BIJU PATNAIK UNIVERSITY OF TECHNOLOGY, ODISHA
ROURKELA

Tentative Curriculum and Syllabus

of

B.Tech (*Aeronautical Engineering)* from the Batch 2018-19

Semester (4th)

Fourth Semester							
Theory							
Sl No	**Category**	**Course Code**	**Course Title**	**L-T-P**	**Credit**	**University Marks**	**Internal Evaluation**
1	PC	RAE4C001	Aerodynamics - I	3-0-0	3	100	50
2	PC	RAE4C002	Aircraft Structures - I	3-0-0	3	100	50
3	HS	REN4E001 / ROB4E002	Engineering Economics / Organisational Behaviour	3-0-0	3	100	50
4	PC	RAE4C003	Aero Engineering Thermodynamics	3-0-0	3	100	50
5	PE	RAE4D001	Introduction to Space Technology	3-0-0	3	100	50
		RAE4D002	Aircraft Materials				
		RAE4D003	Combustion				
6	OE	RAE4G001	Digital Systems Design	3-0-0	3	100	50
		RAE4G002	Microprocessor and Microcontroller				
		RAE4G003	Data Structure				
6	MC*	RCN4F001	Constitution of India	3-0-0	0	__	100 (Pass mark is 37)
Total Credit (Theory)					**18**		
Total Marks						**600**	**300**
Practical							
1	PC	RAE4C201	Aerodynamics - I Laboratory	0-0-3	2		100
2	PC	RAE4C202	Aircraft Structures - I Laboratory	0-0-3	2		100
3	PC	RAE4C203	Aero Engineering Thermodynamics Laboratory	0-0-3	2		100
Total Credit (Practical)					**6**		
Total Semester Credit					**24**		
Total Marks							**300**

***Mandatory Non-Credit Courses (MC) result will be reflected with Pass (P) / Fail (F) grade. Thus the grade obtained will not be affecting the grade point average. However it shall appear on the grade sheet as per AICTE rule.**

4th Semester	**RAE4C001**	**Aerodynamics - I**	**L-T-P 3-0-0**	**3 CREDITS**

Module-I: Basic Fluid Mechanics (10 Hrs.)

Continuity, momentum and energy equations. Type of flow (steady/unsteady, laminar/Turbulent, compressible/incompressible, viscous/in-viscous, Rotational/Irrational, 2-d/3-dect…), Euler and Lagrangian descriptions, Pathlines, Streamlines and Streaklines, Angular velocity, Vorticity, Circulation, Kelvin's circulation theorem, Stream function, Velocity potential and Relationship between them.

Module-II: Two-Dimensional Inviscid Incompressible Flows (8 Hrs.)

Source, Sink, Free and Forced vortex, uniform parallel flow. Their combinations, Ideal Flow over a circular cylinder, D'Alembert's Paradox, Magnus effect, Kutta-Jonkowski's Theorem, Starting Vortex, Kutta condition, Pressure and velocity distributions on cylinder with and without circulation in ideal and real fluid flows,

Module-III: Airfoil Characteristics (9 Hrs.)

Airfoil section geometry and wing platform geometry with its nomenclature, fundamental aerodynamic variables, Aerodynamic forces and moments and pressure coefficient, Centre of pressure, aerodynamic centre.calculation of airfoil lift and drag, pressure distributions with different angle of attack, typical airfoil aerodynamic characteristics at low speeds. speed of sound, Mach number..

Module-IV: Airfoil And Wing Theory (7 Hrs.)

Classical thin airfoil theory for symmetric and cambered airfoils., Vortex Filament, Biot and Savart Law, Bound Vortex and trailing Vortex, Horse Shoe Vortex, Lifting Line Theory and its limitations.

Module-V: Viscous Flow (Hrs.)

Boundary layer and boundary layer thickness, displacement thickness, momentum thickness, Energy thickness, Boundary Layer growth and poit of separation, Reynolds Number, Critical Reynolds Number, Boundary layer equations for a steady, two dimensional incompressible flow, Blasius solution, Prandtl's mixinglength hypothesis, Free shear layers.

Books:

- "Fundamentals of Aerodynamics", Anderson, Jr. J.D. Tata McGraw- Hill Publishing Co. Ltd., New Delhi, 2007. (Special Indian Edition).
- "Aerodynamics for Engineering Students", Houghton E.L and Carpenter P.W, CBS Publications and Distributors, 1993. (4th Edition).
- Clancey, L.J., "Aerodynamics", Pitman, 1986
- Milne Thomson, L.H., "Theoretical aerodynamics", Macmillan, 1985.

