RTM Nagpur University
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
V	Propulsion - II (BTAE 501T)	3	0	0	3	30	70	100	3 Hours

Sr. No.	Course Objective
1	Students will understand the theory of non-Air-breathing and hypersonic propulsion methods, so that they get familiar with various propulsion technologies associated with space launch vehicles, missiles and space probes.
2	To get familiarity in rocket propulsion systems and gain knowledge about the advanced propulsion technique used for interplanetary mission.

Course Outcomes

After successful completion :

CO1	Students will able to explain about working principal and performance characteristics of Ramjet engine in terms of their subcritical, critical and supercritical operation and the combustion process in Ramjet engine, they can also able to apply the same on numerical concept, students will be also able to explain about working principal and performance characteristics of scramjet engine and hypersonic propulsion.
CO2	Students will be able to illustrate about the basic operating principal of rocket propulsion, Rocket nozzle classification, Rocket performance considerations and they able to apply the same of numerical concept.
CO3	Students will able to describe about the solid propellant, Selection criteria of solid propellants, Important hardware components of solid rockets and Propellant grain design considerations.
CO4	Students will be able to understand liquid propellant, Thrust control in liquid rockets, Cooling in liquid rockets, Limitations of hybrid rockets, Relative advantages of liquid rockets over solid rockets and must be able to apply the same on numerical problems.
CO5	Students will able to explain advanced propulsion technique like. Electric rocket propulsion, Ion propulsion techniques, Nuclear rocket, Types, Solar sail, Preliminary Concepts in nozzle less propulsion and their operating principal etc.

SYLLABUS	
Contents	**No. of Hours**
UNIT I: RAMJET PROPULSION Operating principle - Subcritical, critical and supercritical operation - Combustion in ramjet engine. Ramjet performance - Sample ramjet design calculations. Scramjet and Hypersonic Propulsion.	8
UNIT II: FUNDAMENTALS OF ROCKET PROPULSION Operating principle - Specific impulse of a rocket - internal ballistics - Rocket nozzle classification – Rocket performance considerations - Numerical problems.	10
UNIT III: SOLID PROPELLENTS Solid propellant rockets - Selection criteria of solid propellants - Important hardware components of solid rockets - Propellant grain design considerations.	8
UNIT IV: LIQUID PROPELLANT Selection of liquid propellants – Thrust control in liquid rockets - Cooling in liquid rockets - Limitations of hybrid rockets - Relative advantages of liquid rockets over solid rockets - Numerical problems.	10
UNIT V: ADVANCED PROPULSION TECHNIQUES Electric rocket propulsion - Ion propulsion techniques - Nuclear rocket - Types -Sclar sail - Preliminary Concepts in nozzle less propulsion.	9

Total: 45 Hours

Text Books:

1. Sutton, G. P. & Oscar Bilbraz, "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 7th Edition, 2004.
2. Gorden, C. V., "Aerothermodynamics of Gas Turbine and Rocket Propulsion ", AIAA Education Series, New York, 1986.

Reference Books:

1. Mukunda H. S. "Understanding Aerospace chemical propulsion", Interline publications, 2004.
2. Mechanics and Thermodynamics of Propulsion 2nd Edition by Philip Hill and Carl Peterson.

RTM Nagpur University

Syllabus (Practical)

Semester	Course Title(Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
V	Propulsion – II Lab (BTAE 501P)	0	0	2	1	25	25	50

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Understand various propulsion systems with classification.
CO2	Understanding of the characteristics of the several types of propulsion systems.

Minimum Eight out of the following shall be performed:

Sr. No.	List of Practical's
01	Experiment on Subsonic free wall jet apparatus.
02	Experiment on Subsonic forced wall jet apparatus.
03	Study on Supersonic free jet apparatus.
04	Experiment on Propeller performance test apparatus.
05	Study of aircraft engine models.
06	Study/Experiment on Cascade Test setup.
07	Experiment on free convective heat transfer test setup.
08	Experiment on forced convective heat transfer test setup.
09	Study of aircraft's magneto ignition system.
10	Study of gas turbine engine's combustion characteristics.

References:

1. "Gas Turbines", by Ganesan V, Tata McGraw-Hill Publishing Company Ltd., New Delhi, 2nd Edition, (1999).
2. Mathur, M. L., and Sharma, R. P., Gas Turbine, Jet and Rocket Propulsion, Standard Publishers and Distributors, Delhi, 2014.

RTM Nagpur University
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
V	Aircraft System & Instrumentation (BTAE502T)	3	0	0	3	30	70	100	3 Hours

Sr. No.	Course Objectives
1	To impart students in depth understanding of various airplane control/operation systems.
2	To illustrate students operational and maintenance requirements of various airplane control/operation systems.

Course Outcomes

After successful completion of this course:

CO1	Students will be able to understand airplane control systems
CO2	Students will be able to describe aircraft hydraulic systems
CO3	Students will be able to describe aircraft pneumatic & hybrid systems
CO4	Students will be able to understand and illustrate different Engine Systems
CO5	Students will be able to understand and explain auxiliary system of the aircraft

SYLLABUS

Contents	No. of Hours
UNIT I: AIRPLANE CONTROL SYSTEMS Conventional Systems - Power assisted and fully powered flight controls - Power actuated systems– Engine control systems - Push pull rod system, flexible push pull rod system Modern control systems - Digital fly by wire systems - Auto pilot system active control Technology, Communication and Navigation systems Instrument landing systems, VOR - CCV case studies.	10

RTM Nagpur University
Syllabus (Practical)

Semester	Course Title(Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
V	Aircraft Systems & Instrumentation Lab (BTAE-502P)	0	0	2	1	25	25	50

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Know wood crafting and the technology of new materials
CO2	Understand the various procedures of aircraft ground handling
CO3	Knowledge of various procedures related to pressure, temperature tests.
CO4	Get some exposure on Aerospace and related industries.

Minimum Eight out of the following shall be performed:

Sr. No.	List of Practical's
01	Study/Experiment on aircraft "Jacking Up" procedure
02	Study/Experiment on aircraft "Leveling" procedure
03	Study/Experiment on aircraft "Rigging check" procedure
04	Study/Experiment on aircraft "Symmetry Check" procedure
05	"Flow Test" to assess of filter element clogging
06	"Pressure Test" to assess hydraulic External/Internal Leakage
07	"Functional Test" to adjust operating pressure
08	"Pressure Test" procedure on fuel system components
09	"Brake Torque Load Test" on wheel brake units
10	Maintenance and rectification of snags in hydraulic and fuel systems.

Text Books:

1. McKinley, J. L., and Bent, R.D., "Aircraft Maintenance & Repair", McGraw-Hill, 1993.
2. "General Hand Books of Airframe and Power plant Mechanics", U.S. Dept. of Transportation, Federal Aviation Administration, The English Book Store, New Delhi1995.

Reference Books:

1. Pallet, E.H.J., "Aircraft Instruments & Principles", Pitman & Co., 1993.

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Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
V	Aircraft Structure-II (BTAE503T)	3	1	0	4	30	70	100	3 Hours

Sr. No.	Course Objective
1	To impart students in depth understanding of various airplane structural aspects.
2	To illustrate students constructive, operational and design requirements of various airplane structural components.

Course Outcomes

After successful completion of this course:

CO1	Students will be able to understand Unsymmetrical Bending
CO2	Students will be able to describe and analyze Shear Flow in Open Sections.
CO3	Students will be able to describe and analyze Shear Flow in Closed Sections.
CO4	Students will be able to understand different types of buckling of plates.
CO5	Students will be able to explain Stress analysis of Wing and Fuselage.

SYLLABUS

Contents	No. of Hours
UNIT I: UNSYMMETRICAL BENDING Theory of Basic Elasticity, Review of bending of symmetrical sections, Stresses in beams of Un-symmetric sections.	8
UNIT II: SHEAR FLOW IN OPEN SECTIONS General stress, strain and displacement relationships for open and single cell closed section thin-walled beams. Thin walled beams, Concept of shear flow, Shear-Centre, Elastic axis.	8
UNIT III: SHEAR FLOW IN CLOSED SECTIONS Membrane Analogy, Bredt - Batho formula, Single and multi-cell structures. Shear flow in single and Multi-Cell structures under torsion. Shear flow in single and Multi-Cell under bending with walls effective and ineffective.	10
UNIT IV: BUCKLING OF PLATES Rectangular sheets under compression, Local buckling stress of thin walled sections, Crippling stresses by Needham's and Gerard's methods, Thin walled column strength. Sheet stiffener panels. Effective width, Inter rivet and sheet wrinkling failures.	9

UNIT V: STRESS ANALYSIS OF WING AND FUSELAGE	
Procedure - Shear and bending moment distribution for semi cantilever and other types of wings and fuselage, thin webbed beam. With parallel and non-parallel flanges, Shear resistant web beams, Tension field web beams (Wagner's).	10

Total: 45 Hours

Text Books:

1. Megson, New edition T.M.G., "Aircraft Structures for Engineering Students", Edward Arnold, 1985.
2. Bruhn. E.H, "Analysis and Design of Flight vehicles Structures", Tri-state off set company, USA, 1965.
3. L.S.Shrinath, "Advanced Mechanics of Solids", McGraw-Hill 2017.

