RTM Nagpur University

Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessm	University Exami	Total	
VII	**Air Transportation and Management** (BTAE 701T)	3	0	0	3	30	70	100	3

Sr. No.	**Course Objective** **The objective of this course is–**
1	To understand the concept of Development, comparison and role of various international bodies' in air transportation.
2	To study Principles of Airlines Scheduling, fleet planning, fleet sizing, Aircraft Reliability
3	To study about the Technologies in Aircraft Maintenance field
	Course Outcomes
After successful completion of this course the student will be able to:	
CO1	Understand about the concept of Development, comparison and role of various international bodies' in air transportation.
CO2	Understand about the Fleet size, Fleet planning, the aircraft selection process, operating cost, passenger capacity which plays an important role in airline economics
CO3	Present comprehensive idea about Fleet Planning and Understand the Principles of Aircraft Reliability and Extended range operations.
CO4	Understanding the Principles of Airlines Scheduling.
CO5	Understand about the Technology in Aircraft Maintenance.

SYLLABUS	
Contents	**No of hours**
Unit I : Introduction Development of air transportation, comparison with other modes of transport - Role of IATA, ICAO The general aviation industry airline - Factors affecting general aviation, use of aircraft, airport: airline management and organisation - levels of management, functions of management, Principles of organisation planning the organisation - chart, staff departments & line departments.	10

Unit II :Airline Economics and Aircraft Reliability Forecasting - Fleet size, Fleet planning, the aircraft selection process, operating cost, passenger capacity, load factor etc. - Passenger fare and tariffs - Influence of geographical, economic & political factors on routes and route selection. Aircraft reliability - The maintenance schedule & its determinations - Condition monitoring maintenance - Extended range operations (EROPS) & ETOPS - Ageing aircraft maintenance production.	9
Unit III : Fleet Planning The aircraft selection process - Fleet commonality, factors affecting choice of fleet, route selection and Capitol acquisition - Valuation & Depreciation - Budgeting, Cost planning - Aircrew evaluation - Route analysis - Aircraft evaluation.	7
Unit IV :Principles of Airlines Scheduling Equipment maintenance, Flight operations and crew scheduling, Ground operations and facility limitations Equipment's and types of schedule - hub & spoke scheduling, advantages / disadvantages & preparing flight plans- Aircraft scheduling in line with aircraft maintenance practices scheduling in line with aircraft maintenance	9
Unit V : Technology in Aircraft Maintenance Airlines scheduling (with reference to engineering) - Product support and spares - Maintenance sharing - Equipment's and tools for aircraft maintenance - Aircraft weight control - Budgetary control. On board maintenance systems - Engine monitoring - Turbine engine oil. Airlines scheduling (with reference to engineering) - Product support and spares - Maintenance sharing - Equipment's and tools for aircraft maintenance - Aircraft weight control - Budgetary control. On board maintenance Systems - Engine monitoring - Turbine engine oil maintenance - Turbine engine vibration monitoring in aircraft - Life usage monitoring - Current capabilities of NDT - Helicopter maintenance -Future of aircraft maintenance.	10

Total: 45 Hours

Text Books Recommended:

1. Fedric J.H., "Airport Management", English Book House, New Delhi-I.
2. Gene Krope, "Airline Procedures", English Book House, New Delhi-I.
3. Wilson & Bryon, "Air Transportation ", English Book House, New Delhi-I.
4. hilip Lockin D, " Economics of Transportation ", English Book House, New Delhi-I.
5. "Indian Aircraft manual", Published by DGGA, English Book House, New Delhi-I.
6. Alexander T Wells, "Air Transportation", Wadsworth Publishing Company, California, 1993.
7. C.H. Friend, "Aircraft Maintenance Management", English Book House, New Delhi-I.

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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	
VII	**Introduction to multi-disciplinary design optimization** (BTAE 702T(OE)-1)	3	-	-	3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	This course aims at providing basic knowledge in recent design optimization methods and tools. Typical examples of design optimization problems involve the minimization of structural weight and cost while satisfying performance constraints.
2	Optimization techniques allow the designer to efficiently reach non-intuitive optimal (or simply improved) solutions while avoiding trial-and-error cycles.
3	Although the course will cover fundamental theoretical and algorithmic aspects of optimization, the emphasis will be on applied design optimization and its applications in the context of simulation-based design.
4	Techniques ranging from optimal sizing, shape and topology optimization to design of computer experiments and surrogates will be presented

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Introduction and overview of optimization problems including the notion of convergence and convexity.
CO2	Basics of univariate unconstrained minimization.
CO3	Fundamentals of multivariate optimization including equation solving and least squares problem.
CO4	Discussion of professional (applied) methods for multivariate optimization.
CO5	Understand basics of constrained optimization and different family of methods for solving a constrained optimization problem.

SYLLABUS	
Contents	**No of hours**
Unit I SINGLE VARIABLE OPTIMIZATION: Introduction to Optimization, Optimality Criteria.	8
UNIT II BRACKETING METHODS: Exhaustive Search Method, Bounding Phase Method, Region Elimination Methods, Golden Section Search Method.	8
UNIT III GRADIENT BASED METHODS: Newton-Raphson Method, Bisection Method, Secant Method, Cubic Search Method.	8
Unit IV MULTIVARIABLE OPTIMIZATION: ptimality Criteria – Gradient Based Methods: Steepest Descent Method, Conjugate Direction Method, Conjugate Gradient Method and Newton's Method.	9
Unit V CONSTRAINED OPTIMIZATION: Karush-Kuhn-Tucker Optimality Criteria, Direct Methods, Indirect Methods, Penalty Function Methods. Simulated Annealing, Genetic Algorithm, Particle Swarm Optimization, Multi-Objective Optimization – Pareto Optimality –Global Function / Weighted Sum.	12

Total: 45 Hours

Reference Books Recommended:

1. Kalyanmoy Deb, "Optimization for Engineering Design Algorithms and Examples", 2nd edition, Prentice Hall of India, New Delhi, 2012.
2. Kalyanmoy Deb, "Multi-Objective Optimization using Evolutionary Algorithms", Wiley, 2010.
3. J. Arora, "Introduction to Optimum Design," 3rd Edition, Elsevier, 2012.
4. S. S. Rao, Engineering Optimization - Theory and Applications, New Age International, New Delhi, 1998.
5. K. Deb, Optimization for Engineering Design: Algorithms and Examples, Prentice-Hall India, 1995.
6. D. E. Goldberg, Genetic algorithms in Search, Optimization and Machine Learning, Addison Wesley, 1989.

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Syllabus (Theory)

Semester	Course Title(Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
VII	**Relativity, Cosmology, and the Early Universe** (BTAE 702T(OE)-2)	3	-	-	3	30	70	100

Sr. No.	Course Objective The objective of this course is –
1	Gain an appreciation for the main principles of special and general relativity and how the latter provides the natural language to describe the evolution of the early universe.
2	Become familiar with the mathematical and physical structure of Einstein's equations and learn the basic analytical skills needed to solve them (for example, finding simple black hole solutions).
3	This course is a graduate-level introduction to astrophysical cosmology, with emphasis on the "standard" big bang theory of the universe and, in the latter part of the course, its extension to a more detailed theory (the inflation + cold dark matter + cosmological constant model) that is presently the leading scenario for explaining the origin of structure in the universe.
4	The course is intended to give you the background needed to (a) read the current research literature, (b) get started on research in cosmology if you wish to do so, and (c) understand the current issues and debates in the field.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Differentiate wrong general public ideas about the theory and what the theory is really about.
CO2	Understand time – special relations at the local and global levels.
CO3	Understand the basis of Standard model.
CO4	Understand the gravity as bending of space-time.
CO5	Calculate the angle light bends under the influence of gravity.