- "Boundary Layer Theory" Schlichting, HMcGraw Hill, NewYork, 2004

th Semester	**RAE4C201**	**Aerodynamics - I Laboratory**	**L-T-P 0-0-3**	**2 CREDITS**

Laboratory Experiments: (Minimum 8 experiments)

1. Study of wind tunnel
2. Calibration of subsonic wind tunnel
2. Flow visualization in water flow channel
3. Flow visualization of smooth and rough circular cylinder.
4. Pressure distribution over smooth and rough circular cylinder.
6. Pressure distribution over a rough circular cylinder.
7. Pressure distribution over a symmetric aerofoil.
8. Pressure distribution over a cambered aerofoil.
9. Flow visualization of airfoil with different angle of attack..
10. Force measurement using wind tunnel balance of airfoil

4th Semester	**RAE4C002**	**Aircraft Structures - I**	**L-T-P 3-0-0**	**3 CREDITS**

Module-I: Airplane Structures And Materials (9 Hrs.)

General types of construction, monocoque, semi-monocoque and geodesic constructions, typical wing and fuselage structure.metallic and non-metallic materials, use of aluminium alloy, titanium, stainless steel and composite materials. Structural nomenclature–Types of loads ,load factor– Symmetric manoeuvre loads – Velocity (v-n) diagram – Function of structural components.

Module-II: Statically Determinate and Indeterminate Structures (12 Hrs.)

Analysis of plane Truss-Method of joints-3 D Truss-Plane frames.
Propped Cantilever- Fixed-Fixed beams-Clapeyron's Three Moment Equation - Moment Distribution Method, Introduction to Composite beam.

Module-III: Energy Methods (8 Hrs.)

Strain Energy due to axial, bending and Torsional loads – Castigliano's theorems- Maxwell's Reciprocal theorem, Unit load method - application to beams, trusses, frames,rings, etc.

Module-IV: Columns (8 Hrs.)

Columns with various end conditions – Euler's Column curve – Rankine's formula - Column with initial curvature - Eccentric loading – South well plot – Beam column.

Module-V: Failure Theory (8 Hrs.)

Maximum Stress theory – Maximum Strain Theory – Maximum Shear Stress Theory – Distortion Theory – Maximum Strain energy theory – Application to aircraft Structural problems.

Books:

- Megson T. H. G., "Aircraft Structures for Engineering Students", 5th edition, Elsevier, New York, 2012
- Peery D. J., and Azar J. J., "Aircraft Structures", 2nd edition, McGraw – Hill, 1999.
- Bruhn.E.F., "Analysis and design of flight vehicle structures," Tri set of offset company, 1973
- Timoshenko, S., "Strength of Materials", Vol. I and II, Princeton D. Von Nostrand Co, 1990.
- R. K. Rajput, "strength of materials"

4th Semester	**RAE4C202**	**Aircraft Structures - I Laboratory**	**L-T-P 0-0-3**	**2 CREDITS**

Laboratory Experiments: (Minimum 8 experiments)

1. Determination of Young's modulus of steel using mechanical extensometers.
2. Determination of Young's modulus of aluminum using electrical extensometers
3. Determination of fracture strength and fracture pattern of ductile and brittle materials.
4. Determination of forces in statically indeterminate force system.
5. Deflection of beams with various end conditions.
6. Verification of Maxwell's Reciprocal theorem & principle of superposition
7. Column – Testing
8. South – well's plot.
9. Testing of Riveted Joints.
10. Determination of membrane stresses in a thin cylinder under internal pressure.

4th Semester	REN4E001	ENGINEERING ECONOMICS	L-T-P 3-0-0	3 CREDITS

Module - I (10 hours)

Engineering Economics- Nature, Scope, Basic problems of an economy, Micro Economics and Macro Economics.
Demand - Meaning of demand, Demand function, Law of Demand and its exceptions, Determinants of demand, Elasticity of demand & its measurement (Simple numerical problems to be solved), Demand Forecasting – Meaning
Supply-Meaning of supply, Law of supply and its exception, Determinants of supply, Elasticity of supply, Determination of market equilibrium (Simple numerical problems to be solved).

Module - II (08 hours)

Production - Production function, Laws of returns: Law of variable proportion, Law of returns to scale
Cost and Revenue Concepts - Total Costs, Fixed cost, Variable cost, Total revenue, Average revenue and Marginal revenue, Cost-Output Relationships in the Short Run, and Cost-Output Relationships in the Long Run, Analysis of cost minimization.

Module III (08 hours)

Market - Basic understanding of different market structures, Determination of equilibrium price under perfect competition (Simple numerical problems to be solved), Break Even Analysis-linear approach (Simple numerical problems to be solved).

