBJECTIVES:**

- To attain the knowledge of solving Partial Differential Equations using Laplace transform.
- To apply Fourier Transform to solve boundary value problems.
- To achieve maxima and minima of a functional.
- To acquire knowledge on using conformal mapping to fluid flow and heat flow problems.
- To understand the tensor analysis as a tool to solve problems arising in engineering disciplines.

**UNIT I LAPLACE TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS 12**

Laplace transform : Definitions – Properties – Transform error function – Bessel's function - Dirac delta function – Unit step functions – Convolution theorem – Inverse Laplace transform : Complex inversion formula – Solutions to partial differential equations : Heat equation – Wave equation.

**UNIT II FOURIER TRANSFORM TECHNIQUES FOR PARTIAL DIFFERENTIAL EQUATIONS 12**

Fourier transform: Definitions – Properties – Transform of elementary functions – Dirac delta function – Convolution theorem – Parseval's identity – Solutions to partial differential equations : Heat equation – Wave equation – Laplace and Poisson's equations.

**UNIT III CALCULUS OF VARIATIONS 12**

Concept of variation and its properties – Euler's equation – Functional dependant on first and higher order derivatives – Functionals dependant on functions of several independent variables – Variational problems with moving boundaries – Isoperimetric problems – Direct methods – Ritz and Kantorovich methods.



**UNIT IV CONFORMAL MAPPING AND APPLICATIONS 12**

Introduction to conformal mappings and bilinear transformations – Schwarz Christoffel transformation – Transformation of boundaries in parametric form – Physical applications : Fluid flow and heat flow problems.

**UNIT V TENSOR ANALYSIS 12**

Summation convention – Contravariant and covariant vectors – Contraction of tensors – Inner product – Quotient law – Metric tensor – Christoffel symbols – Covariant differentiation – Gradient - Divergence and curl.



**TOTAL : 60 PERIODS**

**COURSE OUTCOMES:**

After completing this course, students should demonstrate competency in the following skills:

- Application of Laplace and Fourier transforms to initial value, initial–boundary value and boundary value problems in Partial Differential Equations.
- Maximizing and minimizing the functional that occur in various branches of Engineering Disciplines.
- Construct conformal mappings between various domains and use of conformal mapping in studying problems in physics and engineering particularly to fluid flow and heat flow problems.
- Understand tensor algebra and its applications in applied sciences and engineering and develops ability to solve mathematical problems involving tensors.
- Competently use tensor analysis as a tool in the field of applied sciences and related fields.

**REFERENCES :**


1. Andrews L.C. and Shivamoggi, B., "Integral Transforms for Engineers", Prentice Hall of India Pvt. Ltd., New Delhi, 2003.
2. Elsgolc, L.D., "Calculus of Variations", Dover Publications Inc., New York, 2007.
3. Mathews, J. H., and Howell, R.W., "Complex Analysis for Mathematics and Engineering", 6th Edition, Jones and Bartlett Publishers, 2012.
4. Kay, D. C., "Tensor Calculus", Schaum's Outline Series, Tata McGraw Hill Edition, 2014.
5. Naveen Kumar, "An Elementary Course on Variational Problems in Calculus ", Narosa Publishing House, 2005.
6. Saff, E.B and Snider, A.D, "Fundamentals of Complex Analysis with Applications in Engineering, Science and Mathematics", 3rd Edition, Pearson Education, New Delhi, 2014.
7. Sankara Rao, K., "Introduction to Partial Differential Equations", 3rd Edition, Prentice Hall of India Pvt. Ltd., New Delhi, 2010.
8. Spiegel, M.R., "Theory and Problems of Complex Variables and its Applications", Schaum's Outline Series, McGraw Hill Book Co., 2009.
9. Ramaniah. G. "Tensor Analysis", S. Viswanathan Pvt. Ltd., 1990.


| AO4101 | AEROSPACE PROPULSION | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

This course will enable the students

1. To gain knowledge on fundamental principles of aircraft and rocket propulsion.
2. To describe various types of propulsion system with their merits and challenges.
3. To gain adequate knowledge on propellers and its characteristics.
4. To be familiar with the working concept of inlets, nozzles and combustion chamber with their applications in a propulsion system.
5. To gain sufficient information about compressors and turbines. Students also will get an exposure on electric propulsion methods

**UNIT I ELEMENTS OF AIRCRAFT PROPULSION 9**

Classification of power plants – Methods of aircraft propulsion – Propulsive efficiency – Specific fuel consumption – Thrust and power- Factors affecting thrust and power- Illustration of working of piston engines and Gas turbine engines – Characteristics of piston engine, turboprop, turbofan and turbojet engines, Ram jet, Scram jet – Methods of Thrust augmentation.

**UNIT II PROPELLER THEORY 9**

Momentum theory, Blade element theory, combined blade element and momentum theory, propeller power losses, propeller performance parameters, prediction of static thrust- and in flight, negative thrust, prop fans, ducted propellers, propeller noise, propeller selection, propeller charts.

**UNIT III INLETS, NOZZLES AND COMBUSTION CHAMBERS 9**

Subsonic and supersonic inlets – Relation between minimum area ratio and external deceleration ratio – Starting problem in supersonic inlets –Modes of inlet operation, jet nozzle – Efficiencies – Over expanded, under and optimum expansion in nozzles – Thrust reversal. Classification of Combustion chambers – Combustion chamber performance – Flame tube cooling – Flame stabilization.