SYLLABUS	
Contents	**No. of Hours**
Unit I Principles of Relativity: Overview of Special Relativity, space time interval and Lorentz metric, proper time, action for free particle, relativistic dynamics, four vectors, electrodynamics in 4 dimensional language. Introduction to general relativity (GR), equivalence principle, gravitation as a manifestation of the curvature of space time.	9
Unit II Geometrical Framework of General Relativity: Curved spaces, tensor algebra, dynamics of particles and affine connection, covariant derivatives and parallel transport, Physics in curved space time, Curvature - Riemann tensor, Bianchi identities, Action Principle, Einstein's field equations, Energy momentum tensors, Space time symmetries and Killing vectors, energy-momentum tensor for a perfect fluid, connection with Newton's theory.	9
Unit III Solutions to Einstein's Equations and their Properties: Spherical symmetry, derivation of the Schwarzschild solution, test particle orbits for massive and massless particles. The three classical tests of GR, Black holes.	9

Unit IV Cosmological Models: Universe at large scales – Homogeneity and isotropy – distance ladder – expansion and red shift - Cosmological Principle - Robertson-Walker metric - Hubble's law- Observable quantities – luminosity and angular diameter distances, Dynamics of Friedman- Robertson-Walker models: Solutions of Einstein's equations, discussion of closed, open and flat Universes.	9
Unit V Physical Cosmology and Early Universe: Thermal History of the Universe, distribution functions in the early Universe – relativistic and non-relativistic limits; Decoupling of neutrinos and the relic neutrino background; Nucleosynthesis; Decoupling of matter and radiation ; Cosmic microwave background radiation (CMB); Inflation – Origin and growth of Density Perturbations; Formation of galaxies and large scale structures; Anisotropies in CMB; The Intergalactic medium and reionization.	9

Text Books Recommended:

1. Cosmological Physics, Cambridge University Press, J. A. Peacock
2. An Introduction to Relativity, J. V. Narlikar, Cambridge University Press, 2010 (For the lectures on General Relativity and Cosmology).
3. Theoretical Astrophysics, Volume III: Galaxies and Cosmology, T. Padmanabhan, Cambridge University Press, 2002 (for lectures on Cosmology)

References:

1. Classical Theory of Fields, Vol. 2, L. D. Landau and E. M. Lifshitz, Oxford : Pergamon Press, 1994 (For more material on General Relativity).
2. Introduction to Cosmology, J. V. Narlikar, Cambridge University Press, 1993 (For the lectures on Cosmology).
3. First course in general relativity, B. F. Schutz, Cambridge university press, 1985 (For material on General Relativity).
4. Structure Formation in the Universe. T. Padmanabhan, Cambridge University Press, 1995 (for material on Cosmology and Structure formation).

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Syllabus (Theory)

Semester	Course Title(Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
VII	**MATLAB for Engineering Applications** BTAE 702T(OE)-3	3	-	-	3	30	70	100

Sr. No.	Course Objective **The objective of this course is –**
1	To learn features of MATLAB as a programming tool.
2	To promote new teaching model that will help to develop programming skills and technique to solve mathematical problems.
3	To understand MATLAB graphic feature and its applications.
4	To use MATLAB as a simulation tool.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Able to understand the basic knowledge of Computer fundamental and its application in computers.
CO2	Able to design and develop various programming problems using MATLAB programming concepts.
CO3	Understand Basics of MATLAB coding.
CO4	Write the program for a given problem in MATLAB coding.
CO5	Simulate various electric circuits in MATLAB simulation tool.

SYLLABUS

Contents	No. of Hours
Unit I. Introduction to MATLAB : The MATLAB Environment, MATLAB Basics – Variables, Numbers, Operators, Expressions, Input and output, Vectors, Arrays – Matrices	9
Unit II MATLAB Functions: Built-in Functions, User defined Functions	9
Unit III Built-in Functions User defined Functions: Files and File Management – Import/Export, Basic 2D, 3D plots, Graphic handling	9
Unit IV Programming with MATLAB : Conditional Statements, Loops, MATLAB Programs – Programming and Debugging, Applications of MATLAB Programming	9
Unit V Mathematical Computing with MATLAB : Algebraic equations, Basic Symbolic Calculus and Differential equations, Numerical Techniques and Transforms	9

Total: 45 Hours

References:

1. "A Guide to MATLAB - for Beginners and Experienced Users", 2nd Ed., Brian R. Hunt, Ronald L. Lipsman, Jonathan M. Rosenberg, Cambridge University Press, (2006).
2. "Essentials of MATLAB Programming", 2nd Ed., Stephen J. Chapman, Cengage Learning, (2009).
3. "MATLAB Demystified", David McMahon, The McGraw-Hill Companies, (2007).
4. "MATLAB® for Engineers", 3rd Ed., Holly Moore, Pearson Education, Inc., (2012).
5. "Engineering computation with MATLAB", 2nd Ed., David M. Smith, Pearson Education, Inc., (2010).

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Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessm	University Exami	Total	
VII	**Reliability centered maintenance** (BTAE 703T(E) – 1)	3	0	0	3	30	70	100	3

Sr. No.	**Course Objective** **The objective of this course is–**
1	To study about the systems reliability concepts and techniques to design problems and applying it for the failure data analysis
2	To overview the historical development, achievements and methodologies of RCM
3	To understand and apply the reliability centered maintenance.
	Course Outcomes
After successful completion of this course the student will be able to:	
CO1	Able to illustrate History, Evolution, Achievements and Methodologies of Reliability Centered Maintenance.
CO2	Able to understand reliability and apply it for the failure data analysis.
CO3	Able to apply systems reliability concepts and techniques to design problems.
CO4	Able to apply Failure Mode and Effect Analysis (FMEA), Analysis & Categories of failure Mode.
CO5	Understand methods needed for RCM Maintainability and able demonstrate understanding and application of RCM.

SYLLABUS	
Contents	**No of hours**
Unit I : **History Reliability Centered Maintenance** Definition of RCM, Evolution of RCM, RCM Achievements, RCM Methodologies- Systems Analysis Process	8
Unit II : **Introduction to Reliability**	8

Definition of reliability, Failure data Analysis, Mean Time to Failure (MTTF), Mean Time between Failure (MTBF), Hazard Rate and Failure density.	
Unit III : System Reliability Reliability in series and Reliability in Parallel, combined series - parallel system, Standby redundancy.	10
Unit IV : Functional Failure of RCM Failure Mode and Effect Analysis (FMEA), Analysis & Categories of failure Modes scheduling in line with aircraft maintenance.	9
Unit V : RCM Maintainability and Application RCM Maintenance Policies, Proactive Maintenance - Predictive Task, Proactive Maintenance - Preventive Task, Proactive Vs. Predictive and Preventive Maintenance, Application of RCM to Airlines industry, Indian air force, Nuclear Power industry.	10

Total: 45 Hours

Text Books Recommended:

1. Charles E. Ebling "Reliability and Maintainability Engineering" Tata Mc Graw Hill.
2. John Moubray " Reliability Centered Maintenance"
3. L.S. Srinath "Reliability Engineering" East West Press
4. Jim August " Reliability Centered Maintenance

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Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessm	University Exami	Total	
VII	**UAV Systems Design** BTAE 703T(E) -2	3	0	0	3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	To expose students to concepts needed in modeling and analyzing an unmanned system.
2	To expose students to the design and development of UAV.
3	To study about the Technologies in Aircraft Maintenance field.
4	To study path planning
5	To understand the avionics hardware used in the UAV
	Course Outcomes
After successful completion of this course the student will be able to:	
CO1	Design UAV system
CO2	Prepare preliminary design requirements for an unmanned aerial vehicle.
CO3	Identify different hardware for UAV
CO4	Perform system testing for unmanned aerial vehicles.
CO5	Design micro aerial vehicle systems by considering practical limitations.