Module - IV (12 hours)

Time Value of Money- Interest - Simple and compound, nominal and effective rate of interest, Cash flow diagrams, Principles of economic equivalence.
Evaluation of Engineering Projects-Present worth method, Future worth method, Annual worth method, Internal rate of return method, Cost benefit analysis for public projects.
Depreciation- Depreciation of capital assert, Causes of depreciation, Methods of calculating depreciation - Straight line method, Declining balance method, SOYD method, After tax comparison of project.

Module –V (07 Hours)

Inflation-Meaning of inflation, types, causes, measures to control inflation.
National Income-Definition, Concepts of national income, Method of measuring national income.
Banking -Commercial bank, Functions of commercial bank, Central bank, Functions of Central Bank.

Books:

1. Principles of Economics by Deviga Vengedasalam and Karaunagaran Madhavan, Oxford
2. Riggs, Bedworth and Randhwa, “Engineering Economics”, McGraw Hill Education India
3. C. S. Park, Contemporary Engineering Economics, 6th Edition, Pearson Education, 2015.
4. Engineering Economy by William G.Sullivan, Elin M.Wicks, C. Patric Koelling, Pearson
5. R.Paneer Seelvan, “ Engineering Economics”, PHI

6. Ahuja,H.L., “Principles of Micro Economics” , S.Chand & Company Ltd
7. Jhingan,M.L., “Macro Economic Theory”
8. Macro Economics by S.P.Gupta, TMH

Course Outcomes of Engineering Economics

At the end of the course the engineering graduates will be able to

1. **Remembering** : Define the basic concept of micro and macro economics, engineering economics and their application in engineering economy.

2. **Understanding** : Evaluate numerically the effects of changes in demand and supply on price determination of products and services.

3. **Analyze :** the macroeconomic environment and financial systems of the country and its impact on business, society and enterprise.

4. **Develop :** the ability to account for time value of money using engineering economy factors and formulas.

5. **Apply:** knowledge of mathematics, economics and engineering principles to solve engineering problems and to analyze decision alternatives in engineering projects considering upon depreciation, taxes and inflation.

4th Semester	ROB4E002	ORGANISATIONAL BEHAVIOUR	L-T-P 3-0-0	3 CREDITS

Objectives:

1. To develop an understanding of the behavior of individuals and groups inside organizations
2. To enhance skills in understanding and appreciating individuals, interpersonal, and group process for increased effectiveness both within and outside of organizations.
3. To develop theoretical and practical insights and problem-solving capabilities for effectively managing the organizational processes.

Module-I: **(06 Hrs.)**

Fundamentals of OB: Definition, scope and importance of OB, Relationship between OB and the individual, Evolution of OB, Theoretical framework (cognitive), behavioristic and social cognitive), Limitations of OB.

Module-II: **(12 Hrs.)**

Attitude: Importance of attitude in an organization, Right Attitude, Components of attitude, Relationship between behavior and attitude, Developing Emotional intelligence at the workplace, Job attitude, Barriers to changing attitudes.
Personality and values: Definition and importance of Personality for performance, The Myers-Briggs Type Indicator and The Big Five personality model, Significant personality traits suitable to the workplace (personality and job – fit theory), Personality Tests and their practical applications.
Perception: Meaning and concept of perception, Factors influencing perception, Selective perception, Attribution theory, Perceptual process, Social perception (stereotyping and halo effect).
Motivation: Definition & Concept of Motive & Motivation, The Content Theories of Motivation (Maslow's Need Hierarchy & Herzberg's Two Factor model Theory), The Process Theories (Vroom's expectancy Theory & Porter Lawler model), Contemporary Theories – Equity Theory of Work Motivation.

Module-III: **(10 Hrs.)**

Foundations of Group Behavior: The Meaning of Group & Group behavior & Group Dynamics, Types of Groups, The Five – Stage Model of Group Development.
Managing Teams: Why Work Teams, Work Teams in Organization, Developing Work Teams, Team Effectiveness & Team Building.
Leadership: Concept of Leadership, Styles of Leadership, Trait Approach Contingency Leadership Approach, Contemporary leadership, Meaning and significance of contemporary leadership, Concept of transformations leadership, Contemporary theories of leadership, Success stories of today's Global and Indian leaders.

Module-IV: **(08 Hrs.)**

Organizational Culture : Meaning & Definition of Organizational Culture, creating & Sustaining Organizational Culture, Types of Culture (Strong vs. Weak Culture, Soft Vs. Hard Culture & Formal vs. Informal Culture), Creating Positive Organizational Culture, Concept of Workplace Spirituality.