**UNIT IV AXIAL FLOW COMPRESSORS, FANS AND TURBINES 9**

Introduction to centrifugal compressors- Axial flow compressor- geometry- twin spools- three spools- stage analysis- velocity polygons- degree of reaction – radial equilibrium theory- performance maps- axial flow turbines- geometry- velocity polygons- stage analysis- performance maps- thermal limit of blades and vanes.

**UNIT V ROCKET AND ELECTRIC PROPULSION 9**

Introduction to rocket propulsion – Reaction principle – Thrust equation – Classification of rockets based on propellants used – solid, liquid and hybrid – Comparison of these engines with special reference to rocket performance – electric propulsion – classification- electro thermal – electro static – electromagnetic thrusters- geometries of Ion thrusters- beam/plume characteristics – hall thrusters.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, students will

**CO1:** Get exposure with the different types of propulsive devices used for jet and rocket propulsion.

**CO2:** Have knowledge on propeller theory and its performance parameters.

**CO3:** Be able to distinguish different types of inlets and their performance trends in subsonic and supersonic flows.

**CO4:** Be able to describe the process of combustion and the parameters that affect combustion in jet engines.

**CO5:** Be able to acquire knowledge on the basic concepts of various types of electric propulsion systems.

**REFERENCES:**




1. Cohen, H, Saravanamuttoo, HIH., Rogers, GFC, Paul Straznicky and Andrew Nix , “Gas Turbine Theory”, Pearson Education Canada; 7th edition, 2017.
2. Gill,WP, Smith,HJ & Ziurys,JE, “Fundamentals of Internal Combustion Engines as applied to Reciprocating, Gas turbine & Jet Propulsion Power Plants”, Oxford & IBH Publishing Co., 1980.
3. Hill, PG. & Peterson, CR. “Mechanics & Thermodynamics of Propulsion” Pearson education, 2nd edition, 2014.
4. Oates, GC,“Aerothermodynamics of Aircraft Engine Components”, AIAA Education Series, 2007.
5. Sutton,GP, “Rocket Propulsion Elements”, John Wiley & Sons Inc., New York, 9th Edition, 2017.
6. J Seddon & E L Goldsmith. “ Intake Aerodynamics”, AIAA education series. 1999.

**AO4102** **AIRCRAFT STRUCTURAL MECHANICS**

| L | T | P | C |
|---|---|---|---|
| 3 | 1 | 0 | 4 |

**COURSE OBJECTIVES:**

This course will enable the students

1. To gain important technical aspects on the theory of bending of structures.
2. To learn the key aspects of shear flow in open and closed sections.
3. To study the stability problems in structures with various modes of loading.
4. To analyse aircraft structural components under various forms of loading.
5. To have basic idea about the importance of flight envelope.

**UNIT I BENDING OF BEAMS** **9+3**

Elementary theory of pure bending – Stresses in beams of symmetrical and unsymmetrical sections – Box beams – Generalized theory of bending – Methods of bending stress determination – Principal axes method – Neutral axis method – 'k' method – Deflection of unsymmetrical beams – Stresses in Composite Beams – Idealization of cross-section – Wing spar sizing

**UNIT II SHEAR FLOW IN THIN-WALLED SECTION** **9+3**

General stress, strain and displacement relationships for open section thin-walled beams – Concept of shear flow – Shear flow in thin walled open sections – Determinations of the shear centre – Symmetrical and unsymmetrical cross-sections – Shear flow due to bending in open sections – Torsion of thin-walled open section members & determination of stresses – Design of thin-walled members



**UNIT III SHEAR FLOW IN CLOSED SECTIONS** **9+3**

Shear flow in thin-walled closed sections – Symmetrical and unsymmetrical sections – Flexural shear flow in two flange, three flange and multi-flange box beams – Determinations of the shear centre – Bredt-Batho theory – Torsional shear flow in multi-cell tubes – Shear flow due to combined bending and torsion – Stress analysis of aircraft components – Tapered wing spar – Introduction to shear lag

**UNIT IV STABILITY PROBLEMS** **9+3**

Stability problems of thin walled structures – Buckling of sheets under compression, shear, and combined loads – Plate buckling coefficient – Inelastic buckling of plates – Sheet-stiffener panels – Effective width – Failure stress in plates and stiffened panels – Crippling stress estimation – Local Buckling – Wagner beam theory – Experimental determination of critical load for a flat plate – Principles of stiffener/web construction

**UNIT V ANALYSIS OF AIRCRAFT STRUCTURAL COMPONENTS** **9+3**

Aircraft Loads – Symmetric manoeuvre loads – Load factor determination – Inertia loads – Aerodynamic loads & Schrenk's curve – The flight envelope – Shear force, bending moment and torque distribution along the span of the wing and fuselage – Structural parts of wing and fuselage and their functions – Analysis of rings and frames –– Introduction to aeroelasticity and shells.

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

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

**CO1:** Apply the concept of normal stress variation in unsymmetrical sections subject to bending moments.

**CO2:** Find the shear flow variation in thin walled open sections with skin effective and ineffective in bending.

**CO3:** Evaluate the shear flow variation in single cell and multi-cell tubes subjected to shear and torque loads.

**CO4:** Analyse the behaviour of buckling of simply supported plates and also to know the effective width of sheet stringers combination.