Reference Books:

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

RTM Nagpur University
Syllabus (Practical)

Semester	Course Title(Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
V	Aircraft Structure – II Lab (BTAE-503P)	0	0	2	1	25	25	50

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Know unsymmetrical bending for different section.
CO2	Understand the various procedures of determining Shear Centre location.
CO3	Knowledge of various procedures related to flexibility matrix for Beams.
CO4	Get some exposure on determination of resonance frequency of Beams.

Minimum Eight out of the following shall be performed:

Sr. No.	List of Practical's
01	Verification of Maxwell's Reciprocal theorem & principle of superposition
02	Determination of Unsymmetrical bending for different sections using bend test set up.
03	Determination of Shear Centre location for open sections
04	Determination of Shear Centre location for closed sections
05	Experiment on Constant strength beam
06	Demonstration of flexibility matrix for cantilever beam
07	Testing of Beam with combined loading
08	Determination of resonance frequency of Beams using free vibrations
09	Determination of resonance frequency of Beams using forced vibrations
10	Column testing and South-well plot.

References:

1. Standard Lab Manual.
2. Peery, D.J., and Azar, J.J, "Aircraft Structures ", 2nd edition, Mcgraw-Hill, N.Y., 1993.
3. L.S.Shrinath, "Advanced Mechanics of Solids", McGraw-Hill 2017.

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Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
V	Industrial Economics & Management (BTAE504T)	3	0	0	3	30	70	100	3 Hours

Sr. No.	Course Objective
1	This course is designed to familiarize the learners with important economic terminologies and key industrial concepts and to create awareness about functions of Industrial management and the concept of marketing and financial management.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Understand the concept of demand and supply and its relationship with the price
CO2	Relate various factors of production with reference to different economic sectors
CO3	Analyze the causes and effects of inflation and understand the market structure
CO4	Acquire knowledge of various functions of management and marketing management
CO5	Perceive the concept of financial management for the growth of business

SYLLABUS

Contents	No. of Hours
Unit I Industrial Economics: Law of demand, Demand analysis, Types of demand, Determinants of demand, Supply, Law of diminishing marginal utility, Elasticity of demand, Types of elasticity of demand.	8
Unit II Factors of production, Firm and Industry, Law of return, Cost concepts, Fixed variable, Average, Marginal and Total cost, Depreciation and methods for depreciation, direct and indirect taxes	9
Unit III Inflation, effect of inflation, Monetary and fiscal measures to control inflation, deflation, Market and market structures, Perfect competition, Monopoly, Monopolistic competition, Oligopoly, Concept & overview of share market, Effect of share market on economy, Share market terminologies	10
Unit IV Definition, nature and scope of management, functions of management, Meaning and concepts of Marketing management, Marketing Mix, Channels of distribution, Advertising and sales promotion.	9

Unit V Meaning, nature and scope of financial management, Brief outline of profit and loss account, balance sheet, Budgets and their importance, Types of budgets- Rigid and flexible budgets.	9

Total: 45 Hours

Text Books:

1. Modern Economics, H. L. Ahuja, S. Chand Publishers
2. Modern Economic Theory, K. K. Dewett., S. Chand Publishers
3. Engineering Economics, D. N. Dwivedi, A. Dwivedi, Vikas Publishing House

Reference Books:

1. Industrial Management I.K. Chopde, A. M. Sheikh
2. Business Organization and Management S. A. Sherlekar

Syllabus of Elective-I

RTM Nagpur University
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
V	Heat and Mass Transfer (BTAE505T(E)-1)	3	0	0	3	30	70	100	3 Hours

Sr. No.	Course Objectives
1	To impart students in depth understanding of heat transfer aspects.
2	To impart students in depth understanding of mass transfer aspects.

Course Outcomes

After successful completion of this course:

CO1	Students will be able to understand basic heat transfer modes and conduction.
CO2	Students will be able to describe and analyze Convection problems
CO3	Students will be able to describe and analyze radiative heat transfer problems.
CO4	Students will be able to understand different types of heat exchangers and aerodynamic heating.
CO5	Students will be able to explain basic concepts mass transfer.

SYLLABUS

Contents	No. of Hours
UNIT I: INTRODUCTION Basic modes of heat transfer, conduction, convection and radiation, Laws of heat transfer and conservation of energy requirement. Heat Conduction – One dimensional steady state heat conduction: Composite Medium – Critical thickness – Effect of variation of thermal Conductivity – Extended Surfaces – Unsteady state. Lumped System Analysis – Heat Transfer in Semi-infinite and infinite solids – Use of Transient – Temperature charts– Biot Number.	7
UNIT II: FREE & FORCED CONVECTION Free or natural convection, Grashoff number, Rayleigh number, Horizontal and vertical plate. Empirical co-relations for cylinders and spheres. Heat transfer with phase change, pool boiling curve & regimes of pool boiling. Film & Drop wise condensation, laminar film condensation on vertical surface, film condensation on horizontal tubes, effect of super-heated & non-condensable gasses on condensation heat transfer, Introduction to heat pipe. Physical significance of non-dimensional parameters. Flow of high moderate & low Prandtl number, fluid over flat surface. Concept of velocity & thermal boundary layer thickness, local and average heat transfer coefficients. Empirical co-relations for external, internal flow, laminar & turbulent flow through conduits.	10

UNIT III: RADIATIVE HEAT TRANSFER Radiation, nature of thermal radiation, black body radiation, radiation intensity, laws of radiation– Kirchoffs, Planks, Weins displacement, Stefan Boltzmann & Lamberts Co-sine law. Emissivity, Absorptivity, Transmissivity, Reflectivity, Radiosity, Emissive power, irradiation. Radiation network, radiation exchange between surfaces, idea of shape factor & reciprocity theorem, radiation between parallel plates, cylinder & spheres. Radiation shields, effect of radiation on temperature measurement.	9
UNIT IV: HEAT EXCHANGERS Classification, Overall heat transfer coefficient, fouling factor, LMTD method of heat exchange analysis for parallel, counter flow & cross flow arrangement. Effectiveness NTU method, heat exchanger analysis by NTU method, design aspects of heat exchangers. Introduction to compact heat exchanger. Heat Transfer problems in gas turbine combustion chambers – Rocket thrust chambers – Aerodynamic heating – Ablative heat transfer.	10
UNIT V: INTRODUCTION TO MASS TRANSFER Basic Concepts — Diffusion Mass Transfer — Fick's Law of Diffusion — Steady state Molecular Diffusion — Convective Mass Transfer — Momentum, Heat and Mass Transfer Analogy –Convective Mass Transfer Correlations.	9

Total: 45 Hours

Text Books:

1. Heat Transfer -A practical approach Yunus A. Cengel , "Tata Mcgraw Hill publication Second Edition
2. Heat and Mass Transfer (McGraw Hill) By P K Nag.
3. Elements of Heat and Mass Transfer, New Age International, 1 By Vijay Gupta.

Reference Books:

1. Introduction to heat Transfer Incropera. F.P.and Dewitt.D.P. , John Wiley and Sons – 2002.
2. Elements of Heat Transfer M. N. Ozisik
3. Heat Transfer J. P. Holman McGraw Hill Publication

RTM Nagpur University
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
V	Smart materials and Introduction to Composites (BTAE 505T(E) -2)	3	0	0	3	30	70	100	3 Hours

Sr. No.	Course Objectives
1	To understand the mechanical behavior of Smart materials use in aerospace sector.
2	To get an overview of the methods of manufacturing composite materials.