Module-V: **(09 Hrs.)**

Organizational Change: Meaning, Definition & Nature of Organizational Change, Types of Organizational Change, Forces that acts as stimulants to change.
Implementing Organizational Change : How to overcome the Resistance to Change, Approaches to managing Organizational Change, Kurt Lewin's-Three step model, Seven Stage model of Change & Kotter's Eight-Step plan for Implementing Change, Leading the Change Process, Facilitating Change, Dealing with Individual & Group Resistance, Intervention Strategies for Facilitating Organizational Change, Methods of Implementing Organizational Change, Developing a Learning Organization.

Books:

1. Understanding Organizational Behaviour, Parek, Oxford
2. Organizational Behaviour, Robbins, Judge, Sanghi, Pearson.
3. Organizational Behaviour, K. Awathappa,HPH.
4. Organizational Behaviour, VSP Rao, Excel
5. Introduction to Organizational Behaviour, Moorhead, Griffin, Cengage.
6. Organizational Behaviour, Hitt, Miller, Colella, Wiley

4th Semester	RAE4C003	Aero Engineering Thermodynamics	L-T-P 3-0-0	3 CREDITS

Module-I: Basic Thermodynamics (9 Hrs.)

SystemZeroth Law, First Law - Heat and work transfer in flow, Second law, Clausiusand kelvin-plank statement - concept of entropy enthalpy change in non-flow processes. Carnot cycle and its specialties. Gibbs and Helmholtz function, maxwell Relation.

Module-II: Air Cycles (9 Hrs.)

Otto, Diesel, Dual combustion and Brayton combustion cycles – Air standard efficiency -
Mean effective pressure – Actual and theoretical PV diagrams of two stroke and four stroke IC Engines, performance of IC Engines, classification of piston engines, cycle for Jet propulsion and Rocket Propusion.

Module-III: Thermodynamics Of One Dimensional Fluid Flow (9 Hrs.)

Application of continuity, momentum and energy equations- Rankine cycle - Isentropic
flow of ideal gases through nozzles - Principles of aircraft propulsion, Types of aircraftpower plantsSimple jet propulsion system - Thrust rocket motor– Specific impulse.

Module-IV: Fundamentals of Gas Turbine Engines (9 Hrs.)

Illustration of working of gas turbine engine–The thrustequation – 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.

Module-V: Basics Of Heat Transfer Stoichiometry (9 Hrs.)

Basics of heat transfer; conduction, convection, radiation, diffusion mass transfer basic concepts and governing equations.

Stoichiometry definition and properties, dry bulb temperature, wet bulb temperature, dew point temperature, degree of saturation, adiabatic saturation temperature, Stoichiometry relation and process. Classification of fuels, Combustion reaction.fuel-air ratio.

Books:

- Rathakrishnan, E, “Fundamentals of Engineering Thermodynamics”, Prentice – Hall, India, 2000
- Nag. P.K., “Engineering Thermodynamics”, Tata McGraw-Hills Co., Ltd., Seventh Edn., 1993
- YunusA.Cengal. “Thermodynamics an Engineering Approach”, Tata McGraw-Hill Co. Ltd., 3rd Edition, 2002.
- Yunus A. Cengel and Michael A. Boles. Thermodynamics: An Engineering Approach; McGraw-Hill College; 4thedition; ISBN-10: 0072383321; (2001).
- D. P. Mishra, Fundamentals of Combustion, Prentice Hall of India, New Delhi, revised edition, 2010.
- Ernst Heinrich Hirschel. Basics of Aerothermodynamics (Progress in Astronautics and Aeronautics); Springer. ISBN-10: 3540672370; (2005).
- Rogers GFC and Mayhew Y. Engineering Thermodynamics: Work and Heat Transfer; Longman; 4thEdition; ISBN-10: 0582045665; (1992).
- V. Ganesan, Internal Combustion Engines, Tata McGraw-Hills Co

4th Semester	**RAE4C203**	**Aero Engineering Thermodynamics Laboratory**	**L-T-P 0-0-3**	**2 CREDITS**

Laboratory Experiments (Minimum 8 experiments)

1. Performance test on a 4-stroke engine
2. Valve timing of a 4 – stroke engine and port timing of a 2 stroke engine
3. Determination of effectiveness of a parallel flow heat exchanger
4. Determination of effectiveness of a counter flow heat exchanger
5. Determination of heating value of a fuel
6. COP test on a vapour compression refrigeration test rig
7. COP test on a vapour compression air-conditioning test rig
8. Determination of specific heat of solid
9. Determination of Thermal Conductivity of solid.
10. Determination of Thermal Resistance of a Composite wall.