**CO5:** Analyse and design structural members subject to compression.

**REFERENCES:**


1. Bruce. K. Donaldson, "Analysis of Aircraft Structures: An Introduction", Cambridge University Press, 2nd edition, 2012.
2. Bruhn. EF, " Analysis and Design of Flight Vehicle Structures", Tristate Offset Co., 1980.
3. Megson, TMG, "Aircraft Structures for Engineering Students", Elsevier, Aerospace Engineering, Series, 7th Edition, 2021.
4. Peery, DJ. And Azar, JJ, "Aircraft Structures", 2nd Edition, McGraw-Hill, New York, 1993.
5. Rivello, R.M, "Theory and Analysis of Flight structures", McGraw-Hill, N.Y., 1993.
6. Sun. CT, "Mechanics of Aircraft Structures", Wiley publishers, 2nd edition, 2006.




| AO4103 | FLIGHT VEHICLE AERODYNAMICS | L | T | P | C |
|---|---|---|---|---|---|
| | | 4 | 0 | 0 | 4 |

**COURSE OBJECTIVES:**

This course will enable the students

1. To gain insights into the basics of fluid flow, its model and tool to solve the fluid flow problems.
2. To be familiar with the conservation laws of fluid dynamics, and how to apply them to practical fluid flows.
3. To gain knowledge on elementary flows to combine and form realistic flows with suitable assumptions.
4. To analyse incompressible flow over three-dimensional bodies like wing and so on.
5. To gain knowledge on the basic concepts of viscous flows, boundary layers to practical flows.

**UNIT I INTRODUCTION TO AERODYNAMICS 12**

Aerodynamic force and moments, lift and Drag coefficients, Centre of pressure and aerodynamic centre, Coefficient of pressure, moment coefficient, Continuity and Momentum equations, Point source and sink, doublet, Free and Forced Vortex, Uniform parallel flow, combination of basic flows, Pressure and Velocity distributions on bodies with and without circulation in ideal and real fluid flows, Magnus effect

**UNIT II INCOMPRESSIBLE FLOW THEORY 12**

Conformal Transformation, Karman ,Trefftz profiles, Kutta condition, Kelvin's Circulation Theorem and the Starting Vortex, Thin aerofoil Theory and its applications. Vortex line, Horse shoe vortex, Biot– Savart law, lifting line theory, effect of aspect ratio.

**UNIT III COMPRESSIBLE FLOW THEORY 13**

Compressibility, Isentropic flow through nozzles, Normal shocks, Oblique and Expansion waves, Moving shock waves, Rayleigh and Fanno Flow, Potential equation for compressible flow, Small perturbation theory, Prandtl- Glauert Rule, Linearized supersonic flow, Method of characteristics.

**UNIT IV AIRFOILS, WINGS AND AIRPLANE CONFIGURATION IN HIGH SPEED FLOWS 11**

Critical Mach number, Drag divergence Mach number, Shock stall, super critical airfoils, transonic area rule, Swept wings (ASW and FSW), Supersonic airfoils, Shock-Expansion Theory, Wave drag, Delta wings.

**UNIT V VISCOUS FLOW THEORY 12**

Basics of viscous flow theory, Boundary Layer,Flow separation, Displacement, momentum and Energy Thickness, Laminar and Turbulent boundary layers ,Boundary layer over flat plate, Blasius Solution, Estimation of skin friction drag in laminar and turbulent flow, The Reference Temperature Method.

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, students will

**CO1:** Comprehend the behaviour of airflow over bodies with particular emphasis on airfoil sections in the incompressible flow regime.

**CO2:** Be able to solve inviscid, incompressible and irrotational flows.

**CO3:** Be able to apply the conservation equations for fluid flows.

**CO4:** Be provided with the knowledge on thermodynamic state of the gas behind normal shock waves, oblique shock waves and expansion waves.

**CO5:** Be provided with adequate knowledge on the basic concepts of laminar and turbulent boundary layers.

**REFERENCES:**


1. J.D. Anderson, Fundamentals of Aerodynamics, McGraw-Hill Education, 6th edition, 2017.
2. Rathakrishnan.E., Gas Dynamics, Prentice Hall of India, 7th edition, 2020.
3. Shapiro, AH, "Dynamics & Thermodynamics of Compressible Fluid Flow", Ronald Press, 1982.
4. Houghton, EL and Caruthers, NB,"Aerodynamics for Engineering Students", Butterworth-Heinemann series, 7th edition 2017.
5. Zucrow, M.J, and Anderson, J.D, "Elements of gas dynamics" McGraw-Hill Book Co., New York, 1989.
6. Rae, WH and Pope, A, "Low speed Wind Tunnel Testing", John Wiley Publications, 3rd edition, 1999.

**RM4151** **RESEARCH METHODOLOGY AND IPR** **L T P C**
**2 0 0 2**

**UNIT I RESEARCH DESIGN** **6**

Overview of research process and design, Use of Secondary and exploratory data to answer the research question, Qualitative research, Observation studies, Experiments and Surveys.

**UNIT II DATA COLLECTION AND SOURCES** **6**

Measurements, Measurement Scales, Questionnaires and Instruments, Sampling and methods. Data - Preparing, Exploring, examining and displaying.

**UNIT III DATA ANALYSIS AND REPORTING** **6**

Overview of Multivariate analysis, Hypotheses testing and Measures of Association. Presenting Insights and findings using written reports and oral presentation.

**UNIT IV INTELLECTUAL PROPERTY RIGHTS** **6**

Intellectual Property – The concept of IPR, Evolution and development of concept of IPR, IPR development process, Trade secrets, utility Models, IPR & Bio diversity, Role of WIPO and WTO in IPR establishments, Right of Property, Common rules of IPR practices, Types and Features of IPR Agreement, Trademark, Functions of UNESCO in IPR maintenance.

**UNIT V PATENTS** **6**

Patents – objectives and benefits of patent, Concept, features of patent, Inventive step, Specification, Types of patent application, process E-filling, Examination of patent, Grant of patent, Revocation, Equitable Assignments, Licences, Licensing of related patents, patent agents, Registration of patent agents.