SYLLABUS	
Contents	**No of hours**
Unit I: INTRODUCTION TO UAV History of UAV –classification – Introduction to Unmanned Aircraft Systems--models and prototypes – System Composition-applications	9
Unit II : THE DESIGN OF UAV SYSTEMS Introduction to Design and Selection of the System- Aerodynamics and Airframe Configurations Characteristics of Aircraft Types- Design Standards and Regulatory Aspects-UK,USA and Europe Design for Stealth--control surfaces-specifications.	9
Unit III : AVIONICS HARDWARE Autopilot – AGL-pressure sensors-servos-accelerometer –gyros-actuators- power supply processor, integration, installation, configuration, and testing	9

Unit IV : COMMUNICATION PAYLOADS AND CONTROLS Payloads-Telemetry-tracking-Aerial photography-controls-PID feedback-radio control frequency range –modems-memory system-simulation-ground test-analysis-trouble shooting	9
Unit V : THE DEVELOPMENT OF UAV SYSTEMS Waypoints navigation-ground control software- System Ground Testing- System In-flight Testing Future Prospects and Challenges-Case Studies – Mini and Micro UAVs.	9

Total: 45 Hours

TEXT BOOKS:

1. Paul G Fahlstrom, Thomas J Gleason, "Introduction to UAV Systems", UAV Systems, Inc, 1998

2. Reg Austin "Unmanned Aircraft Systems UAV design, development and deployment", Wiley, 2010.

REFERENCES:

1. Dr. Armand J. Chaput, "Design of Unmanned Air Vehicle Systems", Lockheed Martin Aeronautics Company, 2001

2. Kimon P. Valavanis, "Advances in Unmanned Aerial Vehicles: State of the Art and the Road to Autonomy", Springer, 2007

3. Robert C. Nelson, Flight Stability and Automatic Control, McGraw-Hill, Inc, 1998.

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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	
VII	**Theory of Vibrations** (BTAE 703T(E) -3)	3	-	-	3	70	30	100	3

Sr. No.	Course Objective The objective of this course is–
1	To understand the fundamentals of Vibration Theory.
2	To be able to mathematically model real-world mechanical vibration problems.
3	To use computer software programs to investigate and understand vibration problems.
4	To understand the basic concept of aero elasticity.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Formulate mathematical models of problems in vibrations using Newton's second law or energy principles.
CO2	Analyze the mathematical modeling of the single degrees of freedom systems and explain about the working principle.
CO3	Compute the natural frequencies and mode shapes of a multi degree of freedom system and explain the modal analysis of a vibrating system using numerical methods to determine natural frequencies.
CO4	Describe the vibration measurement by using transducers and vibration exciters.
CO5	Demonstrate the basic concept of aero elasticity.

SYLLABUS	
Contents	**No. of hours**
Unit I Basic Notions: Simple harmonic motion – Terminologies – Newton's Law – D' Alembert's principle – Energy Methods.	8

Unit II Single Degree of Freedom Systems: Free vibrations – Damped vibrations – Forced Vibrations, with and without damping – support excitation – Vibration measuring instruments. Response to periodic and non-periodic excitations – Duhamel's Integral.	10
Unit III Multi Degrees of Freedom Systems: Two degrees of freedom systems – Static and Dynamic couplings - vibration absorber - Principal coordinates, Principal modes and orthogonality condition – Eigen value problems.	9
Unit IV Generalized Co-ordinates - Hamilton's principle- Lagrange's equation and application. Vibration of strings - Longitudinal, Lateral and Torsional vibrations of beams - forced response of beams.	9
Unit V Elements of Aero elasticity: Concepts – Coupling – Aero elastic instabilities – Basic ideas on wing divergence, loss and reversal of aileron control, Flutter.	9

Reference Books Recommended:

1. P. Srinivasan, Mechanical Vibration Analysis, Tata Mc Graw Hill, New Delhi.
2. J. P. Den Hartog Mechanical Vibration (4th edition Mc Graw Hill, New York 1985.
3. N. L. Meirovitch, Elements of vibration Analysis, Mc Graw Hill New York 1986.
4. W. T. Thomson, Theory of Vibrations with Applications.
5. Broadbent, E.G., "Elementary Theory of Aeroelasticity "BunHill Publications Ltd., 1986.
6. Fung, Y.C., "An Introduction to the Theory of Aeroelasticity ", John Wiley & Sons Inc., New York 1985.
7. Timoshenko, Engineering vibration.

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Syllabus (Theory)

Semester	Course Title(Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
VII	Avionics - II (BTAE 704T(E)-1)	3	-	-	3	70	30	100

Sr. No.	Course Objective The objective of this course is–
1	To develop student's skills and understanding on the principle of auto-flight, radio communication and navigation systems.
2	To include the principles of auto-flight and its applications in modern aircrafts and also covers the principles of radio communications and its application to navigation systems.
3	Primary and secondary radar systems are explained, and Communication and navigation systems such as VHF, VOR, DME, MLS, GPS, FDS, Inertial navigation systems are covered.
4	Cover are practical aircraft installations and data busses.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Understand retrieving the information from RADAR.
CO2	Identifying the various types of field patterns and modes in avionics components.
CO3	Defining the various types of components and devices used in RADAR.
CO4	Illustrate various types of antenna for medium wave.
CO5	Discuss various types of navigation system and describe digital and analogue computer system.

SYLLABUS Contents	No. of hours
Unit I RADAR ENGINEERING: Radar definition, Radar range equation, pulsed, CW and Doppler Radars, MTI, Noise Figure Consideration, various types of radar displays, Detection of radar signals in Noise.	8
Unit II MICROWAVE ENGINEERING: Various types of radar transmission Lines, Rectangular and circular waveguides, coaxial lines, field patterns, modes (high order and evanescent), passive components (e.g. Directional couplers, filters, isolators and circulators).	9
Unit III DEVICES: Magnetron, Klystron, backward wave oscillator, Traveling wave tubes, Amplifiers and parametric amplifiers. Diode detectors and mixers.	9
Unit IV AERIALS AND PROPAGATION: Antenna theory, various types of antenna for medium wave, short wave, VHF and UHF frequencies, propagation at microwave frequencies, atmospheric attenuation, effects of precipitation, reflection, Refraction and Diffraction phenomenon, clutter signals.	9
Unit V ELECTRONIC NAVIGATION: Maps and Charts, classification of various navigation systems, celestial and radio navigation, Radio direction finding at medium, high and very high frequencies. The radio compass and Automatic Direction finders. Hyperbolic navigation systems, Loran and Decca. TACAN. Aids to approach and landing, the standard ILS, various categories of ILS accuracy, MLS, Ground Control Approach Systems. Dead reckoning navigation systems, Doppler navigational and inertial navigation, Global Positioning System (GPS), Traffic Alert and Collision Avoidance System (TCAS). Special Systems: Analogue and Digital computers for aeronautical application, Head up displays.	10

Total: 45 Hours

Text Books:

1. Merril I, Sklonik, Introduction to Radar Systems, McGraw Hill 1980.
2. Myron Kayton and Walter R Fried, Avionics Navigation Systems, John Wiley and Sons.
3. L Tetley and D Calcutt, Electronic Aids to Navigation, Edward Arnold Publishers Ltd. 1986.

Reference Books:

1. G J Sonnenberg, Radar and Electronic Navigation.
2. B S Walker, Introduction to Computer Engineering.
3. P S Dhunta, Avionics for Pilots and Engineers, Deep Publications, 1998.
4. F E Terman, Electronic and Radio Engineering, McGraw Hill Book Company.

RTM Nagpur University
Syllabus (Practical)

Semester	Course Title(Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
VII	Avionics – II { BEAE 704P(E-1)}	-	-	2	1	25	25	50

Sr. No.	List of Practical's(Any Eight Practical's of the following)
01	Addition/Subtraction of binary numbers.
02	Multiplexer/Demultiplexer Circuits.
03	Encoder/Decoder Circuits.
04	Timer Circuits, Shift Registers, Binary Comparator Circuits.
05	Addition and Subtraction of 8-bit and 16-bit numbers.
06	Sorting of Data in Ascending & Descending order.
07	Sum of a given series with and without carry.
08	Greatest in a given series & Multi-byte addition in BCD mode.
09	Interface programming with 4 digit 7 segment Display & Switches & LED's.
10	16 Channel Analog to Digital Converter & Generation of Ramp, Square, Triangular wave by Digital to Analog Converter.
11	Study of Different Avionics Data Buses.