4th Semester	RAE4D001	Introduction to Space Technology	L-T-P 3-0-0	3 CREDITS

MODULE – I (12 hrs)

Fundamentals of Rocket Propulsion and Trajectories: Space Mission- Types-Space environment-launch vehicle selection.; Introduction to rocket propulsion-fundamentals of solid propellant rockets- Fundamentals of liquid propellant rockets-Rocket equation, Two- dimensional trajectories of rockets and missiles-Multi-stage rockets-Vehicle sizing-Two multi-stage rockets-Trade-off ratios-Single stage to orbit-Sounding rocket-Aerospace plane- Gravity turn trajectories-Impact point calculation-Injection conditions-Flight dispersions

MODULE – II (08 hrs)

Atmospheric Re-entry: Introduction-Steep ballistic re-entry-Ballistic orbital re-entry-Skip re-entry-"Double- Dip" re-entry - Aero-braking - Lifting body re-entry

MODULE – III (10 hrs)

Fundamentals of Orbital Mechanics, Orbital Manoeuvres: Two-body motion-circular, elliptic, hyperbolic, and parabolic orbits-Basic orbital elements-Ground trace**.** In-Plane orbit changes-Hohmann transfer-Bi-elliptical transfer-Plane changes-Combined manoeuvres- Propulsion for manoeuvres**.**

MODULE – IV (08 hrs)

Satellite Attitude Dynamics: Torque free axisymmetric rigid body-Attitude control for spinning spacecraft - Attitude control for non-spinning spacecraft - The Yo-Yo mechanism – Gravity – Gradient satellite-Dual spin spacecraft-Attitude determination**.**

MODULE – V (07 hrs)

Space mission Operations: Supporting ground system architecture and team interfaces - Mission phases and core operations- Team responsibilities – Mission diversity – Standard operations practices.

Books:

- 'Spaceflight Dynamics', W.E. Wiesel, 3rd edition, McGraw-Hill, 2010
- 'Rocket Propulsion and Space flight dynamics', Cornelisse JW, Schoyer HFR, and Wakker KF, Pitman, 1984
- 'Fundamentals of Space Systems', Vincet L. Pisacane, Oxford University Press, 2005.
- 'Understanding Space: An Introduction to Astronautics', J. Sellers, 2nd edition, McGraw- Hill, 2004
- 'Introduction to Space Flight', Francis J Hale, Prentice-Hall, 1994
- 'Spacecraft Mission Design', Charles D. Brown, AIAA Education Series, 1998
- 'Elements of Space Technology for Aerospace Engineers', Meyer Rudolph X, Academic Press, 1999

4th Semester	RAE4D002	Aircraft Materials	L-T-P 3-0-0	3 CREDITS

MODULE – I (08 hrs)

Introduction to Aircraft Materials:
General properties of materials, Definition of terms, Requirements of aircraft materials, Testing of aircraft materials, Inspection methods, Application and trends in usage in aircraft structures and engines, Introduction to smart materials and nanomaterials; Selection of materials for use in aircraft.

MODULE – II (08 hrs)

Aircraft Metal Alloys and Super alloys:
Aluminum alloys, Magnesium alloys, Titanium alloys, Plain carbon and Low carbon Steels, Corrosion and Heat resistant steels, Maraging steels, Copper alloys, Producibility and Surface treatments aspects for each of the above;

Super alloys, Nickel based super alloys, Cobalt based super alloys, and Iron based super alloys, manufacturing processes associated with super alloys, Heat treatment and surface treatment of super alloys.

MODULE – I II (08 hrs)

Polymers, Polymeric Materials & Plastics and Ceramics & Glass:
Knowledge and identification of physical characteristics of commonly used polymeric material: plastics and its categories, properties and applications; commonly used ceramic, glass and transparent plastics, properties and applications, adhesives and sealants and their applications in aircraft.

Introduction to Composite Materials
Basics of composite materials, classification of composite materials, Fabrication of composite materials, metal matrix composite, polymer matrix composite, ceramic matrix composite, Applications of composite materials.

MODULE – IV (10 hrs)

Ablative and Super Conducting Materials:
Ablation process, ablative materials and applications in aerospace; Phenomenon of super conduction, super conducting materials and applications in aerospace.

Aircraft Wood, Rubber, Fabrics & Dope And Paint:
Classification and properties of wood, Seasoning of wood, Aircraft woods, their properties and applications, Joining processes for wood, Plywood; Characteristics and definition of terminologies pertaining to aircraft fabrics and their applications, Purpose of doping and commonly used dopes; Purpose of painting, Types of aircraft paints, Aircraft painting process.

MODULE – V (08 hrs)

High Energy Materials: Materials for rockets and missiles. Types of propellants and its general and desirable properties, insulating materials for cryogenic engines. Types of solid propellants: Mechanical characterization of solid propellants using uni-axial, strip-biaxial and tubular tests.