**TOTAL : 30 PERIODS**

**REFERENCES**

1. Cooper Donald R, Schindler Pamela S and Sharma JK, “Business Research Methods”, Tata McGraw Hill Education, 11e (2012).
2. Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007.
3. David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007.
4. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, “Professional Programme Intellectual Property Rights, Law and practice”, September 2013.

| AO4111 | LOW SPEED AND HIGH SPEED AERODYNAMICS LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**COURSE OBJECTIVES:**

This laboratory course will enable the students

1. To gain knowledge on the principles of subsonic and supersonic wind tunnel and their operation.
2. To acquire practical knowledge on various aerodynamic principles related to inviscid incompressible fluids.
3. To calculate various aerodynamic characteristics of various objects.
4. To characterize laminar and turbulent flows.
5. To get practical exposure on flow visualization techniques pertaining to subsonic flows.

**LIST OF EXPERIMENTS:**

1. Calibration of subsonic wind tunnel.
2. Pressure distribution over a smooth cylinder.
3. Pressure distribution over a rough cylinder.
4. Pressure distribution over a symmetric aerofoil section.
5. Pressure distribution over a cambered aerofoil section.
6. Pressure distribution over a wing of cambered aerofoil section.
7. Study on Force and moment measurements by using strain gauge.
8. Wake measurements behind a bluff body.
9. Velocity boundary layer measurements over a flat plate.
10. Force and moment measurements on aircraft model by using strain gauge.
11. Force and Moment measurements using wind tunnel balance.
12. Calibration of supersonic wind tunnel.
13. Subsonic flow visualization studies.

Any 10 experiments may be conducted.

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

At the end of this course, students will be

**CO1:** Able to operate and calibrate subsonic and supersonic wind tunnel.
**CO2:** Able to analyse the pressure distribution over the streamlined and bluff bodies.
**CO3:** Able to carry out measurement of force and moments on aircraft models.
**CO4:** Capable of measuring boundary layer thickness over various models.
**CO5:** Able to carry out flow visualization at subsonic speeds.

**LABORATORY EQUIPMENTS REQUIRED**

1. Subsonic wind tunnel
2. Rough and smooth cylinder
3. Symmetrical and Cambered aerofoil
4. Wind tunnel balance
5. Schlieren system
6. Pressure Transducers
7. Supersonic wind tunnel
8. Blower
9. Testing models like flat plate, bluff body

| AO4112 | JET PROPULSION LABORATORY | L | T | P | C |
|---|---|---|---|---|---|
| | | 0 | 0 | 4 | 2 |

**COURSE OBJECTIVES:**

This course will enable the students

1. To gain knowledge on wall pressure distribution on subsonic and supersonic inlets and nozzles.
2. To perform testing on compressor blades.
3. To interpret the experimental data using software.
4. To get practical exposure on flow visualization techniques pertaining to supersonic jets.
5. To gain basic knowledge on cold flow studies.

**LIST OF EXPERIMENTS:**

1. Wall pressure measurements of a subsonic diffuser.
2. Cascade testing of compressor blades.
3. Pressure distribution on a cavity model.
4. Wall pressure measurements on non-circular combustor.
5. Wall pressure measurements on converging nozzle.
6. Wall pressure measurements on convergent-divergent nozzle.
7. Total pressure measurements along the jet axis of a circular subsonic jet.
8. Total pressure measurements along the jet axis of a circular supersonic jet.
9. Total pressure measurements in the radial direction of the subsonic jet.
10. Total pressure measurements in the radial direction of the supersonic jet.
11. Cold flow studies of a wake region behind flame holders.
12. Wall pressure measurements on supersonic inlets.
13. Flow visualization on supersonic jets.
14. Prediction of flow angles using angle probe.



Any 10 experiments may be conducted.

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

At the end of the course, students will be

**CO1:** Able to perform wall pressure distribution on subsonic and supersonic nozzles.

**CO2:** Able to acquire knowledge on fundamental concepts of low speed and high speed jets and experimental techniques pertains to measurements.

**CO3:** Provided with adequate knowledge on pressure distribution on cavity models.

**CO4:** Able to perform wake survey methods.

**CO5:** Able to carry out flow visualization on supersonic jets.

**LABORATORY EQUIPMENTS REQUIRED**

1. Subsonic wind tunnel
2. High speed jet facility
3. Blower
4. Pressure scanner
5. Schlieren system
6. Nozzle and cavity models

AO4077

## THEORY OF VIBRATIONS

| L | T | P | C |
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**COURSE OUTCOME:**

- Upon completion of the course, students will learn the dynamic behaviour of different aircraft components and the interaction among the aerodynamic, elastic and inertia forces

**UNIT I SINGLE DEGREE OF FREEDOM SYSTEMS 9**

Simple harmonic motion, definition of terminologies, Newton's Laws, D'Alembert's principle, Energy methods. Free and forced vibrations with and without damping, base excitation, and vibration measuring instruments.

**UNIT II MULTI-DEGREES OF FREEDOM SYSTEMS 9**

Two degrees of freedom systems, Static and dynamic couplings, eigen values, eigen vectors and orthogonality conditions of eigen vectors, Vibration absorber, Principal coordinates, Principal modes. Hamilton's Principle, Lagrange's equation and its applications.

**UNIT III VIBRATION OF ELASTIC BODIES 9**

Transverse vibrations of strings, Longitudinal, Lateral and Torsional vibrations. Approximate methods for calculating natural frequencies.