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Syllabus (Theory)

Semester	Course Title(Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
VII	Computational Fluid Dynamics {BEAE 704T(E-2)}	3	-	-	3	70	30	100

Sr. No.	Course Objective The objective of this course is–
1	Equip students with the knowledge base essential for application of computational fluid dynamics to engineering flow problems.
2	Provide the essential numerical background for solving the partial differential equations governing the fluid flow.
3	Develop students' skills of using a commercial software package.
4	Understand both flow physics and mathematical properties of governing Navier-Stokes equations and define proper boundary conditions for solution.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Get chance for reviewing the basic fluid dynamics governing equations (continuity, energy and momentum) and get knowledge about Importance of CFD to various engineering streams.
CO2	Get the knowledge in depth for the description and procedure used in Finite Difference. Able to apply the knowledge of Finite Difference method to 1D & 2D steady and unsteady conduction problems and get idea about the use of different numerical schemes.
CO3	Get the knowledge in depth for initial and boundary value problems and numerical methods like Runge Kutta and shooting method.
CO4	Get the idea about the numerical and analytical solution methods for 1D and 2D Conduction and convection problems, application of Navier Stokes equations for incompressible flow. Pressure correction scheme, staggered grid, SIMPLE and SIMPLER schemes.
CO5	Get the knowledge about FVM method for compressible flow.

SYLLABUS	
Contents	**No. of hours**
Unit I Importance of CFD to various engineering streams. Basic fluid dynamics equations – continuity, momentum and energy, Conservation law form and non-conservation law forms of the Governing Differential Equations, Lagrangian and Eulerian formulations. Classification of PDE's.	10
Unit II Description and procedure used in Finite Difference, Finite Element and Finite Volume schemes for simple one dimensional conduction problems, Application to unsteady one-dimensional conduction problems. Application of Finite Difference method to 1D & 2D steady and unsteady conduction problems. Central and backward difference schemes. Explicit & Implicit schemes, Crank-Nicholson scheme.	10
Unit III Solution of linear algebraic equations - Direct solution methods and Iterative schemes. Boundary value and initial value problems and their solution procedure. Runge Kutta methods. Shooting methods.	9
Unit IV Conduction and convection problems. Navier Stokes equations. Application to incompressible flow. Pressure correction scheme, staggered grid, SIMPLE and SIMPLER schemes.	8
Unit V Finite Volume method for compressible flow. Schemes like Jameson, MacCormack. Acceleration devices, Grid independent studies, Grid Generation.	8

Total: 45 Hours

Reference Books Recommended:

1. Bose, T.K., "Computation Fluid Dynamics" , Wiley Eastern Ltd., 1988.
2. Chow, C.Y., "Introduction to Computational Fluid Dynamic", John Wiley, 1979.
3. Hirsch, A.A., "Introduction to Computational Fluid Dynamics", McGraw Hill, 1989.
4. Fletcher, "Computational Fluid Dynamics ", Vol. I & II, Springer Verlag, 1993.
5. Patankar, S.V., "Numerical heat transfer and fluid flow", Hemispher Publishing Corporation, 1992.
6. Anderson J. D,"Computational fluid dynamics", 1995.

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Syllabus (Practical)

Semester	Course Title(Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
VII	Computational Fluid dynamics {BEAE 704P(E)}	-	-	2	1	25	25	50

Sr. No.	List of Practical's (Any eight practical's of the following)
01	Introduction to any one of the suitable software employed in modeling and simulation of aerodynamic problems.
02	Solution for the following equations using finite difference method (code development): One dimensional wave equations using explicit method of lax.
03	Solution for the following equations using finite difference method (code development): One dimensional heat conduction equation using explicit method.
04	Generation of the following grids (code development): Algebraic Grid.
05	Generation of the following grids (code development): Elliptic Grids.
06	Numerical simulation of the following flow problems using commercial software packages: Flow over an airfoil.
07	Numerical simulation of the following flow problems using commercial software packages: Supersonic flow over a wedge.
08	Numerical simulation of the following flow problems using commercial software packages: Flat plate boundary layer.
09	Numerical simulation of the following flow problems using commercial software packages: Laminar flow through pipe.
10	Numerical simulation of the following flow problems using commercial software packages: Flow past a cylinder.
11	Aerodynamic shape design using deep learning.

Suggested software:

1. ANSYS FLUENT, CFX, Solid works.
2. MATLAB
3. OPENFOAM

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Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessm	University Exami	Total	
VII	**Finite Element Method** (BTAE 704T(E)-3)	3	0	0	3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	Understanding the basic concepts and principles of Finite Element Method and its applications in engineering and science.
2	Developing the ability to formulate and solve practical engineering problems using Finite Element Method.
3	Developing knowledge of different types of Finite Element Method formulations, such as displacement, stress, and mixed formulations.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Understand about the fundamentals of stress and strain, its components and relationship
CO2	Understand the concepts of FEM - Historical background, scope along with Raleigh–Ritz method
CO3	Analyze the mathematical modeling of Bar and Beam elements and Two dimensional plane trusses
CO4	Compute the Two dimensional problem using CST & LST
CO5	Analyze the formulation of mass matrix for one-dimensional bar element

SYLLABUS	
Contents	**No of hours**
Unit I : Fundamentals of stress and strain, stress and strain components, stress strain relationship, Elastic constants, plane stress, plane strain, differential equation of equilibrium, compatibility equation, Boundary conditions, Saint Venant's principle, Airy's stress function.	9

Unit II: Fundamental concepts of FEM - Historical background, Scope of FEM in Engg. Applications, Principle of minimum potential energy, Concept of Virtual work, Raleigh–Ritz method, FEM analysis procedure. Concept of discretization of body into elements, degrees of freedom, bandwidth, Basic types of 2-D & 3-D elements, displacement models, convergence requirements, shape function.	9
Unit III: Finite element modelling and analysis using Bar and Beam elements – stiffness matrix, assembly, boundary conditions, load vector, temperature effects. Two dimensional plane trusses – Local & Global coordinate system, element stiffness matrix, assembly, boundary conditions, and load vector, force and stress calculations	9
Unit IV: Two dimensional problem using CST & LST – formulation of CST & LST elements, elemental stiffness matrix, assembly, boundary conditions, load vector, stress calculation, Temperature effect.	9
Unit V: Introduction to Iso-parametric & Higher order elements. Introduction to dynamic analysis, formulation of mass matrix for one-dimensional bar element, free vibration analysis using one dimensional bar element. Torsion of prismatic bars using triangular elements. Pre & Post processing in FEA, Commercial F E Software's.	9

Total: 45 Hours

Text Books:
1. Introduction to Finite Elements in Engineering– T.R.Chandrupatla & AD Belegundu.
2. Theory of Elasticity – S.P. Timoshenko
3. Concept and applications of Finite element Analysis – P.D. Cook
4. Finite Element Analysis (Throry & Programming) - Krishnamurthy CS - Tata McGraw Hill Publishing Co.

Reference Books:
1. The Finite Element Method–A Basic introduction for engineers–D W.Griffths, D.A Nethercot-
2. Introduction to Finite Element- Reddy J.N. - McGraw Hill
3. Applied Finite Element Analysis - Larry J. Segelind - John Wiley
4. Finite Element Method Vs. Classical Methods - H.S. Govinda Rao- New Age International Pub.
5. The Finite Element Method -Zienkiewiez OC - Tata McGraw Hill Publishing Co.
6. Finite Element Methods: Basic Concepts & Application- Chennakesava R. Alavala
7. PHI Learing PVT. LTD.

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Syllabus (Practical)

Semester	Course Title(Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
VII	**Finite Element Method** (BTAE 704P(E)-3)	0	0	2	1	25	25	50

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Students will be able to understand the concept of finite element method and develop algorithms for analysis of mechanical systems
CO2	Students will be able to apply the knowledge of FEM for 1D stress analysis, modal analysis, heat transfer analysis and flow analysis.