Books:

- Handbook of Aircraft materials Interline publishers, C G Krishnadas Nair, Bangalore, 1993.
- Aicraft Material and Processes, Titterton G F, English Book Store New Delhi, 1998
- Advanced Aerospace Material, H Buhl, Spring Berlin 1992

4th Semester	RAE4D003	Combustion	L-T-P 3-0-0	3 CREDITS

Module-I (**7hours)**

FUNDAMENTAL CONCEPTS IN COMBUSTION, CHEMICAL KINETICS AND FLAMES
Thermo chemical equations – heat of reaction- first, second and third order reactions – premixed flames – diffusion flames – measurement of burning velocity – various methods – effect of various parameters on burning velocity – flame stability – deflagration – detonation – Rankine- Hugoniot curves – radiation by flames.

Module-II (**8hours)**

COMBUSTION IN AIRCRAFT PISTON ENGINES
Introduction to combustion in aircraft piston engines – various factors affecting the combustion efficiency - fuels used for combustion in aircraft piston engines and their selection – detonation in piston engine combustion and the methods to prevent the detonation

Module-III (**10hours)**

COMBUSTION IN GAS TURBINE AND RAMJET ENGINES 10
Combustion in gas turbine combustion chambers - recirculation – combustion efficiency, factors affecting combustion efficiency, fuels used for gas turbine combustion chambers – combustion stability – ramjet combustion – differences between the design of ramjet combustion chambers and gas turbine combustion chambers- flame holders types – numerical problems.

Module-IV (**8hours)**
SUPERSONIC COMBUSTION
Introduction to supersonic combustion – need for supersonic combustion for hypersonic airbreathing propulsion- supersonic combustion controlled by diffusion, mixing and heat convection – analysis of reactions and mixing processes - supersonic burning with detonation shocks - various types of supersonic combustors.

Module-V (**10hours)**

COMBUSTION IN SOLID, LIQUID AND HYBRID ROCKETS
Solid propellant combustion - double and composite propellant combustion – various combustion models – combustion in liquid rocket engines – single fuel droplet combustion model – combustion hybrid rockets.

Books:

- Sharma, S.P., and Chandra Mohan, “Fuels and Combustion”, Tata Mc. Graw Hill Publishing Co., Ltd., New Delhi, 1987.
- Mathur, M.L., and Sharma, R.P., “Gas Turbine, Jet and Rocket Propu lsion”,Standard Publishers and Distributors, Delhi, 1988.
- Loh, W.H.T., “Jet, Rocket, Nuclear, Ion and Electric Propulsion: Theory and Design”, Springer Verlag, New York, 1982.
- Beer, J.M., and Chiger, N.A. “Combustion Aerodynamics”, Applied Science Publishers Ltd., London, 1981.
- Sutton, G.P., “Rocket Propulsion Elements”, John Wiley & Sons Inc., New York, 5th Edition, 1993.

4th Semester	RAE4G001	Digital Systems Design	L-T-P 3-0-0	3 CREDITS

MODULE – I (10 Hours)

Revision of Number System: Introduction to various number systems and their Conversion. Arithmetic Operation using 1's and 2`s Compliments, Signed Binary and Floating Point Number Representation Introduction to Binary codes and their applications.

Revision Boolean Algebra and Logic Gates: Boolean algebra and identities, Complete Logic set, logic gates and truth tables. Universal logic gates, Algebraic Reductionand realization using logic gates

MODULE – II (11 Hours)

Combinational Logic Design: Specifying the Problem, Canonical Logic Forms, Extracting Canonical Forms, EX-OR Equivalence Operations, Logic Array, K-Maps: Two, Three and Four variable K-maps, NAND and NOR Logic Implementations.

Logic Components: Concept of Digital Components, Binary Adders, Subtraction and Multiplication, An Equality Detector and comparator, Line Decoder, encoders, Multiplexers and De-multiplexers.

MODULE – III (8 Hours)

Synchronous Sequential logic Design: sequential circuits, storage elements: Latches (SR, D), Storage elements: Flip-Flops inclusion of Master-Slave, characteristics equation and state diagram of each FFs and Conversion of Flip-Flops. Analysis of Clocked Sequential circuits and Mealy and Moore Models of Finite State Machines**.**

MODULE – IV (9 Hours)

Binary Counters : Introduction, Principle and design of synchronous and asynchronous counters, Design of MOD-N counters, Ring counters. Decade counters, State Diagram of binary counters.
Shift resistors: Principle of 4-bit shift resistors. Shifting principle, Timing Diagram, SISO, SIPO, PISO and PIPO resistors.