**UNIT IV EIGEN VALUE PROBLEMS & DYNAMIC RESPONSE OF LARGE SYSTEMS 9**

Eigen value extraction methods – Subspace hydration method, Lanczos method – Eigen value reduction method – Dynamic response of large systems – Implicit and explicit methods.



**UNIT V ELEMENTS OF AEROELASTICITY 9**

Aeroelastic problems – Collar's triangle of forces – Wing divergence – Aileron control reversal – Flutter.

**TOTAL: 45 PERIODS**

**REFERENCES**


1. Timoshenko, S. "Vibration Problems in Engineering", John Wiley & Sons, Inc., 2018.
2. Meirovitch, L. "Elements of Vibration Analysis", New Delhi, McGraw-Hill Education, 2014.
3. Thomson W.T, Marie Dillon Dahleh, "Theory of Vibrations with Applications", Harlow, Essex Pearson 2014
4. F.S. Tse., I.F. Morse and R.T. Hinkle, "Mechanical Vibrations", Prentice-Hall of India, 1985.
5. Rao.J.S. and Gupta.K. "Theory and Practice of Mechanical Vibrations", New Delhi, New Age International, 1999.
6. Fung, Y.C., "An Introduction to the Theory of Aeroelasticity", Dover Publications., Mineola, N.Y., 2008.

| AO4001 | ROCKETRY AND SPACE MECHANICS | L | T | P | C |
|---|---|---|---|---|---|
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**COURSE OBJECTIVES:**

1. This course presents the fundamental aspects of rocket motion along with detailed estimation of rocket trajectories.
2. This course also imparts knowledge on optimization of multistage rockets.
3. This course provides the basics of space mechanics required for an aeronautical student
4. This course helps students to provide with the basics of orbit transfer of satellites.
5. This course will help students to gain knowledge on various control methods of rockets.

**UNIT I ORBITAL MECHANICS 9**

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

**UNIT II SATELLITE DYNAMICS 9**

Geosynchronous and geostationary satellites- factors determining life time of satellites – satellite perturbations – orbit transfer and examples –Hohmann orbits – calculation of orbit parameters– Determination of satellite rectangular coordinates from orbital elements- satellite epiphermis.

**UNIT III ROCKET MOTION 9**

Principle of operation of rocket motor – thrust equation – one dimensional and two dimensional rocket motions in free space and homogeneous gravitational fields – Description of vertical, inclined and gravity turn trajectories– determinations of range and altitude – simple approximations to burnout velocity.



**UNIT IV ROCKET AERODYNAMICS 9**

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

**UNIT V STAGING AND CONTROL OF ROCKET VEHICLES 9**

Need for multi staging of rocket vehicles – multistage vehicle optimization – stage separation dynamics and separation techniques- aerodynamic and jet control methods of rocket vehicles – SITVC.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, students will be able

**CO1:** To knowledge on the fundamental laws of orbital mechanics with particular emphasis on interplanetary trajectories.

**CO2:** To calculate orbital parameters and perform conceptual trajectory designs for geocentric or interplanetary missions.

**CO3:** To familiarize themselves with trajectory calculations for planar motion of rockets.

**CO4:** To determine forces and moments acting on airframe of a missile.

**CO5:** To acquire knowledge on the need for staging and stage separation dynamics of rocket vehicles.

**REFERENCES:**


1. Cornelisse,JW, “Rocket Propulsion and Space Dynamics”, J.W. Freeman & Co., Ltd., London, 1982.
2. Parker,ER,“Materials for Missiles and Spacecraft”, McGraw-Hill Book Co., Inc., 1982.
3. Suresh. B N & Sivan. K, “Integrated Design for Space Transportation System”, Springer India, 2016.
4. Sutton,GP, Biblarz,O, “Rocket Propulsion Elements”, John Wiley & Sons Inc., New York, 9th Edition, 2017.
5. Van de Kamp, “Elements of Astromechanics”, Pitman Publishing Co., Ltd., London, 1980.


| AS4072 | COMPUTATIONAL HEAT TRANSFER | L | T | P | C |
|---|---|---|---|---|---|
| | | 3 | 0 | 0 | 3 |

**COURSE OBJECTIVES:**

This course will enable students

1. To get insights into the basic aspects of various discretization methods.
2. To provide basic ideas on the types of PDE’s and its boundary conditions to arrive at its solution.
3. To impart knowledge on solving conductive, transient conductive and convective problems using computational methods.
4. To solve radiative heat transfer problems using computational methods.
5. To provide a platform for students in developing numerical codes for solving heat transfer problems.



**UNIT I INTRODUCTION 9**

Finite Difference Method-Introduction-Taylor’s series expansion-Discretization Methods Forward, backward and central differencing scheme for first order and second order Derivatives – Types of partial differential equations-Types of errors-Solution to algebraic equation-Direct Method and Indirect Method-Types of boundary condition-FDM – FEM – FVM.

**UNIT II CONDUCTIVE HEAT TRANSFER 9**

General 3D-heat conduction equation in Cartesian, cylindrical and spherical coordinates. Computation (FDM) of One –dimensional steady state heat conduction –with Heat generation-without Heat generation- 2D-heat conduction problem with different boundary conditions-Numerical treatment for extended surfaces- Numerical treatment for 3D- Heat conduction-Numerical treatment to 1D-steady heat conduction using FEM.