Course Outcomes

After successful completion of this course the student will be able to:

CO1	Understand the Aerospace Materials, Classification and their properties.
CO2	Understand the composites and manufacture of composite/Smart materials.
CO3	Describe the moulding techniques for manufacturing of composites.
CO4	Explain creep and design for creep resistance
CO5	Explain about various Super alloys and Other Materials use in aerospace sector

SYLLABUS

Contents	No. of Hours
UNIT I : INTRODUCTION TO AEROSPACE MATERIALS Classification, composition, properties, heat treatment & application of plain carbon steels, alloy steels. Stainless steels. Classification, composition, properties, heat treatment & application of aluminium and its alloys. Titanium alloys, Special alloys for high temperature.	8
UNIT II: INTRODUCTION TO COMPOSITE MATERIALS Definition – Classification of Composite materials based on structure – based on matrix. Advantages of composites – application of composites – functional requirements of reinforcement and matrix. FIBERS: Preparation, properties and applications of glass fibers, carbon fibers, Kevlar fibers and metal fibers – properties and applications of whiskers, particle reinforcements.	10
UNIT III : MANUFACTURING OF ADVANCED COMPOSITES Polymer matrix composites: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Manufacturing of Metal Matrix Composites: Casting – Solid State diffusion technique, Cladding – Hot isostatic pressing	10

UNIT IV : CREEP Factors influencing functional life of components at elevated temperatures, definition of creep curve, various stages of creep, metallurgical factors influencing various stages, effect of stress, temperature and strain rate. Design for Creep Resistance: Design of transient creep time, hardening, strain hardening, expressions of rupture life of creep, ductile and brittle materials, Monk man-Grant relationship.	8
UNIT V : SUPER ALLOYS AND OTHER MATERIALS Iron base, Nickel base and Cobalt base super alloys, composition control, solid solution strengthening, precipitation hardening by gamma prime, grain boundary strengthening, TCP phase, embrittlement, solidification of single crystals, Intermetallic, high temperature ceramics.	9

Total: 45 Hours

TEXT BOOKS

1. Material Science and Technology – Vol 13 – Composites by Cahn – VCH, West Germany Composite Materials – K. K. Chawla.
2. Calcote, L R. "The Analysis of laminated Composite Structures", Von – Noastrand Reinhold Company, New York 1998.
3. Jones, R.M., "Mechanics of Composite Materials", McGraw-Hill, Kogakusha Ltd., Tokyo, 1985.
4. Agarwal, B.D., and Broutman, L.J., "Analysis and Performance of Fibre Composites", John Wiley and sons. Inc., New York, 1995.
5. Lubin, G., "Handbook on Advanced Plastics and Fibre Glass", Von Nostrand Reinhold Co., New York, 1989.
6. Aircraft Structures by THG Megson

REFERENCE BOOKS:

1. Raj. R., "Flow and Fracture at Elevated Temperatures", American Society for Metals, USA, 1985.
2. Hertzberg R. W., "Deformation and Fracture Mechanics of Engineering materials", 4th Edition, John Wiley, USA, 1996.
3. Courtney T.H, "Mechanical Behavior of Materials", McGraw-Hill, USA, 1990.
4. Boyle J.T, Spencer J, "Stress Analysis for Creep", Butterworths, UK, 1983.
5. Bressers. J., "Creep and Fatigue in High Temperature Alloys", Applied Science, 1981.
6. McLean D., "Directionally Solidified Materials for High Temperature Service", The Metals Society, USA, 1985.

RTM Nagpur University
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
V	Airworthiness & Certification BTAE 505T(E)-3	3	0	0	3	30	70	100	3 Hours

Sr. No.	Course Objectives
1	Describe the legal basis which underpins airworthiness regulation in aircraft design, production, operation and maintenance.
2	Communicate the importance of airworthiness requirements as they relate to aircraft design, production, operation and maintenance.
3	Illustrate the issues to be faced in the certification of new systems and aircraft.
Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Understand Regulatory Frameworks. Interpret the principles of airworthiness as applied to the process of aircraft and engine certification.
CO2	Articulate the process for Continuing Airworthiness management for different types and sizes of operator.
CO3	Understand National and International Requirements for airworthiness.
CO4	Understand various approaches to the problems of assessing the safety of increasingly complex aircraft systems.
CO5	Evaluate and apply the technique(s) appropriate for the system and differentiate between the various stages of safety assessment in the development of the aircraft systems.

SYLLABUS	
Contents	**No. of Hours**
UNIT I Regulatory Framework, CAR - 66 Certifying Staff - Maintenance, CAR-145 - Approved Maintenance Organizations. Introduction to Airworthiness: Air Law, Certification Process, including the safety assessment of aircraft systems, Airworthiness Lessons learned - Review of significant accidents.	8
UNIT II Aircraft Operations and Aircraft Certification : Maintenance and Operations Approvals, Continuing Airworthiness management, Engine certification, Application of Safety Management Systems in the field of airworthiness, Human Factors in maintenance, Incident reporting and Service Difficulty Reports (SDRs), Engine failure modes.	10

UNIT III CAR-M, Applicable National and International Requirements. Air traffic management safety culture, accidents and incidents investigations, human factors in training.	8
UNIT IV Safety Management System : Requirements for safety assessment as part of regulatory approval and continued airworthiness process, Development of requirements for safety assessment, FAR and EASA CS25-1309, Introduction to probability methods and safety analysis techniques, Fuel Tank Safety.	9
UNIT V Common mode failures Fault tree analysis, dependence diagrams and Boolean algebra for quantification of system reliability, Reliability analysis using Weibull distribution, Zonal safety analysis (ZSA) and Particular Risk Analysis (PRA), Failure Mode and Effect Analysis (FMEA). Typical safety assessment for a stall warning and identification system. Certification maintenance requirements, Current airworthiness challenges.	10

Total: 45 Hours

Text Books:

1. 'AIRWORTHINESS PROCEDURES MANUAL' Issue 2 Rev 24, December, 2019.
2. "Initial Airworthiness : Determining the Acceptability of New Airborne Systems" By Guy Gratton · 2018.

Reference Books:

1. Airworthiness: An Introduction to Aircraft Certification and Operations, Third Edition by 'Filippo De Florio'.
2. "Aircraft System Safety: Assessments for Initial Airworthiness Certification" Book by Duane Kritzinger.

RTM Nagpur University
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
V	Introduction to Helicopter Dynamics (BTAE 505T(E)-4)	3	0	0	3	30	70	100	3 Hours

Sr. No.	Course Objectives
1	Describe & comprehend the basic concepts of helicopter dynamics.
2	Acquire and Understand the knowledge of critical speed and rotor bearing system.
3	Understand the turbo-rotor system and blade vibration.

Course Outcomes

After successful completion of this course the student will be able to:

CO1	Understand the basics of helicopter.
CO2	Understand and illustrate the various hovering Theories.
CO3	Describe and Analyze Vertical Flight and Forward Flight of helicopters.
CO4	Understand the aspects of helicopter stability and control.
CO5	Understand the Standards and Specifications of helicopters for design variations in different applications.

SYLLABUS

Contents	No. of Hours
UNIT I Introduction: Historical Development of Helicopters, Helicopter Configuration, Control Requirements. Types of Rotor Systems, Basic Power Requirements.	8
UNIT II Introduction to Hovering Theory: Momentum Theory, Blade Element Theory, Combined Blade Element and Momentum theories, For non-uniform inflow calculation, Ideal Rotor Vs Optimum Rotor.	10
UNIT III Vertical Flight: Various flow states of Rotor, Autorotation in Vertical Descent, Ground Flight. Forward Flight: Momentum Theory, Variable Inflow Models, Blade Element Theory, Rotor Reference Planes. Hub Loads, Power variation with forward speed, Rotor Blade flapping Motion: Simple Model	8

UNIT IV Helicopter Stability and Control. Introductory concepts of stability. Forward speed disturbance, vertical speed disturbance, pitching angular velocity disturbance, side-slip disturbance, yawing disturbance. Static stability of Helicopters: longitudinal, lateral-directional and directional. Dynamic stability aspects. Main rotor and tail rotor control. Flight and Ground Handling Qualities-General requirements and definitions. Control characteristics, Levels of handling qualities. Flight Testing- General handing flight test requirements and, basis of limitations.	9
UNIT V Standards and Specifications: Scope of requirements. General and operational requirements. Military derivatives of civil rotorcraft. Structural strength and design for operation on specified surfaces. Rotorcraft vibration classification. Conceptual Design of Helicopters: Overall design requirements. Design of main rotors-rotor diameter, tip speed, rotor solidity, blade twist and airfoil selection, Fuselage design, Empennage design, Design of tail rotors, High speed rotorcraft.	10

Total: 45 Hours

Text Books:

1. 'Principles of Helicopter Aerodynamics', J. Gordon Leishman, Cambridge University Press, 2002
2. 'Dynamics of Helicopter Flight', George H. Saunders, John Wiley & Sons, Inc, NY, 1975

Reference Books:

1. Helicopter Dynamics', ARS Bramwell, George Done, and David Balmford, Butterworth-Heinemann Publication, 2nd Edition, 2001.
2. 'Basic Helicopter Aerodynamics', John, M. Seddon and Simon Newman, Wiley.2011

RTM Nagpur University
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks		Exam Duration (Hrs.)
		L	T	P		College Assessment	Total	
V	Introduction to Aero - Modeling (BTAE506T)	2	0	0	0	Grades: (O, A, B, C)		2

Sr. No.	Course Objectives
1	Apply their Engineering knowledge of all the fundamental, Core subjects & the Hardware and Software skills in the development (design, fabrication, analysis, testing and flying) of Aero models (UAV & DRONES).
2	Knowledge of key factors of environment; awareness of interconnectedness of multiple factors in environmental challenges.
3	Attitude building for motivating students for the aeromodelling.