Minimum Eight out of the following shall be performed:

Sr. No.	List of Practical's
01	Introduction to Finite Element Analysis software
02	Solve 1D – Structural, thermal and fluid problems using FEA software.
03	Solve Plane truss problems, using FEA software. Include problems with symmetry.
04	Solve Beam problems with different boundary and loading conditions using FEA software.
05	Solve 2D problems using different element types in a FEA software. Also analyse effect of element formulation and number of elements.
06	Solve 3D problems using FEA software.
07	Solve plate and shell problems using FEA software.
08	Solve Dynamic problems using FEA software.

References:

1. The Finite Element Method–A Basic introduction for engineers–D W.Griffths, D.A Nethercot-
2. Introduction to Finite Element- Reddy J.N. - McGraw Hill
3. Applied Finite Element Analysis - Larry J. Segelind - John Wiley
4. Finite Element Method Vs. Classical Methods - H.S. Govinda Rao- New Age International Pub.
5. The Finite Element Method -Zienkiewiez OC - Tata McGraw Hill Publishing Co.
6. Finite Element Methods: Basic Concepts & Application- Chennakesava R. Alavala
7. PHI Learing PVT. LTD.

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Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessm	University Exami	Total	
VII	**Aircraft Maintenance and Overhaul** {BTAE 704T(E)-4}	3	0	0	3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	Understanding the basic concepts and principles of Finite Element Method and its applications in engineering and science.
2	Maintain the aircraft maintenance manual and logbook.
3	Do the quality control and calibration and Incorporate the safety regulations and rules

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Understand about the fundamentals of Aircraft ground handling and support equipment
CO2	Understand the concepts of Ground servicing various sub systems
CO3	Understand the concepts of Inspection Process - Purpose - Types - Inspection intervals
CO4	Understand the concepts of Specification and correct use of various aircraft hardware
CO5	Understand the concepts of Maintenance Safety & Trouble shooting

SYLLABUS	
Contents	**No of hours**
Unit I : Aircraft ground handling and support equipment, Mooring, jacking, leveling and towing operations - Preparation - Equipment and precautions - Engine starting procedures - Piston engine, turboprops and turbojets - Engine fire extinguishing - Ground power units.	9
Unit II: Ground servicing various sub systems, Air conditioning and pressurization - Oxygen and oil systems - Ground units and their maintenance.	9

Unit III: : Inspection Process - Purpose - Types - Inspection intervals - Techniques - Checklist - Special inspection - Publications, bulletins, various manuals - FAR Air worthiness directives - Type certificate Data Sheets - ATA specifications	9
Unit IV Specification and correct use of various aircraft hardware (i.e. nuts, bolts, rivets, screws, etc.) - American and British systems of specifications - Threads, gears, bearings, etc. - Drills, tapes &reamers - identification of all types of fluid line fittings.	9
Unit V: Maintenance Safety & Trouble shooting Safety regulations, occupational safety and health standards maintenance safety program, Airlines safety management, General safety rules, Accident & injury reporting, Hazardous materials storage and handling aircraft furnishing practices trouble shooting, Knowledge of malfunctions.	9

Total: 45 Hours

Text Books:

1. KROES WATKINS DELP., "Aircraft Maintenance and Repair ", McGraw Hill, New York 1993.
2. A & P MECHANICS, "Aircraft hand Book - F.A.A. Himalayan Book House ", New Delhi, 1996.
3. A & P MECHANICS, "General hand Book - F.A.A. Himalayan Book House ", New Delhi, 1996.
4. ATA SPECFICATIONS - F.A.A. Himalayan Book House ", New Delhi, 1996.

Reference Books:

1. Larry Reithmaier " Aircraft Repair Manual" Palmar Books, Marquette, 1992.
2. Brimm. DJ, Bogges, HE, Aircraft Maintenance, Pitman publishing corp, London, 1952

RTM Nagpur University Syllabus (Practical)

Semester	Course Title(Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
VII	**Aircraft Maintenance and Overhaul** BTAE 704P(E)-4	0	0	2	1	25	25	50

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Students will be able to understand the fundamentals of Aircraft ground handling and support equipment
CO2	Understand the concepts of Maintenance Safety & Trouble shooting

Sr. No.	List of Practical's
01	Study/Performance of Engine starting procedures - Piston engine
02	Study/Performance of Engine starting procedures - Turboprops
03	Study/Performance of Engine starting procedures - Turbojets
04	Study of different types of ground power units and APU
05	Study/Performance of aircraft inspection process as per DGCA
06	Study/ Ground servicing of Air conditioning and pressurization system of an aircraft
07	Cleaning and visual inspection of engine components
08	Composite Materials - Fabrication and Repair

RTM Nagpur University

Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
VII	Project Work Phase- I (BTAE 705P)	0	0	8	4	100	100	200

Sr. No.	Course Objective The objective of this course is–
1	To prepare themselves to undertake lively project which will found end application to Industry / Society.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Develop leadership quality to effectively manage and work in team.
CO2	Apply engineering knowledge gained to develop Industry/Society welfare projects

SYLLABUS	
Contents	**No of hours**
Preparation for the project work involve: 1. Form a team of like-minded students (not more than 4 in numbers) to carry out the project. 2. Survey and study of published literature on the assigned topic; 3. Working out a preliminary Approach to the Problem relating to the assigned topic; 4. Conducting preliminary Analysis/Modelling/Simulation/Experiment/Design/Feasibility; 5. Preparing a Written Report on the Study conducted for presentation to the Department; 6. Final Seminar, as oral Presentation before a departmental committee.	60

Total: 45 Hours

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Semester	**Course Title (Subject)**	**Hours / Week**			**Credits**	**Maximum Marks**		**Exam Duration (Hrs.)**
		L	**T**	**P**		College Assessment	**Total**	
VII	**Universal Human Values** (BTAE 706T)	2	0	0	0	Grades: (O, A, B, C)		2

Sr. No.	**Course Objectives**
1	Development of a holistic perspective based on self-exploration, about themselves (human being), family, society and nature/existence.
2	Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
3	Strengthening human relationship.
4	Development of commitment and courage to act.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Students are expected to become more aware of themselves, and their surroundings (family, society,nature)
CO2	Students would become more responsible in life, and in handling problems with sustainable solutions,while keeping human relationships and human nature in mind.
CO3	They would become sensitive to their commitment towards human relationship
CO4	They would also become sensitive to their commitment towards what they have understood (human values, human relationship and human society).

SYLLABUS	
Contents	**No. of Hours**
Unit I: Value education, definition, need for value education. The content and the process of value education,basic guidelines for value education, self-exploration as a means of value education, happiness and prosperity as part of value education.	6
Unit II: Harmony of self with body, coexistence of self and body, understanding the needs of self and the needs of body, understanding the activities in the self and the activities in the body.	6
Unit III: Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships), Understanding meaning of Trust; Difference between intention and competence, Understanding harmony in society: Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals	6
Unit IV: Basics for ethical human conduct, defects in ethical human conduct, human rights violations and social disparities, value based life.	6

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

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. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria,ExcelBooks, NewDelhi,2010

Reference Books:

1. Jeevan Vidya: EkParichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak,1999.
2. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3. Indian Ethos and Modern Management: Amalgam of the best of the ideas from the East and the West, B.L. Bajpai, New Royal Book Bo., Lucknow, 2004
4. Human society in ethics and politics, Bertrand Russel, Routledge Publications, 2009

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Syllabus (Theory)

Semester	Course Title(Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
VIII	**Hypersonic Aerodynamics** BTAE 801T	3	-	-	3	70	30	100

Sr. No.	Course Objective The objective of this course is–
1	To prepare the students for futuristic design of aerospace vehicles and give them a capability to work out on the technical aspect of the high-speed vehicles in the hypersonic range.
2	To learn the fundamentals of hypersonic flows. To develop approximate relations for inviscid flow over hypersonic vehicles.
3	To develop approximate relations for boundary-layer flows over hypersonic vehicles.
4	To have knowledge about viscous interaction in hypersonic flows.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Differentiate the hypersonic regime from other non-hypersonic high-speed regimes.
CO2	Use simple solution methods viz. local surface inclination method, shock and expansion wave method and approximate method and solve simple inviscid hypersonic flow problems.
CO3	Understand and work out with the viscous flow in the hypersonic regime and will be able to solve simple problems in the same.
CO4	Understand and conceptualize the viscous interaction with the hypersonic flow and differentiate the weak and strong interactions.
CO5	Analyzed and work out with the heat transfer and viscous interactions related problems in the hypersonic regime.