**UNIT III TRANSIENT HEAT CONDUCTION 9**

Introduction to Implicit, explicit Schemes and crank-Nicolson Schemes Computation(FDM) of One– dimensional un-steady heat conduction –with heat Generation-without Heat generation – 2D-transient heat conduction problem with different boundary conditions using Implicit, explicit Schemes-Importance of Courant number- Analysis for I-D,2-D transient heat Conduction problems.

**UNIT IV CONVECTIVE HEAT TRANSFER 9**

Convection- Numerical treatment (FDM) of steady and unsteady 1-D and 2-d heat convection-diffusion steady-unsteady problems- Computation of thermal and Velocity boundary layer flows. Upwind scheme-Stream function-vorticity approach-Creeping flow.

**UNIT V RADIATIVE HEAT TRANSFER 9**

Radiation fundamentals-Shape factor calculation-Radiosity method- Absorption Method – Montacalro method-Introduction to Finite Volume Method- Numerical treatment of radiation enclosures using finite Volume method. Developing a numerical code for 1D, 2D heat transfer problems.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, Students will

**CO1:** Have an Idea about discretization methodologies for solving heat transfer problems.
**CO2:** Be able to solve 2-D conduction and convection problems.
**CO3:** Have an ability to develop solutions for transient heat conduction in simple geometries.
**CO4:** Be capable of arriving at numerical solutions for conduction and radiation heat transfer problems.
**CO5:** Have knowledge on developing numerical codes for practical engineering heat transfer problems.

**REFERENCES:**


1. Chung,TJ, “Computational Fluid Dynamics”, Cambridge University Press, 2002.
2. Holman,JP, “Heat Transfer”, McGraw-Hill Book Co, Inc., McGraw-Hill College; 10th edition, 2017.
3. John D. Anderson, “Computational Fluid Dynamics”, McGraw Hill Education, 2017.
4. John H. Lienhard, “A Heat Transfer”, Text Book, Dover Publications, 5th edition, 2020.
5. Richard H. Pletcher, John C. Tannehill & Dale Anderson**, “**Computational Fluid Mechanics and Heat Transfer”, 4th edition, CRC Press**,** 2021
6. Sachdeva,SC, “Fundamentals of Engineering Heat & Mass Transfer”, New age publisher, 4th edition Internationals, 2017.




| AO4002 | THEORY OF ELASTICITY | L | T | P | C |
|---|---|---|---|---|---|
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**COURSE OBJECTIVES:**

This course will enable students

1. To learn the basic concepts and equations of elasticity.
2. To provide with the concepts of plain stress and strain related problems.
3. To gain knowledge on equilibrium and stress-strain equations of polar coordinates.
4. Will be exposed to axisymmetric problems.
5. To get insight into the basic concepts of plates and shells.

**UNIT I BASIC EQUATIONS OF ELASTICITY 9**

Definition & sign convention for stress and strain – Hooke’s law – Relation between elastic constants – Equilibrium and compatibility equations – Analysis of stress, strain and deformation – Stress and strain transformations equations – Cauchy’s formula – Principal stress and principal strains in 2D & 3D – Octahedral stresses and its significance – Boundary conditions.

**UNIT II APPLIED CONCEPTS 9**

Plane stress and plane strain problems – Airy stress function – Biharmonic equation – Compatibility equation in terms of stress – Solution of bar and beam problems using the elasticity approach – Torsion of bars – Determination of stresses, strain and displacements – Warping of cross-sections – Prandtl's stress function approach – St. Venant's method.

**UNIT III POLAR COORDINATES 9**

Strain-displacement relations in polar coordinates – Equilibrium and stress-strain equations in polar coordinates – Infinite plate with a small central hole – Stress concentration – Bending of a curved beam (Winkler-Bach theory) – Deflection of a thick curved bar – Stresses in straight and curved beams due to thermal loading – Thermal stresses in cylinders and spheres – Stress concentration in bending.

**UNIT IV AXISYMMETRIC PROBLEMS 9**

Equilibrium and stress-strain equations in cylindrical coordinates – Lame's problem – Thick-walled cylinders subject to internal and external pressure – Application of failure theories – Stresses in composite tubes – Shrink fitting – Stresses due to gravitation – Analysis of a rotating disc of uniform thickness – Discs of variable thickness – Rotating shafts and cylinders.

**UNIT V PLATES AND SHELLS 9**

Classical plate theory – Assumptions, governing equations and boundary conditions – Navier's method of solution – Levy's method of solution – Rectangular and circular plates – Solution techniques – Analysis of a shell – Membrane Theory – Deformation and stresses due to applied loads.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, students will

**CO1:** Have knowledge of basic elasticity relationships and equations.
**CO2:** Know how to carry out stress analysis in 2-D and 3-D.
**CO3:** Get exposure on the formulation of constitutive and governing equations for basic problems in cartesian and cylindrical coordinates.
**CO4:** Be able to analyse and solve practical problems in cartesian and cylindrical coordinates.
**CO5:** Be able to determine the stress, strain and displacement field for common axisymmetrical members.

**REFERENCES:**


1. Harry Kraus, "Thin Elastic Shells", John Wiley and Sons, 1987.
2. Flugge, W, "Stresses in Shells", Springer – Verlag, 1990.
3. Timoshenko, S.P. and Gere, J.M, "Theory of Elastic Stability", McGraw Hill Book Co. 2010.
4. Timoshenko, S.P. Winowsky. S., and Kreger, "Theory of Plates and Shells", McGraw Hill Book Co., 2nd edition, 2015.
5. Varadan, TK andBhaskar,K, "Analysis of plates-Theory and problems", Narosha Publishing Co., 2001.

| AO4003 | EXPERIMENTAL AERODYNAMICS | L T P C |
|---|---|---|
| | | 3 0 0 3 |

**COURSE OBJECTIVES:**

1. This course will enable the students to learn basics of wind tunnel operation and its associated measurements.
2. To present the concepts of different flow visualization methods.
3. This course also imparts knowledge on flow measurement variables
4. This course enables students to be familiar with data acquisition methods pertaining to experiments in aerodynamics.
5. This course will help students to do uncertainty analysis for their experiments.