Course Outcomes

After successful completion of this course the student will be able to:

CO1	To understand the basics of aero modelling and types of aero models
CO2	To acquire knowledge of various types of materials and tools require for aero modelling
CO3	To understand about the fixed wing aero models
CO4	To understand about the design and making of quadcopter
CO5	To apply their knowledge for designing and fabrication of a prototype

SYLLABUS

Contents	No. of Hours
Unit I: Introduction to Aero modeling, Basics of aircraft theory, components of an aircraft, history of aero modeling, Classification of aero models.	4
Unit II: Materials and tools used in aero modeling, Balsa, Styrofoam, wood, parchment, composites based model making, static model, powered model. Gliders: chuck glider, towline glider. Power plants used in aero models	5
Unit III: Introduction to fixed wing aero models , classification, electronic components of RC planes	5
Unit IV: Introduction to Quad/Hexa-copter, introduction to components of quadcopter, electronic component of quadcopter, quadcopter assembly.	5
Unit V: Design and fabrication of a particular prototype aero model.	5

Total: 24 Hours

GUIDELINES FOR EVALUATION

At the end of the course, the student shall be evaluated for 100 marks with distribution as below:

Model Report- 25 Marks

Objective Questions - 50 Marks (50 questions, each of one mark)

Model presentation- 25 Marks

Passing marks - 40 Marks

OR

In view of the above entire course the students in terms of batches of 10 students each may be assigned a Aero modelling work (designing, fabrication, report preparation) under the guidance of a teacher.

The result shall be declared in grades as follows:

Grade O: above 75 Marks;

Grade A: 61–75 Marks;

Grade B: 51-60 Marks;

Grade C: 40-50 Marks

Text Books:

1. RC advisor's Model Airplane Design Made Easy: The Simple Guide to Designing R/C Model Aircraft or Build Your Own Radio Control Flying Model Plane

2. The Basics of Aeromodelling by Vic Smeed, published by Nexus Special Interests 1995 1st Edition 67pp.

Reference Books:

1. Flight Mechanics Modeling and Analysis By Jitendra R. Raol, Jatinder Singh
2. Structural Design Optimization, Affiliated East-West Press Ltd., New Delhi, 1997, by G. R. Iyengar and S K Gupta.

RTM Nagpur University
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
VI	Aircraft Design (BTAE-601T)	3	0	0	3	30	70	100	3 Hours

Sr. No.	Course Objectives
1	To impart thorough understanding of conceptual, preliminary & detail design phases of aircrafts.
2	To familiarize students with analytical skill in various aircraft components design.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Explain and illustrate the airplane design process including conceptual, preliminary & detail design phases
CO2	Describe the principal features and various considerations for aircraft design
CO3	Analyze the weight estimation of an aircraft
CO4	Describe and illustrate wing designing parameters
CO5	Describe and illustrate fuselage designing parameters

SYLLABUS	
Contents	**No. of Hours**
Unit I Airplane design process – conceptual, preliminary & detail design phases, Classification of airplanes based on purpose and configuration, Factors affecting configuration, Merits of different airplane layouts	8
Unit II Shaping the Airplane: Principal features, Aerodynamic consideration, Lift, Drag and Interference effects, Weights and Strength considerations, Peculiarities in layout, Designing for manufacturability, Maintenance, Operational costs, Interactive design.	9
Unit III Conceptual Design Procedure: Data collection and 3-View drawings, their purpose, initial sizing - weight estimation, choice of wing loading and thrust loading, rubber engine sizing, fixed engine sizing. Constraint analysis. Power plant selection - Choices available, Comparative merits, Location of power plants, Functions dictating the locations.	9

Unit IV Design of Major Airplane Components – I Wing design: Airworthiness requirements, V-n diagram, loads, Elements of wing design, Structural features	9
Unit V Design of Major Airplane Components – II Fuselage design: Loads on fuselage, Elements of fuselage design, Determination of tail surface areas, Structural features and Landing gear design: Loads or Landing gear, Preliminary landing gear design.	10

Total: 45 Hours

Text Books:

1. Bruhn E F, Design and Analysis of Flight Vehicle Structures, Tri-state Offset Press.
2. Kuechemann, D., "Aerodynamic Design of Aircraft", Pergamon Press,1978

Reference Books:

1. Torenbeek, E., "Synthesis of Subsonic Airplane Design", Delft University Press, U.K.1986.
2. Raymer, D.P., "Aircraft Conceptual Design", AIAA Series, 1989s.

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Syllabus (Practical)

Semester	Course Title(Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
VI	Aircraft Design Laboratory (BTAE-601P)	0	0	2	1	25	25	50

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Describe about the aircraft design process.
CO2	Understand and able explain to about technical aspects of an aircraft

Sr. No.	List of Practical's
01	Study of different types of airplanes
02	Comparative graphs preparation and selection of main parameters for the design
03	Technical specifications of selected aircraft
04	Preliminary weight estimation of a selected aircraft
05	Design calculation to find wing loading and Thrust/Power loading
06	Selection of Power plant, type of wing and tail configuration
07	Preparation of mission profile of the selected aircraft
08	Design of wing and fuselage components
09	Preparation of 3View drawings of a selected aircraft
10	Preparation of a detailed design report with CAD drawings

References:

1. Kuechemann, D., "Aerodynamic Design of Aircraft", Pergamon Press, 1978.
2.Raymer, D.P., "Aircraft Conceptual Design", AIAA Series, 1989s

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Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
VI	Space Technology (BTAE-602T)	3	1	-	4	30	70	100	3

Sr. No.	Course Objectives
1	Knowing about our solar system and coordinate systems.
2	List out and explaining the various body problems in orbital system.
3	Operate and locate satellite injection in orbit by several methods.
4	Discussion on Interplanetary Trajectories, Ballistic Missile Trajectories and materials for Spacecraft.

Course Outcomes

After successful completion of this course the student will be able to:

CO1	Understand about basic concept of Solar System.
CO2	Outline the various aspects of orbital mechanics including N-Body Problems.
CO3	Explain the satellite injection and satellite general perturbations theory.
CO4	Understand about basic concept of interplanetary trajectories.
CO5	Outline about missile trajectories.

SYLLABUS

Contents	No. of Hours
Unit I BASIC CONCEPTS: The solar system - Reference frames and coordinate systems - The celestial sphere - The ecliptic - Motion of vernal equinox - Sidereal time - Solar time - Standard time - The earth's atmosphere.	8
Unit II THE GENERAL N-BODY PROBLEM: The Many body problems - Lagrange - Jacobi identity - The circular restricted three body problem – Libration points - Relative Motion in the N-body problem - The two - body problem - Satellite orbits - Relations between position and time - Orbital elements.	10
Unit III SATELLITE INJECTION AND SATELLITE ORBIT PERTURBATIONS: General aspects of satellite injections - Satellite orbit transfer - Various cases - Orbit deviations due to injection errors - Special and general perturbations - Cowell's Method - Encke's method – Method of variations of orbital elements - General perturbations approach.	10

Unit IV INTERPLANETARY TRAJECTORIES:	
Two dimensional interplanetary trajectories - Fast interplanetary trajectories - Three dimensional interplanetary trajectories - Launch of interplanetary spacecraft - Trajectory about the target plant.	8
Unit V BALLISTIC MISSILE TRAJECTORIES:	
The boost phase - The ballistic phase - Trajectory geometry - Optimal flights - Time of flight - Reentry phase - The position of the impact point - Influence coefficients. Space environment - Peculiarities - Effect of space environment on the selection of materials of spacecraft.	9

Total: 45 Hours

Text Books :

1. Sutton, G. P. & Oscar Bilbraz, "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 7th Edition, 2004.
2. Foundations of Space Dynamics, Wiley, Hoboken, N.J., U.S.A., 2021, by A. Tewari.

Reference Books:

1. Van de Kamp, P., "Elements of Astromechanic", Pitman, 1979.
2. Cornelisse, J. W., "Rocket propulsion and space dynamics", W. H. Freeman & Co., 1984.
3. Parker, E. R., "Materials for Missiles and Spacecraft", McGraw Hill Book Co., Inc., 1982.
4. Wiesel, W. E., "Spaceflight Dynamics", 2nd Edition, McGraw Hill, 1997.
5. Thompson, W. T., "Introduction to Space Dynamics", Dover, New York, 1986.