Memory and Programmable Logic: Types of Memories, Memory Decoding, error detection and correction), RAM and ROMs. Programmable Logic Array, Programmable Array Logic, Sequential Programmable Devices.

MODULE – V (7 Hours)

IC Logic Families: Properties DTL, RTL, TTL, I^2L and CMOS and its gate level implementation. A/D converters and D/A converters**.**

College Level (20%)
Basic hardware description language: Introduction to Verilog/VHDL programming language, Verilog/VHDL program of logic gates, adders, Substractors, Multiplexers, Comparators, Decoders flip-flops, counters, Shift resistors.

Books:

- Digital Design, 3rd Edition, Moris M. Mano, Pearson Education.
- Fundamentals of digital circuits, 8th edition, A. Anand Kumar, PHI
- Digital Fundamentals, 5th Edition, T.L. Floyd and R.P. Jain, Pearson Education, New Delhi.
- Digital Electronics, G. K. Kharate, Oxford University Press.
- Digital Systems – Principles and Applications, 10th Edition, Ronald J. Tocci, Neal S. Widemer and Gregory L. Moss, Pearson Education.
- A First Course in Digital System Design: An Integrated Approach, India Edition, John P. Uyemura, PWS Publishing Company, a division of Thomson Learning Inc.
- Digital Systems – Principles and Applications, 10th Edition, Ronald J. Tocci, Neal S. Widemer and Gregory L. Moss, Pearson Education.

4th Semester	RAE4G002	Microprocessor and Microcontroller	L-T-P 3-0-0	3 CREDITS

Module-I (10 Hours)

Introduction to 8 bit and 16 bit Microprocessors-H/W architecture

Introduction to microprocessor, computer and its organization, Programming system; Address bus, data bus and control bus, Tristate bus; clock generation; Connecting Microprocessor to I/O devices; Data transfer schemes; Architectural advancements of microprocessors. Introductory System design using microprocessors; 8086 – Hardware Architecture; External memory addressing; Bus cycles; some important Companion Chips; Maximum mode bus cycle; 8086 system configuration; Memory Interfacing; Minimum mode system configuration, Interrupt processing.

Module -II (08 Hours)

16-bit microprocessor instruction set and assembly language programming: Programmer's model of 8086; operand types, operand addressing; assembler directives, instruction Set-Data transfer group, Arithmetic group, Logical group.

Module-III (08 Hours)

Microprocessor peripheral interfacing:

Introduction; Generation of I/O ports; Programmable Peripheral Interface (PPI)-Intel 8255; Sample-and-Hold Circuit and Multiplexer; Keyboard and Display Interface; Keyboard and Display Controller (8279).

Module-IV (12 Hours)

8-bit microcontroller- H/W architecture instruction set and programming:

Introduction to 8051 Micro-Controllers, Architecture; Memory Organization; Special Function register; Port Operation; Memory Interfacing, I/O Interfacing; Programming 8051 resources, interrupts; Programmer's model of 8051; Operand types, Operand addressing; Data transfer instructions, Arithmetic instructions, Logic instructions, Control transfer instructions; Programming.

Module-V (07 Hours)

8086: Maximum mode system configuration, Direct memory access, Interfacing of D-to-A converter, A-to-D converter, CRT Terminal Interface, Printer Interface, Programming of 8051 timers, 8051 serial interface, Introduction to 80386 and 80486 Microprocessor family.

Books:

- Microprocessor Architecture, Programming and application with 8085, R.S. Gaonkar, PRI Penram International publishing PVT. Ltd., 5th Edition
- Microprocessors and Interfacing, Programming and Hardware, Douglas V Hall, TMH Publication, 2006.
- Microprocessors and Interfacing, N. Senthil Kumar, M. Saravanan, S. Jeevananthan and S.K. Shah, Oxford University Press.
- The 8051 Microcontroller and Embedded Systems, Muhammad Ali Mazidi, Janice Gillispie Mazidi, Rolin D.M C Kinlay, Pearson Education, Second Edition, 2008.
- Microcontrollers: Principles and Application, Ajit Pal, PHI Publication
- Microprocessors and Microcontrollers Architecture, programming and system design using 8085, 8086, 8051 and 8096, Krishna Kant, PHI Publication, 2007.
- Advanced Microprocessors and Peripherals, A.K. Ray, K M Bhurchandi, TMH Publication, 2007.
- Textbook of Microprocessor and Microcontroller, Thyagarajan, Scitech Publication.

4th Semester	RAE4G003	Data Structure	L-T-P 3-0-0	3 CREDITS

Module - I (12 Hrs.)