**UNIT I LOW SPEED TUNNEL 9**

Objective of experimental studies, Types of wind tunnels, Low speed tunnel, Energy ratio, Power losses in a wind tunnel – Calibration of subsonic wind tunnels – Speed Setting – Flow Direction – Three-Hole and Five-Hole Yaw Probes – Turbulence – Wind tunnel balance – Water tunnel.

**UNIT II HIGH SPEED TUNNEL 9**

Transonic wind tunnel – Transonic Test Section – Supersonic wind tunnels – Losses in Supersonic Tunnels – Supersonic Wind Tunnel Diffusers– Effects of Second Throat – Runtime calculation –Calculating Air Flow Rates –Calibration of Supersonic Wind Tunnels – Hypersonic wind tunnel and Calibration –Ludwieg Tube – Shock tube and shock tunnels – Gun tunnel – Plasma arc tunnels – Measurement of shock speed.

**UNIT III FLOW VISUALIZATION TECHNIQUES 9**



Visualization techniques – Smoke tunnel –-Dye Injection –Bubble Techniques –Surface Flow Visualization techniques – oil – Tufts –China Clay – Ultraviolet Fluorescence Photography – Interferometer – Fringe-Displacement method – Shadowgraph –Schlieren system – Background Oriented Schlieren (BOS) system – Laser sheet flow visualization.

**UNIT IV MEASUREMENTS OF PROPERTIES 9**

Pressure measurement techniques-Pitot, Static, and Pitot-Static Tubes-Pitot-Static tube characteristics – Pressure Sensitive Paints - Pressure transducers – Velocity measurements – Hot-wire anemometry-Constant current and Constant temperature Hot-Wire anemometer – Hot-film anemometry - Laser Doppler Velocimetry (LDV) – Particle Image Velocimetry (PIV)-Temperature measurements – Measurement of heat flux – Foil type heat flux gauge –Transient analysis of foil gauge– Thin film sensors – Slug type heat flux sensor.

**UNIT V DATA ACQUISITION SYSTEMS AND UNCERTAINTY ANALYSIS 9**

Data acquisition and processing – Signal conditioning – Statistical analysis of experimental data – Regression analysis – Estimation of measurement errors – Uncertainty calculation – Uses of uncertainty analysis.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

Upon completion of this course, students will

**CO1:** Have knowledge on measurement of flow properties in wind tunnels and their associated instrumentation.

**CO2:** Be able to demonstrate and conduct experiments related to subsonic and supersonic flows.

**CO3:** Gain idea on flow visualization of subsonic and supersonic flows.
**CO4:** Be familiar with calibration of transducers and other devices used for flow measurement.
**CO5:** Be able to estimate errors and to perform uncertainty analysis of the experimental data.

**REFERENCES:**


1. Allan Pope and Kenneth L Goin, "High Speed Wind Tunnel Testing", Krieger Publishing Company, 1978.
2. Jewel B. Barlow, Willian. H.Rae and Allan Pope,"Low-Speed Wind Tunnel Testing", Wiley-Interscience, 3rd edition, 1999.
3. Rathakrishnan, E, "Instrumentation, Measurements, and Experiments in Fluids", CRC Press –Taylor & Francis, 2020.
4. Robert B Northrop, "Introduction to Instrumentation and Measurements", Second Edition, CRC Press, Taylor & Francis, 2017.


| AO4004 | CONTROL ENGINEERING | L | T | P | C |
|---|---|---|---|---|---|
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**COURSE OBJECTIVES:**

1. To introduce the mathematical modeling of systems, open loop and closed loop systems and analyses in time domain and frequency domain.
2. To impart the knowledge on the concept of stability and various methods to analyze stability in both time and frequency domain.
3. To introduce sampled data control system.



**UNIT I INTRODUCTION** **9**

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

**UNIT II OPEN AND CLOSED LOOP SYSTEMS** **9**

Feedback control systems – Control system components - Block diagram representation of control systems, Reduction of block diagrams, Signal flow graphs, Output to input ratios.

**UNIT III CHARACTERISTIC EQUATION AND FUNCTIONS** **9**

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** **9**

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

**UNIT V SAMPLED DATA SYSTEMS** **9**

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

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

1. Ability to apply mathematical knowledge to model the systems and analyse the frequency domain
2. Ability to check the stability of the both time and frequency domain
3. Ability to solve simple pneumatic, hydraulic and thermal systems, Mechanical and electrical component analogies based problems.
4. Ability to solve the Block diagram representation of control systems, Reduction of block diagrams, Signal flow graph and problems based on it.
5. Ability to understand the digital control system, Digital Controllers and Digital PID Controllers.

**REFERENCES:**

1. Azzo, J.J.D. and C.H. Houpis, “Feed back control system analysis and synthesis”, McGraw-Hill international 3rs Edition, 1998.
2. OGATO, Modern Control Engineering, Pearson, New Delhi, 2016.