Unit III **Design of shaft** for power transmission, static and fatigue criteria for shaft design, ASME codes for shaft design, Design of keys. Design of rigid and flexible coupling.	9
Unit IV: **Design against fluctuating loads:** variables stresses, reversed, repeated, fluctuating stresses. Fatigue failure: static and fatigue stress concentration factors, Endurance limit- estimation of endurance limit, Design for finite and infinite life, Soderberg and Goodman design criteria, Fatigue design under combined stresses. **Curved Beams:** Assumptions made in the analysis of curved beams, Design of curved beams, bending stresses in curved beams, such as crane hook, C-frame, etc.	9
Unit V: **Design of clutches and brakes:** Single and multiple plate clutch, constant wear and constant pressure theory for plate clutches, Internal and external shoe brakes and band brakes. Introduction to disc brakes and its design concepts. **Design of Springs:** Spring material, Helical compression & tension springs under static and variable loads, Leaf spring, Laminated Springs.	9

Total: 45 Hours

Text Books:

1. Design of Machine Elements, B.D. Shiwalkar. Central Techno publications
2. Design of Machine Elements, V. B. Bhandari., McGraw Hill education.
3. Design of Machine Elements, Sharma & Purohit, PHI.
4. Design Data book, B.D. Shiwalkar, Central Techno publications.
5. Mechanical Engg. Design, Shigley J E, TMH.
6. Design Data Book, PSG.

Reference Books:

1. Mechanical Design Analysis, M. F. Spotts, Prentice-Hall.
2. Machine Component Design, Robert C. Juvinall, Kurt M. Marshele, Wiley.
3. Machine Design, Maleev& Hartman, CBS publishers.
4. Hand book of Machine Design, Shigley&Mischke, McGraw Hill.
5. Machine Design, Robert L.Norton, Pearson.

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Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
VI	Finance and Accounting (BTAE603T(OE)-2)	3	0	0	3	30	70	100	3 Hours

Sr. No.	Course Objective
1	The objective of this paper is to help students to acquire conceptual knowledge of the financial accounting and to impart skills for recording various kinds of business transactions.

Course Outcomes

After successful completion of this course the student will be able to:

CO1	Understand the basic aspects of accounting principles and standards.
CO2	Explain the various types of accounting transactions.
CO3	Understand and illustrate basics of Capital and Revenue.
CO4	Understand the various aspects of Depreciation and Reserves.
CO5	Illustrate the basics of Company Accounts and Stock Trading.

SYLLABUS

Contents	No. of Hours
Unit I: Meaning and Scope of Accounting: Need, development, and definition of accounting; Bookkeeping and accounting; Persons interested in accounting; Disclosures; Branches of accounting; Objectives of accounting. Accounting Principles: International Accounting Standards (only outlines); Accounting principles; Accounting Standards in India.	10
Unit II: Accounting transactions: Accounting Cycle; Journal; Rules of debit and credit; Compound journal entry; Opening entry; Relationships between Journal and Ledger; Rules regarding posting; Trial balance; Subdivisions of a journal.	9
Unit III: Capital and Revenue: Classification of income; Classification of expenditure; Classification of receipts Accounting concepts of income; Accounting concepts and income measurement; Expired costs and income measurement Final Accounts; Manufacturing account; Trading account; Profit and loss account; Balance Sheet; Adjustment entries, Rectification of errors; Classification of errors; Location of errors; Suspense accounts; Effects on profit.	10

Unit IV: Depreciation Provisions and Reserves: Concept of depreciation; Causes of depreciation; Depreciation, depletion, amortization, and dilapidation; Depreciation accounting; Methods of recording depreciation; Methods for providing depreciation; Depreciation of different assets; Depreciation of replacement cost; Depreciation accounting as per accounting standard; Depreciation accounting; Provisions and reserves	8
Unit V: Introduction to Company Accounts: Introduction, Kinds of Companies, Formation of Companies, Share Capital, Issue of Shares, Under Subscription & Oversubscription, Issue of Shares at Premium & Discount, Buyback of Shares and Treasury Stock, Accounting Treatments and Ledger Preparation. Company Accounts: Introduction, Forfeiture of Shares, Reissue of Shares, Issue of Bonus Shares, Rights Issue, Share Split, Buy Back of Shares, Redemption of Preference Shares, Debentures	9

Total: 45 Hours

Text Books:

1. Lal, Jawahar and Seema Srivastava, Financial Accounting, Himalaya Publishing House.
2. Monga, J.R., Financial Accounting: Concepts and Applications, Mayoor Paper Backs, New Delhi.
3. Shukla, M.C., T.S. Grewal and S.C.Gupta. Advanced Accounts. Vol.-I. S. Chand & Co., New Delhi.

References Books:

1. S. N. Maheshwari, Financial Accounting, Vikas Publication, New Delhi.
2. T.S, Grewal, Introduction to Accounting, S. Chand and Co., New Delhi
3. P.C. Tulsian, Financial Accounting, Tata McGraw Hill, New Delhi.
4. Bhushan Kumar Goyal and HN Tiwari, Financial Accounting, Vikas Publishing House, New Delhi.

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Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
VI	Renewable Energy Sources (BTAE603T(OE)-3)	3	0	0	3	30	70	100	3 Hours

Sr. No.	Course Objectives
1	Understanding basic characteristics of renewable sources of energy and technologies for their utilization.
2	To give review on utilization trends of renewable sources of energy.
3	To give review on legislative and regulatory rules related to utilization of renewable sources of energy.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Define basic properties of different renewable sources of energy and technologies for their utilization.
CO2	Describe main elements of technical systems designed for utilization of renewable sources of energy e.g. Solar energy.
CO3	To provide importance of Wind Energy.
CO4	To get the utilization of Biomass as a renewable source.
CO5	Describe about ocean and geothermal energy as a renewable source.

SYLLABUS

Contents	No. of Hours
Unit I INTRODUCTION: Energy demand growth and supply: Historical Perspectives; Fossil fuels: Consumption and Reserve; Environmental Impacts of Burning of Fossil fuels; Sustainable Development and Role of Renewable Energy.,	8
Unit II SOLAR ENERGY BASICS: Solar geometry; Primary and Secondary Solar energy and Utilization of Solar Energy. Characteristic advantages and disadvantages. Low temperature applications: solar water heating, space heating, drying. SOLAR THERMAL ELECTRICITY GENERATION: Solar concentrators and tracking; Dish and Parabolic trough concentrating generating systems, Central tower solar thermal power plants; Solar Ponds.	10

Unit III WIND Energy Systems: Types of turbines, Coefficient of Power, Betz limit, Wind electric generators, Power curve; wind characteristics and site selection; Windfarms for bulk power supply to grid; Potential of wind electricity generation in India and its current growth rate.	10
Unit IV BIOMASS ENERGY: Biomass: Sources and Characteristics; Wet biogas plants; Biomass gasifiers: Classification and Operating characteristics; Updraft and Downdraft gasifiers; Gasifier based electricity generating systems; Maintenance of gasifiers.	8
Unit V OCEAN ENERGY: Tidal power plants: single basin and two basis plants, Variation in generation level; Ocean Thermal Electricity Conversion (OTEC); Electricity generation from Waves: Shoreline and Floating wave systems. GEOTHERMAL ENERGY: Geothermal sites in India; High temperature and Low temperature sites; Conversion technologies- Steam and Binary systems; Geothermal power plants.	9

Total: 45 Hours

Text Book:

1. Renewable energy resources: Tiwari and ghosal, Narosa publication.
2. Non-conventional Energy Sources, Khanna Publication

Reference Books:

1. Renewable Energy Sources: Twidell & Weir, CRC Press.
2. Solar Energy/ S.P. Sukhatme, Tata McGraw-Hill.
3. Non-Conventional Energy Systems: K M. Mittal, A. H. Wheeler Publishing Co Ltd.
4. Renewable Energy Technologies: Ramesh & Kumar, Narosa publication.
5. Biomass Energy, Oxford &IBH Publication Co.

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Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
VI	Industrial Safety and Environment (BTAE603T(OE)-3)	3	0	0	3	30	70	100	3 Hours

Sr. No.	Course Objectives
1	The objective of the course is to prepare the students.
2	To recognize and evaluate occupational safety and health hazards in the workplace.
3	To determine appropriate hazard controls following the hierarchy of controls.
4	Students would get an insight into the dispersion of pollution in the atmosphere

Course Outcomes

After successful completion of this course the student will be able to:

CO1	Understand the safety terms and identify the various hazards around the work environment. Identify and analyze the failures of the components and subcomponents of mechanical items.
CO2	Use the safety measures while performing work on Mechanical Machine Tools and handling materials.
CO3	Aware of the safety measures while performing work on fire prone equipment and processes. Distinguish different concepts in maintenance and explore in order to increase the service life of the products/machines/Electric equipment's.
CO4	Realize the importance of safety training, safety displays and its application.
CO5	Understand the type and nature of air pollutants, the behavior of plumes and relevant meteorological determinants influencing environmental accounts and auditing.