Introduction: Basic Terminologies: Elementary Data Organizations, Data Structure Operations: insertion, deletion, traversal etc.; Analysis of an Algorithm, Asymptotic Notations, Time-Space trade off.
Searching: Linear Search and Binary Search Techniques and their complexity analysis.

Module – II (08 Hrs.)

Stacks and Queues: ADT Stack and its operations: Algorithms and their complexity analysis, Applications of Stacks: Expression Conversion and evaluation – corresponding algorithms and complexity analysis. ADT queue, Types of Queue: Simple Queue, Circular Queue, Priority Queue; Operations on each types of Queues: Algorithms and their analysis.

Module - III (08 Hrs.)

Linked Lists: Singly linked lists: Representation in memory, Algorithms of several operations: Traversing, Searching, Insertion into, Deletion from linked list; Linked representation of Stack and Queue, Header nodes, Doubly linked list: operations on it and algorithmic analysis; Circular Linked Lists: all operations their algorithms and the complexity analysis.

Module - IV (10 Hrs.)

Sorting and Hashing: Objective and properties of different sorting algorithms: Selection Sort, Bubble Sort, Insertion Sort, Quick Sort, Merge Sort, Heap Sort; Performance and Comparison among all the methods, Hashing.

Module - V (07 Hrs.)

Trees: Basic Tree Terminologies, Different types of Trees: Binary Tree, Threaded Binary Tree, Binary Search Tree, AVL Tree; Tree operations on each of the trees and their algorithms with complexity analysis. Applications of Binary Trees. B Tree, B+ Tree: definitions, algorithms and analysis.

Graph: Basic Terminologies and Representations, Graph search and traversal algorithms and complexity analysis.

Books:

- "Fundamentals of Data Structures", Illustrated Edition by Ellis Horowitz, Sartaj Sahni, Computer Science Press.
- Algorithms, Data Structures, and Problem Solving with C++", Illustrated Edition by Mark Allen Weiss, Addison-Wesley Publishing Company
- "How to Solve it by Computer", 2nd Impression by R.G. Dromey, Pearson Education.

4th Semester	**RCN4F001**	**Constitution of India**	**L-T-P 3-0-0**	**0 CREDIT**

Basic features and fundamental principles

The Constitution of India is the supreme law of India. Parliament of India can not make any law which violates the Fundamental Rights enumerated under the Part III of the Constitution. The Parliament of India has been empowered to amend the Constitution under Article 368, however, it cannot use this power to change the "basic structure" of the constitution, which has been ruled and explained by the Supreme Court of India in its historical judgments. The Constitution of India reflects the idea of "Constitutionalism" – a modern and progressive concept historically developed by the thinkers of "liberalism" – an ideology which has been recognized as one of the most popular political ideology and result of historical struggles against arbitrary use of sovereign power by state. The historic revolutions in France, England, America and particularly European Renaissance and Reformation movement have resulted into progressive legal reforms in the form of "constitutionalism" in many countries. The Constitution of India was made by borrowing models and principles from many countries including United Kingdom and America.

The Constitution of India is not only a legal document but it also reflects social, political and economic perspectives of the Indian Society. It reflects India's legacy of "diversity". It has been said that Indian constitution reflects ideals of its freedom movement, however, few critics have argued that it does not truly incorporate our own ancient legal heritage and cultural values. No law can be "static" and therefore the Constitution of India has also been amended more than one hundred times. These amendments reflect political, social and economic developments since the year 1950. The Indian judiciary and particularly the Supreme Court of India has played an historic role as the guardian of people. It has been protecting not only basic ideals of the Constitution but also strengthened the same through progressive interpretations of the text of the Constitution. The judicial activism of the Supreme Court of India and its historic contributions has been recognized throughout the world and it gradually made it "as one of the strongest court in the world".

Course content

1. Meaning of the constitution law and constitutionalism
2. Historical perspective of the Constitution of India
3. Salient features and characteristics of the Constitution of India
4. Scheme of the fundamental rights
5. The scheme of the Fundamental Duties and its legal status
6. The Directive Principles of State Policy – Its importance and implementation
7. Federal structure and distribution of legislative and financial powers between the Union and the States
8. Parliamentary Form of Government in India – The constitution powers and status of the President of India
9. Amendment of the Constitutional Powers and Procedure
10. The historical perspectives of the constitutional amendments in India

11. Emergency Provisions : National Emergency, President Rule, Financial Emergency
12. Local Self Government – Constitutional Scheme in India
13. Scheme of the Fundamental Right to Equality
14. Scheme of the Fundamental Right to certain Freedom under Article 19
15. Scope of the Right to Life and Personal Liberty under Article 21.