SYLLABUS	
Contents	**No. of hours**
Unit I FUNDAMENTALS OF HYPERSONIC AERODYNAMICS: Introduction to hypersonic aerodynamics– differences between hypersonic aerodynamics and supersonic aerodynamics – concept of thin shock layer and entropy layers – hypersonic flight paths –	10

hypersonic similarity parameters - Shock wave and expansion wave relations of inviscid hypersonic flows.	
Unit II SIMPLE SOLUTION METHODS FOR HYPERSONIC INVISCID FLOWS: Local surface inclination method – Newtonian theory – modified Newtonian law Tangent wedge and tangent cone and shock expansion methods Approximate methods – hypersonic small disturbance theory – thin shock layer theory.	8
Unit III VISCOUS HYPERSONIC FLOW THEORY: Boundary layer equation for hypersonic flow – hypersonic boundary layers – self similar and non-self-similar layers – solution methods for non-self-similar boundary layers Aerodynamic heating.	8
Unit IV VISCOUS INTERACTION IN HYPERSONIC FLOWS: Introduction to the concept of viscous interaction in hypersonic flows – Strong and weak interactions – hypersonic viscous interaction similar parameter - Introduction to shock wave layer interactions.	9
Unit V HEAT TRANSFER PROBLEMS IN AEROSPACE ENGINEERING: Nature of the high temperature flows – chemical effects in air – real and perfect gases – Gibb's free energy and entropy Chemically reacting mixtures – recombination and dissociations. Governing Equations for Chemically Reacting Viscous Flow, Alternate Forms of the Energy Equation, Boundary-Layer Equations for a Chemically Reacting Gas, Boundary Conditions: Catalytic Walls, Boundary-Layer Solutions: Stagnation-Point Heat Transfer for a Dissociating Gas.	10

Total: 45 Hours

Reference Books:

1. John D. Anderson Jr., "Hypersonic and High Temperature Gas Dynamics," McGraw Hill Series, New York, 1996.
2. William, H. D., "Viscous Hypersonic Flow – Theory of Reacting and Hypersonic Boundary Layers," Dover Publications Inc. Mineola, New York, 2017.
3. Murthy, T. K. S., "Computational Methods in Hypersonic Aerodynamics," Springer, New Delhi, 1992 edition.
4. Dr. Mukarram Hussain, "Hypersonic Aerodynamic Performances of Asymmetric Re-Entry Vehicles," LAP Lambert Academic Publishing, Saarbrücken, Germany, 2011.
5. John D. Anderson Jr., "Modern Compressible Flow with Historical Perspective". McGraw Hill Publishing Company, New York, 1996.
6. John T. Bertin, "Hypersonic Aerothermodynamics", published by AIAA Inc.,

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Syllabus (Theory)

Semester	Course Title(Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
VIII	**Experimental Stress Analysis** {BTAE 802T(E)-1}	3	-	-	3	30	70	100

Sr. No.	Course Objective The objective of this course is–
1	To make the students aware about the Fundamentals of stress & strain, Measurements & Extensometer.
2	Create awareness about the Electrical Resistance Strain Gauges, Photo elasticity, Two dimensional photo elasticity.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Explain the Fundamentals of stress & strain, stress strain relationship, equations of Equilibrium, compatibility equation.
CO2	Describe the Measurements & Extensometer, merits and demerits.
CO3	Create awareness about the Electrical Resistance Strain Gauges, Types and their uses, Materials for strain gauge, Calibration.
CO4	Describe about Photo elasticity, Two dimensional photo elasticity and Concept of light – photo elastic effects.
CO5	Describe the Brittle Coating and Moire Methods.

SYLLABUS	
Contents	**No. of hours**
Unit I INTRODUCTION Fundamentals of stress & strain, stress strain relationship, Elastic constant, plane stress and plane strain. Stress Analysis for two dimensional problems in Cartesian co-ordinate system, equations of Equilibrium, compatibility equation. Principal Planes and Strains.	10
Unit II MEASUREMENTS & EXTENSOMETER: Principles of measurements, Accuracy, Sensitivity and range of measurements, Mechanical, Optical Acoustical and Electrical extensometers and their uses, Advantages and disadvantages.	8

Unit III ELECTRICAL RESISTANCE STRAIN GAUGES: Principle of operation and requirements, Types and their uses, Materials for strain gauge, Calibration and temperature compensation, cross sensitivity, Rosette analysis, Wheatstone bridge and potentiometer circuits for static and dynamic strain measurements, strain indicators	8
Unit IV PHOTOELASTICITY: Two dimensional photo elasticity, Concept of light – photo elastic effects, stress optic law, Interpretation of fringe pattern, Compensation and separation techniques, Photo elastic materials	9
Unit V BRITTLE COATING AND MOIRE METHODS: Introduction to Moire techniques, brittle coating methods and holography, Messener's theorem.	10

Total: 45 Hours

References:

1. Srinath, L.S., Raghava, M.R., Lingaiah, K., Garagesha, G., Pant B., and Ramachandra, K., "Experimental Stress Analysis", Tata McGraw-Hill, New Delhi, 1984.
2. Dally, J.W., and Riley, W.F., "Experimental Stress Analysis", McGraw-Hill Inc., New York, 1998.
3. Hetyenyi, M., "Hand book of Experimental Stress Analysis", John Wiley and Sons Inc., New York, 1972.
4. "Experimental Stress Analysis" Dr. Sadhu Singh, Khanna Publishers,2009.

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Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessm	University Exami	Total	
VIII	**Wind Tunnel techniques** BTAE 802T (E)-2	3	0	0	3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	To interpret the basic concepts of measurement of forces and moments on models during the wind tunnel testing
2	To understand the application of various types of wind tunnels
3	To learn the basic measurement procedure involving wind tunnel testing

Course Outcomes

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

CO1	Ability to understand basics of aerodynamics and to identify the type of wind tunnel
CO2	Ability to develop and understand flow visualization techniques over model
CO3	Ability to understand concepts of low speed and high speed wind tunnels
CO4	Ability to understand measurement and balancing of loads on model
CO5	Ability to understand the different types of equipment's for measuring pressure and velocity

SYLLABUS

Contents	No of hours
Unit I: WIND TUNNELS Wind Tunnel, layouts and nomenclature, Types of Wind Tunnels – continuous and intermittent -closed circuit and open circuit - closed jet and open jet test section – application. Special purpose tunnels - Smoke Tunnels – Water Tunnels – Spin tunnel, automobile wind tunnel and environmental wind tunnel Important parameters of flow similarity. types of flow similarities for compressible and incompressible flows Model power consideration.	9
Unit II : FLOW VISUALIZATION TECHNIQUES Path – Streak – Stream and Timelines; Techniques: Smoke, Tuft, Streaks, Surface oil flow. Pressure measurements: Manometers – U-Tube, Inclined and Precession. Bourdon Gauge and Pressure Transducer – Strain Gauge, Semi conductor – Absolute and Differential. Velocity Measurements: Pivot Tube – Static and Total. Calibration of test section: Test section flow calibration and Boundary Layers	9

Unit III : MEASUREMENTS OF FORCES AND MOMENTS Forces, moments and Reference Frames – Balances – Internal and External - Requirements and Specifications – Fundamentals of Model Installations. Boundary correction, types of blockages	9
Unit IV : HIGH SPEED WIND TUNNELS Supersonic Wind Tunnels and - Classification - Runtime - Compressors - Charging Times - nozzle Mass Flows - Starting Loads - Model Size – Calibration. Hypersonic Wind Tunnels: Classification – Runtime – Vacuum Tanks – Vacuum pumps – Evacuation Times. Shock Tube: Driver – driven – Vacuum Pumps – Diaphragm	9
Unit V : HIGH SPEED FLOW VISUALIZATIONS AND MEASUREMENTS Schlieren and Shadow Graph – Pressure sensitive Paints – Temperature sensitive Paints – Force Measurements – Strain Gauge Balances – Pressure Measurements, Case study – Experimental analysis of flow over a bullet.	9

Total: 45 Hours

TEXT BOOKS:

. Rae, W.H. and Pope, A. —Low Speed Wind Tunnel Testingǁ, John Wiley Publication, 1999

2. Pope, A., and Goin, L., —High Speed wind Tunnel Testingǁ, John Wiley Publication , 1999

3. Pope, J B Barlow —low speed wind tunnel testing — 3 edition j.w publication

REFERENCES:

1. John D. Anderson, Jr., "Fundamentals of Aerodynamics", Third edition, McGraw-Hill publications, 2001

2. E L Houghton and PW Carpenter, "Aerodynamics for Engineering students", Fourth edition, Edward Arnold publications, 1993.