SYLLABUS	
Contents	**No. of Hours**
Unit I Introduction to safety, safety terms: definitions, accident, safety, hazard, safe, safety devices, safety guard, security, precaution, caution, appliance, slip, trip, fall. Ladders and scaffolding. Unsafe acts, reason for accidents, OSHA & WHO norms. Safe material handling and storage. Evolution of modern safety concept-safety policy - creating awareness, awards, celebrations, safety posters, safety displays, safety pledge, safety incentive scheme, safety campaign.	8
Unit II Mechanical safety, Personal protective equipment's, safety guards, SOP and safety rules to follow while working on Mechanical Machine Tools, Safety while handling materials and material handling devices. Concept of an accident, reportable and non-reportable accidents, reporting to statutory authorities – principles of accident prevention – accident investigation and analysis – records for accidents, departmental accident reports, documentation of accidents – unsafe act and condition – domino sequence – supervisory role – cost of accident., Bureau of Indian Standards on Safety and Health: 14489 – 1998 and 15001 – 2000, ILO and EPA Standards. Toxicity- TLV- Types of Chemical Hazards-Occupational diseases caused by dust, fumes, gases, smoke and solvent hazards- control measures.	10
Unit III Introduction to fire safety, Fire classes, Fire triangle, Fire extinguishers, Fire hazard and analysis, prevention of fire. Fire protection and loss prevention, steps after occurrence of fire. Portable fire extinguishers. Fire detection, fire alarm and firefighting systems. Safety sign boards. Introduction to electrical safety, effect of electric current on human body, Electric hazards, causes and prevention of electrical accidents, Electric shock and safety precautions.	10
Unit IV Education, Training and Employee Participation in Safety: Element of training cycle, Assessment of needs. Techniques of training, design and development of training programs. Training methods and strategies types of training. Evaluation and review of training programs. Competence Building Techniques (CBT), Concept for training, safety as an on-line function. Employee Participation: Purpose, areas of participation, methods, Role of trade union in Safety, Health and Environment Protection.	8
Unit V Environmental Management: Concept and scope, Systems and approaches, Standards -international and national; Ecomark Environmental Management. Concept and scope, Systems and approaches, Standards -international and national; Ecomark; Environmental accounts and auditing, Green funding and taxes, Trade and environmental management. Environmental accounts and auditing, Green funding and taxes, Trade and environmental management.	9
	Total: 45 Hours

Text Books:

1. Blake R.B., "Industrial Safety" Prentice Hall, Inc., New Jersey, 1973
2. Heinrich H.W. "Industrial Accident Prevention" McGraw-Hill Company, New York, 1980.
3. Krishnan N.V. "Safety Management in Industry" Jaico Publishing House, Bombay, 1997.
4. John Ridley, "Safety at Work", Butterworth & Co., London, 1983.
5. Deshmukh L M, Industrial Safety and Management, McGraw Hill Education (India) private Limited, ISBN-13
6. Rao, Jain R. K. and Saluja, Electrical Safety, fire safety and safety management, Khanna Publishers, ISBN: 978-81-7409-306-6

Reference Books:

1. Safety and Health for Engineers - Roger L. Brauer, John Wiley Sons, 2006
2. Accident Prevention Manual for Industrial Operations", N.S.C.Chicago, 1982
3. Raju K S N, Chemical process Industrial safety, McGraw Hill Education (India) private Limited, ISBN-13
4. Gerard Kiely, Environmental engineering, McGraw Hill Education (India) private Limited.
5. Publications from International Standard Organizations like ISO, OSHA, IOSH, NEBOSH

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Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
VI	Aircraft Mechanisms Analysis and Synthesis (BTAE604T(E)-1)	3	0	0	3	30	70	100	3 Hours

Sr. No.	Course Objectives
1	To impart students understanding of Synthesis of Mechanisms and Balancing of linkages.
2	To impart students analyzing skill for Kinematics and Dynamics of 3D Mechanisms.
3	To impart students understanding of motion analysis of Mechanisms of Aircraft.

Course Outcomes

After successful completion of this course the student will be able to:

CO1	Understand Synthesis of Mechanisms.
CO2	Analyze and illustrate the Balancing of linkages.
CO3	Analyze and solve Kinematics of 3D Mechanisms based Problems.
CO4	Analyze and solve Dynamics of 3D Mechanisms based Problems.
CO5	Understand the basic motion analysis of Mechanisms of Aircraft.

SYLLABUS

Contents	No. of Hours
Unit I Synthesis of Mechanisms: Harding's notation, classification of four bar chains, Immersions, Deciding Mobility bonds of immersion, synthesis for rigid body guidance, space synthesis of mechanism, Analytical treatment for synthesis of planer mechanism.	10
Unit II Balancing of linkages: Force & moment balancing of four bar Mechanisms, Quantitative analysis of effect of unbalance, Treatment of Berkof & Oven.	8
Unit III Kinematics of 3D Mechanisms: D-H notation, Application of D-H Notation of RSSR, RSSS, PSC PSR Mechanisms, Forward and reverse kinematics.	8

Unit IV Dynamics of 3D Mechanisms: Derivation of (i) Lagragrian (ii) Largragrian Euler (iii) Recursive Lagrangian formulation for dynamics of 3D Mechanisms (iv) D-Alembart's formulation, Application of these treatments to RSSR, RSSS, RSCPSR linkages	9
Unit V Motion Analysis of Mechanisms of Aircraft I & II Kinematic Analysis, Dynamics & design of Mechanisms for operating Flaps & Aileron, Rudder, and Elevator, Landing Gear, Conveyor for luggage Transport in Cargo.	10

Total: 45 Hours

Text Books:

1. Sandor G.N., and Erdman A.G., "Advanced Mechanism Design Analysis and Synthesis", Prentice Hall, 1984.
2. Shigley, J.E., and Uicker, J.J., "Theory of Machines and Mechanisms", McGraw Hill, 1995.

Reference Books:

1. Amitabha Ghosh and Asok Kumar Mallik, "Theory of Mechanism and Machines", EWLP, Delhi, 1999.
2. Norton R.L., "Design of Machinery", McGraw Hill, 1999.
3. Kenneth J, Waldron, Gary L. Kinzel, "Kinematics, Dynamics and Design of Machinery", John Wiley-sons, 1999.

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Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
VI	Flight Dynamics (BTAE604T(E)-2)	3	0	0	3	30	70	100	3 Hours

Sr. No.	Course Objectives
1	To impart students understanding of airplane flight dynamics in detail.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Understand basics of airplane dynamics.
CO2	Illustrate in detail the longitudinal stability and control.
CO3	Illustrate in detail the Lateral-directional stability and control.
CO4	Understand and analyze dynamical equations of aircraft motion.
CO5	Understand and analyze the basic Aircraft motion modes and flight simulation.

SYLLABUS

Contents	No. of Hours
Unit I: Introduction to airplane dynamics: Equilibrium, static and dynamic stability, control.	8
Unit II Longitudinal stability and control: Longitudinal equilibrium and static stability, stick fixed neutral point, all moving horizontal tail OR elevator as longitudinal control. Trimmed lift curve slope and advantages of reduced/negative longitudinal static stability. Hinge moments, reversible control, stick force, and trim tab. Stick free static stability, stick-free neutral point.	9
Unit III Lateral-directional stability and control: Directional equilibrium, stability and rudder as control. Lateral stability, dihedral angle, aileron control.	8

Unit IV Dynamical equations: Euler angles. Body angular velocity and Euler angle rates. Body-fixed axis, wind axis, stability axes. Equations of motion of rigid aircraft in body fixed axes. Stability derivatives. Steady flight and perturbed flight leading to linearized equations of motion.	10
Unit V Aircraft motion modes: Decoupling of longitudinal dynamics and lateral-directional dynamics. Short period and phugoid modes of longitudinal dynamics. Dutch roll, spiral and roll subsidence modes of lateral-directional dynamics. Effect of winds. Flight simulation.	10

Total: 45 Hours

Text Books:

1. Nelson, R. C., Flight Stability and Automatic Control, Mc Graw Hill International, 1990.
2. Etkin, B. and Duffy, L. D., Dynamics of Flight: stability and control, John Wiley, NY 1995.
3. Perkins, C. D. and Hage, R. E., Airplane Performance Stability and Control, Wiley, New York, 1949.
4. Basic Flight Mechanics, Springer, Basel, Switzerland, 2016, by A. Tewari.