## AUDIT COURSES

**AX4091 ENGLISH FOR RESEARCH PAPER WRITING L T P C**
**2 0 0 0**

**OBJECTIVES**

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

**UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6**

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

**UNIT II PRESENTATION SKILLS 6**

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

**UNIT III TITLE WRITING SKILLS 6**

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

**UNIT IV RESULT WRITING SKILLS 6**

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

**UNIT V VERIFICATION SKILLS 6**

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission

**TOTAL: 30 PERIODS**

**OUTCOMES**

CO1 –Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

**REFERENCES**


1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

| AX4092 | DISASTER MANAGEMENT | L | T | P | C |
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**OBJECTIVES**

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

**UNIT I INTRODUCTION 6**

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

**UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS 6**

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.



**UNIT III DISASTER PRONE AREAS IN INDIA 6**

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

**UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6**

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

**UNIT V RISK ASSESSMENT 6**

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

**TOTAL : 30 PERIODS**

**OUTCOMES**

CO1: Ability to summarize basics of disaster

CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO5: Ability to develop the strengths and weaknesses of disaster management approaches

**REFERENCES**


1. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company,2007.
3. Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall of India, New Delhi,2001.


**AX4093** **CONSTITUTION OF INDIA** **L T P C**
**2 0 0 0**

**OBJECTIVES**

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.



**UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION**

History, Drafting Committee, (Composition & Working)

**UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION**

Preamble, Salient Features

**UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES**

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

**UNIT IV ORGANS OF GOVERNANCE**

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

**UNIT V LOCAL ADMINISTRATION**

District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

**UNIT VI ELECTION COMMISSION**

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

**TOTAL: 30 PERIODS**

**OUTCOMES**

Students will be able to:

- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization
- of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

**SUGGESTED READING**


- The Constitution of India,1950(Bare Act),Government Publication.
- Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
- M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
- D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.


**AX4094** **நற்றமிழ் இலக்கியம்** **L T P C**
**2 0 0 0**



**UNIT I** **சங்க இலக்கியம்** **6**

1. தமிழின் துவக்க நூல் தொல்காப்பியம்
– எழுத்து, சொல், பொருள்
2. அகநானூறு (82)
- இயற்கை இன்னிசை அரங்கம்
3. குறிஞ்சிப் பாட்டின் மலர்க்காட்சி
4. புறநானூறு (95,195)
- போரை நிறுத்திய ஔவையார்

**UNIT II** **அறநெறித் தமிழ்** **6**

1. அறநெறி வகுத்த திருவள்ளுவர்
- அறம் வலியுறுத்தல், அன்புடைமை, ஒப்புறவு அறிதல், ஈகை, புகழ்
2. பிற அறநூல்கள் - இலக்கிய மருந்து
– ஏலாதி, சிறுபஞ்சமூலம், திரிகடுகம், ஆசாரக்கோவை (தூய்மையை வலியுறுத்தும் நூல் )

**UNIT III** **இரட்டைக் காப்பியங்கள்** **6**

1. கண்ணகியின் புரட்சி
   - சிலப்பதிகார வழக்குரை காதை
2. சமூகசேவை இலக்கியம் மணிமேகலை
   - சிறைக்கோட்டம் அறக்கோட்டமாகிய காதை

**UNIT IV** **அருள்நெறித் தமிழ்** **6**

1. சிறுபாணாற்றுப்படை
   - பாரி முல்லைக்குத் தேர் கொடுத்தது,
   பேகன் மயிலுக்குப் போர்வை கொடுத்தது, அதியமான் ஔவைக்கு நெல்லிக்கனி கொடுத்தது, அரசர் பண்புகள்
2. நற்றிணை
   - அன்னைக்குரிய புன்னை சிறப்பு
3. திருமந்திரம் (617, 618)
   - இயமம் நியமம் விதிகள்
4. தர்மச்சாலையை நிறுவிய வள்ளலார்
5. புறநானூறு
   - சிறுவனே வள்ளலானான்
6. அகநானூறு (4) - வண்டு
   நற்றிணை (11) - நண்டு
   கலித்தொகை (11) - யானை, புறா
   ஐந்தினை 50 (27) - மான்
   ஆகியவை பற்றிய செய்திகள்



**UNIT V** **நவீன தமிழ் இலக்கியம்** **6**

1. உரைநடைத் தமிழ்,
   - தமிழின் முதல் புதினம்,
   - தமிழின் முதல் சிறுகதை,
   - கட்டுரை இலக்கியம்,
   - பயண இலக்கியம்,
   - நாடகம்,
2. நாட்டு விடுதலை போராட்டமும் தமிழ் இலக்கியமும்,
3. சமுதாய விடுதலையும் தமிழ் இலக்கியமும்,
4. பெண் விடுதலையும் விளிம்பு நிலையினரின் மேம்பாட்டில் தமிழ் இலக்கியமும்,
5. அறிவியல் தமிழ்,
6. இணையத்தில் தமிழ்,
7. சுற்றுச்சூழல் மேம்பாட்டில் தமிழ் இலக்கியம்.

**TOTAL: 30 PERIODS**

**தமிழ் இலக்கிய வெளியீடுகள் / புத்தகங்கள்**

1. தமிழ் இணைய கல்விக்கழகம் (Tamil Virtual University)

   - www.tamilvu.org

2. தமிழ் விக்கிப்பீடியா (Tamil Wikipedia)

-https://ta.wikipedia.org

3. தர்மபுர ஆதின வெளியீடு
4. வாழ்வியல் களஞ்சியம்
   - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்
5. தமிழ்கலைக் களஞ்சியம்
   - தமிழ் வளர்ச்சித் துறை (thamilvalarchithurai.com)
6. அறிவியல் களஞ்சியம்
   - தமிழ்ப் பல்கலைக்கழகம், தஞ்சாவூர்