3. L.M Miline Thomson, —Theoretical Aerodynamicsǁ, 1996 McGraw-Hill, New Delhi.

4. R. Halmshaw (1991), Non-Destructive Testing, 2nd edition, Edward Arnold, New York

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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	
VIII	**Introduction to Hybrid Propellant and Cryogenics** BTAE 802T (E)-3	3	0	0	3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	To understand cryogenic system, principles, modes and its process.
2	To have detailed knowledge of thermo-physical properties of cryogenic system.
3	To study applications of cryogenics and safety with cryogenic systems.
	Course Outcomes
After successful completion of this course the student will be able to:	
CO1	Understand the cryogenic system and superconductivity, applications
CO2	To have complete knowledge of cryogenic heat transfer, basic modes, variables
CO3	To be able to understand the thermo-physical properties of cryogenic system
CO4	To able to understand cryo-insulation and devices
CO5	To be able to apply cryogenic in various Equipment's.

SYLLABUS Contents	No. of Hours
Unit I : BASIC PRINCIPLES Introduction to Cryogenics and superconductivity – Applications of Cryogenics – Common Cryogens and their properties – Cryogenic rockets – Thermodynamic analysis of low- temperature systems – Basic principles of low temperature heat transfer, Cryogenic liquefaction process.	9
Unit II: CRYOGENIC HEAT TRANSFER Basic modes of heat transfer: Conduction, Convection and Radiation in cryogenic systems in steady and unsteady conditions – Temperature dependent thermal conductivity, Boiling and two phase flow, Pool and film boiling of cryogenic fluids – Thermal contact resistance: Unique problems of heat transfer in cryogenic applications.	9
Unit III: THERMO-PHYSICAL PROPERTIES OF CRYOGENIC SYSTEM PVT behaviour of a pure substance – Mechanical properties of materials used in cryogenic systems – Transport properties of solids – thermal properties, emissivity, absorptivity and reflectivity, electrical properties and superconductivity – Prediction of thermodynamic properties, ultra-low temperature refrigerators, Cryocoolers.	9
Unit IV: CRYO INSULATION AND DEVICES Storage vessel, thermal shields and insulation, effect of size and shape of storage vessel on heat in-leak, vapour shielding, vacuum insulation, evacuated porous insulation, solid foams, multilayer insulation,	9

composite insulation, critical radius of insulation – Micro-sphere insulation, typical insulation systems for space propulsion, aerogel beds, light density Mylar, comparison of insulations.	
Unit V: CRYOGENIC INSTRUMENTATION AND SAFETY WITH CRYOGENIC SYSTEMS Strain, displacement and position, pressure, flow, liquid level, density and temperature for cryogenic applications. **Cryogenic Equipment's:** Introduction of Compressors, pumps, expansion engines, valves, and heat exchangers for cryogenic applications. Introduction – Physiological hazards, explosions and flammability, excessive pressure gas, suitability of materials and construction techniques, Safety considerations for liquid hydrogen and liquid oxygen – General safety principles.	9

Total: 45 Hours

References:

1. Thomas M. Flynn, 'Cryogenic Engineering', Second Edition, CRC Press, Taylor and Francis Inc., 2009.
2. Barron, R., 'Cryogenic Systems', Second Edition, Oxford University Press, New York, 1985.
3. Barron, R.F, 'Cryogenic Heat Transfer', Philadelphia, PA: Taylor and Francis Publishers, second edition, 2016.
4. Augustynowicz, S. D. and Fesmire, J.E., "Cryogenic Insulation System for Soft Vacuum", Advances on Cryogenic Engineering, Vol. 45, Kluwer Academic / Plenum Publishers, pp. 1691-1698,2000.
5. MamataMukhopadhyay, 'Fundamentals of Cryogenic Engineering', Prentice Hall India Pvt. Ltd., New Delhi, 2010.

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Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessm	University Exami	Total	
VIII	**Bio-Fluid Dynamics** BTAE 802T (E-4)	3	0	0	3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	To classify the fluids according to its characteristics.
2	To study the pressure and flow patterns in blood vessels.
3	To use this knowledge in studying the mechanics available at Cardiac system.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Understand the basics of Fluid and its classifications
CO2	Understand different types of fluid flows
CO3	Understand the concept of boundary layer flow
CO4	Understand the pressure and flow in blood vessels
CO5	Analyze the cardio vascular dynamics and Understand about the concept of myocardial mechanics and fluid dynamics of aortic and mitral valves.

SYLLABUS	
Contents	**No of hours**
Unit I : INTRODUCTORY CONCEPTS Fluids and non-fluids, continuum coordinate systems, force and moments, stress at a point, rate of strain, properties of fluids, classification of fluids.	10
Unit II : FLUID FLOW Different types of fluid flows, laminar and turbulent flow, transition from laminar to turbulent flow, laminar flow-annulus, laminar flow between parallel plates, measurement of viscosity.	10

Unit III : BOUNDARY LAYER FLOW Development of boundary layer, estimates of boundary layer thickness, boundary layer equation, nature of turbulence, smooth and rough surface, boundary layer separation.	7
Unit IV : PRESSURE AND FLOW IN BLOOD VESSELS Friction loss in flow in a tube, velocity distribution of aortic system, waveform of pressure and velocity in aorta, wave reflections and impedance in arterial segments, blood flow in veins and blood flow in capillaries.	8
Unit V : ANALYSIS OF CARDIO VASCULAR DYNAMICS Introduction, Control theory and system analysis, mechanical analysis of circulatory systems, Basic concept of myocardial mechanics, index of contractibility, fluid dynamics of aortic and mitral valves.	10

Total: 45 Hours

References:

1. K.L.Kumar, "Engineering fluid mechanics", Eurasia Publishing House (P) Ltd., New Delhi, 1998.

2. D.H.Bergel, "Cardiovascular fluid dynamics"- Vol. I, Academic press, London & New York, 1972.

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Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks			Exam Duration (Hrs.)
		L	T	P		Continual Assessm	University Exami	Total	
VIII	**Aero Engine Maintenance** BTAE 803T (E)-1	3	0	0	3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	To study the basic concepts of the maintenance and repair of both piston and jet aero engines and the procedures followed for overhaul of aero engines.
2	To gather the knowledge about propellers and their inspection

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Ability to understand basics of Types of piston engines and their operations, along with their inspection and maintenance
CO2	Ability to develop and understand about the classification of propellers and General Inspection procedures
CO3	Ability to understand concepts of Symptoms failure and Fault diagnostics, along with the Case studies of different engine systems
CO4	Ability to understand the types of jet engines and their inspection & checks
CO5	Ability to understand the Engine Testing and Storage, Engine Overhaul and troubleshooting

SYLLABUS	
Contents	**No of hours**
Unit I: Types of piston engines - Principles of operation - Function of components - Materials used - Details of starting the engines - Details of carburetion and injection systems for small and large engines - Ignition system components - spark plug detail - Engine operating conditions at various altitudes - Maintenance and inspection check to be carried out. Inspection and maintenance and troubleshooting - Inspection of all engine components - Daily and routine checks - Overhaul procedures - Compression testing of cylinders - Special inspection schedules - Engine fuel, control and exhaust systems - Engine mount and super charger - Checks and inspection procedures.	9
Unit II : Classification of propellers - General Inspection procedures - Checks on constant speed propellers - Pitch setting – Installation and maintenance checks.	9