Reference Books:

1. Stengel, R. F., Flight Dynamics, Princeton University Press, 2004.
2. Roskam, J., Airplane Flight Dynamics and Automatic Flight Controls, DAR Corporation, 1995.

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Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
VI	Principles of Combustion (BTAE604T(E)-3)	3	0	0	3	30	70	100	3 Hours

Sr. No.	Course Objectives
1	To make the student understand the fundamentals of combustion and to teach them combustion in different regions like basic flame to gas turbine engines to rocket engines and finally how it is done in supersonic speeds.

Course Outcomes

After successful completion of this course the student will be able to:

CO1	Explain basic process of combustion.
CO2	Illustration of basics of chemical kinetics and flames.
CO3	Understand the concepts of gas turbine engine.
CO4	Understand and illustration of combustion in solid propellant rocket engines.
CO5	Explain the principle of supersonic combustion.

SYLLABUS

Contents	No. of Hours
Unit I: INTRODUCTION TO COMBUSTION Thermo-chemical equations –Heat of formation –Activation energy -Multi-step reactions - Heat of reaction -first order, second order and third order reactions – Calculation of adiabatic flame temperature.	8
Unit II: BASICS OF CHEMICAL KINETICS AND FLAMES Premixed flames –Diffusion flames –measurement of burning velocity – various methods –Effect of various parameters on burning velocity – flame stability –Deflagration – Detonation – Rankine- Hugoniot curve – Radiation by flames.	9
Unit III: COMBUSTION IN GAS TURBINE ENGINES Combustion in gas turbine combustion chambers -Recirculation – combustion efficiency, Factors affecting combustion efficiency-Fuels used for gas turbine combustion chambers – combustion stability –Flame holder types.	8

Unit IV: COMBUSTION IN ROCKETS Solid propellant grain types – types of solid propellant burning in rocket combustion chambers – basic mechanism of composite propellant combustion – solid propellant burn rate laws – criterion for stable combustion - combustion in liquid rocket engines – single fuel droplet combustion model – combustion in hybrid rockets.	10
Unit V: SUPERSONIC COMBUSTION Introduction – supersonic combustion controlled by diffusion, mixing and heat convection – Analysis of reactions and mixing processes - supersonic burning with detonation shocks.	10

Total: 45 Hours

TEXT BOOKS:

1. Sharma, S.P., and Chandra Mohan, "Fuels and Combustion", Tata Mc. Graw Hill Publishing Co., Ltd., New Delhi, 1987.
2. Fundamentals of Combustion, Prentice Hall of India, New Delhi, revised edition, 2010, by D. P. Mishra.

REFERENCES:

1. Beer, J.M., and Chiierar, N.A. "Combustion Aerodynamics", Applied Science Publishers Ltd., London, 1981.
2. Chowdhury, R., Applied Engineering Thermodynamics, Khanna Publishers, New Delhi, 1986.
3. Loh, W.H.T., "Jet, Rocket, Nuclear, Ion and Electric Propulsion: Theory and Design, Springer Verlag, New York, 1982.
4. Mathur, M.L. and Sharma, R.P., "Gas Turbine, Jet and Rocket Propulsion", Standard Publishers & Distributors, Delhi, 2nd edition 2014.
5. Sutton,G.P., Rocket Propulsion Elements, John Wiley, 1993.

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Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
VI	(Aerodynamic Design of Compressors and Turbine BTAE604T(E)-4)	3	0	0	3	30	70	100	3 Hours

Sr. No.	Course Objectives
1	To impart students detailed understanding of various Rota-dynamic machines.
2	To provide deep analytical skills to students for different types of compressors and turbines.

Course Outcomes

After successful completion of this course the student will be able to:

CO1	Understand in detail Axial flow compressors and Fans. Understand and interpret Radial Equilibrium Equation as applicable to Rota-dynamic machines.
CO2	Understand the physics of Transonic Compressors.
CO3	Understand in detail the Axial flow turbines.
CO4	Illustrate Centrifugal Compressors in detail.
CO5	Explain in detail Radial Turbine.

SYLLABUS

Contents	No. of Hours
Unit I:	
Axial flow compressors and Fans: Introduction; Aero-Thermodynamics of flow through an Axial flow Compressor stage; Losses in axial flow compressor stage; Losses and Blade performance estimation; Secondary flows (3-D); Tip leakage flow and scrubbing; Simple three dimensional flow analysis; Radial Equilibrium Equation; Design of compressor blades; 2-D blade section design: Airfoil Data; Axial Flow Track Design; Axial compressor characteristics; Multi-staging of compressor characteristics.	10

Unit II: Transonic Compressors; Shock Structure Models in Transonic Blades; Transonic Compressor Characteristics; 3-D Blade shapes of Rotors and Stators; Instability in Axial Compressors; Loss of Pressure Rise; Loss of Stability Margin; Noise problem in Axial Compressors and Fans.	9
Unit III: Axial flow turbines: Introduction; Turbine stage; Turbine Blade 2-D (cascade) analysis Work Done; Degree of Reaction; Losses and Efficiency; Flow Passage; Subsonic, transonic and supersonic turbines, Multi-staging of Turbine; Exit flow conditions; Turbine Cooling; Turbine Blade design – Turbine Profiles : Airfoil Data and Profile construction.	10
Unit IV: Centrifugal Compressors: Introduction; Elements of centrifugal compressor/ fan; Inlet Duct Impeller; Slip factor; Concept of Rothalpy; Modified work done; Incidence and lag angles; Diffuser ; Centrifugal Compressor Characteristics; Surging; Chocking; Rotating stall; Design.	8
Unit V: Radial Turbine: Introduction; Thermodynamics and Aerodynamics of radial turbines; Radial Turbine Characteristics; Losses and efficiency; Design of radial turbine.	8

Total: 45 Hours

Text Books:

1. Aerodynamics of Turbines and Compressors. (HSA-1), Volume 1 by William R. Hawthorne.
2. "Turbines Compressors and Fans" S. M. Yahya, Tata McGraw-Hill Education, 2010

Reference Books:

1. Centrifugal Compressors: A Strategy for Aerodynamic Design and Analysis by Ronald H. Aungier.
2. Axial-Flow Compressors: A Strategy for Aerodynamic Design and Analysis by Ronald H. Aungier.
3. Turbine Aerodynamics: Axial-Flow and Radial-Flow Turbine Design and AnalysisRonald H. Aungier.

RTM Nagpur University
Syllabus (Practical)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
VI	Aero-Design and Simulation Laboratory (BTAE-605P)	0	0	2	1	25	25	50

Sr. No.	Course Objectives
1	After successful completion of this course the student will be able to work on advancement and application of computational engineering for the design, optimization, and control of aerospace and other complex systems.

Course Outcomes

After successful completion of this course the student will be able to:

CO1	Understanding of basic aspects of CAD software.
CO2	Detail illustration and analysis of different modules in ANSYS.

Minimum Eight out of the following shall be performed:

Sr. No.	List of Practical's
01	Introduction to CAD software
02	Introduction to ANSYS
03	Modeling and Simulation Procedure in ANSYS
04	Simulation of flow through a converging-diverging nozzle
05	Simulation of flow through an axial flow compressor blade passage
06	Simulation of flow over an airfoil at different angles
07	Hot flow simulation through an axial flow turbine blade passage
08	Simulation of flow through subsonic and supersonic diffusers
09	Structural analysis of a tapered wing
10	Structural analysis of a fuselage structure
11	Structural analysis of a landing gear
12	Thermos-structural analysis of a composite laminate structure

References:

1. CATIA V5-6R2014 For Beginners, CD folks.
2. Working with ANSYS A Tutorial Approach: Divya Zindani, Apurba Kumar Roy, Kaushik Kumar, Wiley.

RTM Nagpur University
Syllabus (Practical)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
VI	Non Destructive Inspection Lab (BTAE-606P)	0	0	2	1	25	25	50

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Understand various non-destructive techniques such as ultrasonic, radiography, dye penetration etc. for determination of defects/damage in structural component for maintenance.
CO2	Perform various non-destructive techniques such as ultrasonic, radiography, dye penetration etc.

Minimum Eight out of the following shall be performed:

Sr. No.	List of Practical's
01	Experiment/Study on Simple optical inspection.
02	Experiment/Study on Borescope.
03	Experiment/Study on Ultrasonic flaw detection.
04	Experiment/Study on Ultrasonic thickness measurement.
05	Experiment/Study on Dye Penetration testing.
06	Experiment/Study on Eddy current testing.
07	Experiment/Study on Magnetic particle testing.
08	Experiment/Study on Radiography testing.
09	Experiment/Study on weld inspection.
10	Experiment/Study on Metallurgical Microscope.

References:

1. Basics of Non-Destructive Testing by Lari & Kumar, S.K. Kataria & Sons; 2013 Edition.
2. "Non - destructive testing" by Mr. T. Raja Santhosh Kumar, Dr. A. Anderson, dr. S. Ramachandran, Airwalk Publications; First Edition (2017).

RTM Nagpur University
Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
VI	Effective Technical Communication (BTAE-607T)	2	0	0	2	15	35	50	2 Hours

Sr. No.	Course Objectives
1	At the end of the semester, students will have enough confidence to face competitive examinations (IELTES/ TOEFL/CAT/ MAT/ XAT/SNAP/GMAT/GATE etc.) to pursue master's degree.
2	They will also acquire language skills required to write their Reviews/Projects/Reports. They will be able to organize their thoughts in English and hence face job interviews more confidently

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Acquire knowledge of structure of language.
CO2	Build vocabulary and face interview process and can become employable.
CO3	Develop business writing skills
CO4	Understand technical and scientific writing skills.

SYLLABUS

Contents	No. of Hours
UNIT I: FUNCTIONAL GRAMMAR Common errors, Transformation of Sentences (Change the voice, Change the narration, transformation of Simple, Compound, Complex sentences), Use of Phrases, Idioms & Proverbs.	6
UNIT II: ENGLISH FOR COMPETITIVE EXAMS & INTERVIEW TECHNIQUES Prefix, Suffix, Word building processes, English words /phrases derived from other languages, Technical Jargons, Synonyms/Antonyms, Verbal Analogies, Give one word for, Types & Techniques of Interview	6
UNIT III: FORMAL CORRESPONDENCE AND ANALYTICAL COMPREHENSION Job applications and Resume Writing, Business Letters, (Enquiry, Quotation, Orders, Complaints), Writing Memorandum, Circulars, notices, e-mail etiquettes, Unseen Comprehension passages	6

UNIT IV: TECHNICAL & SCIENTIFIC WRITING	
Features of Technical Writing, Technical Report writing, Writing Manuals, Writing Project and research Proposals, Writing Research papers.	6

Total: 24 Hours

Text Books:

1. Effective technical Communication by Barun K. Mitra, Oxford University Press.
2. Technical Communication-Principles and Practice by Meenakshi Raman & Sharma, Oxford University Press, 2011, ISBN-13-978-0-19-806529.
3. How to Prepare a Research Proposal: Guidelines for Funding and Dissertations in the Social and Behavioral Sciences by Krathwohl & R David.

Reference Books :

1. Technical Writing- Process and Product by Sharon J. Gerson & Steven M. Gerson, 3rd edition, Pearson Education Asia, 2000.
2. Developing Communication skills by Krishna Mohan & Meera Banerjee.
3. Functional English by Dr. P. Mahato and Dr. Dora Thompson, Himalaya Publications.

RTM Nagpur University
Syllabus (Practical)

Semester	Course Title(Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
VI	Mini Project-II:{Internship/Case Study/Seminar} (BTAE-608P)	0	0	6	3	50	50	100

Course Outcomes	
After successful completion of this course the student will be able :	
CO1	To create an Industrial environment and culture within the institution.
CO2	To standardize laboratories to industrial standard, thereby giving exposure to industrial housekeeping standards.
CO3	To provide students hands on experience on, troubleshooting, maintenance, fabrication, innovation, record keeping, documentation etc. thereby enhancing the skill and competency part of technical education.

Sr. No.	**The mini project-II can be organized based on the recommendations and evaluation criteria listed below.**
01	Standardization of Laboratories: This phase of the mini project can be clubbed with laboratory hours of the semester. Before the commencement of cycle of experiments for the semester, the students should be given instructions on 5S method of industrial housekeeping. Video resources available in the internet can be utilized for the purpose. After the initial summarizing, students should be grouped into batches of 5 and should be entrusted with activities of implementing or maintaining 5S standardization of the laboratory. This ensures that all experiments of the laboratory are performed as per industrial standard.The case can suitably be adopted for any departments as standardization concept is the same for all industry, whether it is manufacturing, service or hospitality.
02	Case study: Based on area of interest related to aerospace industry allotted to students group.
03	The evaluation should be made as group performance in implementing the standardization and individual contribution in setting work place clean and tidy. Evaluations by way of surprise visits made by the Head of Department and Guide during laboratory hours at least twice the semester contribute to the part of total marks.
04	Seminar Presentation and report submission.

With intent to get some exposure on Aerospace and related industries institution should arrange:

• Industry Visits to some of the Industries in Aerospace like HAL (Hindustan Aeronautics Limited), NAL (National Aerospace Limited), ISRO (Indian Space Research Organization).

(OR)

• Visits to Aerospace Museums.

(OR)

• Building miniature models of Aircraft /Gliders etc. as hands on exercises conducted as competitions.

References:

Innovative ideas of commercial values should be encouraged to be continued as project for the forth coming semester.

1. Evaluation Standardization (30%), Group (15%) and Individual (15%).
2. Problem identification and solving (50%) or collaborative work (50%) or involvement in production center (50%).
3. Documentation (20%).

RTM Nagpur University Aeronautical Engineering –VI Sem. SPORTS
Course Code BTAE-609P

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
VI	SPORTS (BTAE-609P)	0	0	3		0	0	0	0

Sr. No.	COURSE OBJECTIVE
1	Through sports, students should able to build a wide range of abilities and skills such as leadership, confidence, teamwork, patience, self-reliance, trust, and many more which facilitate the overall development of an individual.
2	Students should learn to manage time between their lectures, sports, and personal life.

EXPECTATION FROM INSTITUTES

1. Provide sports facilities.
2. Provide platforms for participation in events.
3. Develop interest for sports amongst students.
4. Conduct regular events (every month) in college for all indoor and outdoor sports.

RTM Nagpur University Aeronautical Engineering –VI Sem. YOGA
Course Code BTAE-609P

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
VI	YOGA (BTAE-609P)	0	0	3		0	0	0	0

Sr. No.	COURSE OBJECTIVE
1	To introduce basic wellness principles and practices of Yoga to students
2	To bring awareness of the fundamentals of Yoga for wellness in their daily lives
3	To bring peace and harmony in the society at large by introducing the Yogic way of life.

EXPECTATION FROM TRAINERS

1. Brief to origin of Yoga,
2. History and Development of Yoga: Vedic Period, Classical Period, Post classical period, Modern Period.
3. Etymology and Definitions of Yoga in classical Yoga texts
4. Meaning, Aim and Objectives of Yoga,
5. Misconceptions about Yoga;
6. True Nature of Yoga;
7. Principles of Yoga;
8. Basis of Yoga.

RTM Nagpur University
Aeronautical Engineering –VI Sem.
National Service Scheme (NSS)
Course Code BTAE-609P

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
III & IV	National Service Scheme (NSS) (BTAE-609P)	0	0	3		0	0	0	0

Sr. No.	COURSE OBJECTIVE
1	1. Understand the community in which they work. 2. Understand themselves in relation to their community. 3. Identify the needs and problems of the community and involve them in problem- solving. 4. Develop among them a sense of social and civic responsibility. 5. Utilize their knowledge in finding practice solutions to individual and community problems. 6. Develop competence required for group-living and sharing of responsibilities. 7. Gain skills in mobilizing community participation. 8. Acquire leadership qualities and democratic attitudes 9. Develop capacity to meet emergencies and natural disasters. 10. Practice national integration and social harmony

EXPECTATION FROM TRAINERS

1. To assist and guide the NSS unit for implementation of NSS programs at college level.
2. To advise in organizing camps, training and orientation programs for the NSS volunteers.
3. To visit the NSS units for monitoring and evaluation.
4. To ensure implementation of NSS regular activities and special camping programs.

RTM Nagpur University
Aeronautical Engineering –VI Sem.
National Cadet Corps (NCC)
Course Code BTAE-609P

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessment	University Examination	Total	
VI	National Cadet Corps (NCC) (BTAE-609P)	0	0	3		0	0	0	0

ABOUT NCC

1. NCC is the Indian military cadet corps wing of the Indian armed forces.
2. NCC offers training to the students of schools and colleges.
3. This is not compulsory training for all students.

Sr. No.	OUTCOMES EXPECTED
1	During the training of NCC, candidates should get the basic military training. This training should be conducted to develop the interest of young students in all three forces; the army, the navy and the air force of India. Students should be able to check their abilities to join the Indian Defense Services.

Sr. No.	AIM
1	To create an organized, trained and motivated youth, create soldiers for the nation, develop the leadership skills in the youth.

EXPECTATION FROM INSTITUTES

- Create awareness amongst students about NCC
- Make understand the students about the importance of NCC
- Conduct regular Drills and Training exercises
- Conduct Regular exams
- Arrange for Training Camps