Unit III : Symptoms of failure - Fault diagnostics - Case studies of different engine systems - Rectification during testing equipments for overhaul: Tools and equipments requirements for various checks and alignment during overhauling - Tools for inspection - Tools for safety and for visual inspection - Methods and instruments for non destructive testing techniques - Equipment for replacement of part and their repair. Engine testing: Engine testing procedures and schedule preparation - Online maintenance.	9
Unit IV : i) 12 Types of jet engines - Principles of operation - Functions of components - Materials used - Details of starting and operating procedures - Gas turbine engine inspection & checks - Use of instruments for online maintenance - Special inspection procedures : Foreign Object Damage - Blade damage - etc. ii) Gas turbine engine maintenance: Minor and Major maintenance. Maintenance procedures of gas turbine - Trouble shooting and rectification procedures - Component maintenance procedures - Systems maintenance procedures.	9
Unit V : Engine Testing and Storage: Gas turbine testing procedures - test schedule preparation - Storage of Engines - Preservation and de-preservation procedures. i) Engine Overhaul: Overhaul procedures - Inspections and cleaning of components - Repairs schedules for overhaul - Balancing of Gas turbine components. ii) Trouble Shooting : Procedures for trouble shooting - Condition monitoring of the engine on ground and at altitude - engine health monitoring and corrective methods	9

Total: 45 Hours

REFERENCES:

1. Kroes & Wild, "Aircraft Power plants", 7th Edition - McGraw Hill, New York, 1994.

2. Turbomeca, "Gas Turbine Engines ", The English Book Store ", New Delhi, 1993.

3. United Technologies' Pratt & Whitney, "The Aircraft Gas turbine Engine and its Operation ", The English Book Store, New Delhi.

4. Maintenance Manuals from different engine manufacturers

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	
VIII	Theory of Aero elasticity BTAE 803T(E) -2	3	0	0	3	30	70	100	3

Sr. No.	Course Objective The objective of this course is–
1	Explain structural concepts such as elastic stiffness, inertia, influence coefficients, elastic axis, and shear center.
2	Describe structural dynamics of wings, including bending and torsion modes of vibration and their associated natural frequencies.
3	Apply aeroelastic concepts of divergence, flutter, lift and roll effectiveness, aileron reversal, and mode coalescence.
4	Knowledge to formulate and derive static and dynamic aeroelastic equations of motion.
5	To Apply Rayleigh-Ritz Method for Approximate continuous aeroelastic systems able to Interpret velocity-damping and velocity-frequency flutter diagrams.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Investigate the different aero elastic phenomenon and the methods of counteracting it.
CO2	Explain how the aeroelastic phenomena flutter, divergence and aileron reversal arise and how they affect aircraft performance.
CO3	Formulate aeroelastic equations of motion and use them to derive fundamental relations for aeroelastic analysis.
CO4	Perform a preliminary aeroelastic analysis of a slender wing structure in lowspeed airflow, and explain under what circumstances an aeroelastic analysis can be expected to produce useful results.
CO5	Estimate the critical divergence, reversal and flutter speeds of an airplane and to investigate the stability of the disturbed motion.

SYLLABUS Contents	No. of Hours
Unit I : AERO ELASTICITY PHENOMENA Vibration of beams due to coupling between bending and torsion – The aero-elastic triangle of forces – Stability versus response problems – Aeroelasticity in Aircraft Design – Vortex induced vibration – Introduction to aero servo elasticity.	9
Unit II: DIVERGENCE OF A LIFTING SURFACE Simple two dimensional idealizations – Strip theory – Fredholm integral equation of the second kind – Exact solutions for simple rectangular wings – Semi rigid assumption and approximate solutions – Generalized coordinates – Successive approximations – Numerical approximations using matrix equations.	9
Unit III: STEADY STATE AEROELASTIC PROBLEMS Loss and reversal of aileron control – Critical aileron reversal speed – Aileron efficiency -Semi rigid theory and successive approximations – Lift distributions – Rigid and elastic wings.	9

Unit IV: FLUTTER ANALYSIS Non-dimensional parameters – Stiffness criteria Dynamic mass balancing – Model experiments – Dimensional similarity – Flutter analysis – Two dimensional thin airfoils in steady incompressible flow – Quasi steady aerodynamic derivatives – Galerkin's method for critical speed – Stability of distributed motion – Torsion flexure flutter – Solution of the flutter determinant – Methods of determining the critical flutter speeds – Flutter prevention and control.	9
Unit V : EXAMPLES OF AEROELASTIC PROBLEMS Galloping of transmission lines and flow induced vibrations of tall slender structures and suspension bridges – Aircraft wing flutter- Vibrational problems in Helicopters.	9

Total: 45 Hours

Text Books:

1. Fung, Y.C. An Introduction to the theory of Aeroelasticity, Dover Publications Inc., 2008.

References:

1. Bisplinghoff., R.L. Ashley, H., and Halfman, R.L, "Aeroelasticity" Addison Wesley Publishing Co., Inc. II ed. 1996.
2. Broadbent, E.G., Elementary Theory of Aeroelasticity, Bunhill Publications Ltd, 1986.
3. Blevins R.D, "Flow induced vibrations", Krieger Pub Co; 2 Reprint editions, 2001.
4. Scanlan, R.H. and Rosenbaum, R., Introduction to the Study of Aircraft Vibration and Flutter, Macmillan Co., N.Y., 1991.

RTM Nagpur University

Syllabus (Theory)

Semester	Course Title(Subject)	Hours / Week			Credits	Maximum Marks		
						Continual Assessment	University Examination	Total
		L	T	P				
VIII	**Industrial Aerodynamic** {BTAE803T(E) -3}	3	-	-	3	30	70	100

Sr. No.	**Course Objective** **The objective of this course is–**
1	Enabling concept of atmosphere.
2	Enable knowledge of aerodynamics on bluff bodies.
3	Enable the wind energy calculation and flow inducted vibrations.
4	Enrich the knowledge on vehicles and building aerodynamics

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Understand the types of winds, its variation, atmospheric boundary layer, effect terrain w. r. t. gradient and flows, Bluff body aerodynamics.
O2	Have a fundamental knowledge on different types wind machines and Betz coefficient momentum theory.
CO3	Understand the power requirements and drag coefficients of automobiles, Effects of cut back angle, Aerodynamics of trains and hovercraft.
CO4	Understand of pressure distribution, forces of building and special problems of tall buildings.
CO5	Understand effects of Reynolds number, wake formation of bluff shapes, vortex induced vibrations, galloping and stall flutter.

SYLLABUS	
Contents	**No. of hours**
Unit I ATMOSPHERE and BLUFF BODY AERODYNAMICS: Types of winds, Causes of variation of winds, Atmospheric boundary layer, Effect of terrain on gradient height, Structure of turbulent flows. Boundary layers and separation, Two dimensional wake and vertex formation, Strouhal and Reynolds numbers , Separation and reattachments, Power requirements and drag coefficients of automobiles, Effect of cut back angle, Aerodynamics of Trains.	9
Unit II WIND ENERGY COLLECTORS: Horizontal axis and vertical axis machines, Power coefficient, Betz coefficient by momentum theory – Piezo wind energy collectors – various bladeless wind energy harvesting methods.	9

Unit III VEHICLE AERODYNAMICS: Power requirements and drag coefficients of automobiles, Effects of cut back angle, Aerodynamics of trains and Hovercraft, Various drag reduction and optimization techniques, flow control and its applications.	9
Unit IV BUILDING AERODYNAMICS: Pressure distribution on low rise buildings, wind forces on buildings. Environmental winds in city blocks, Special problems of tall buildings, Building codes, Building ventilation and architectural aerodynamics, urban planning and human comfort.	9
Unit V FLOW INDUCED VIBRATIONS: Effects of Reynolds number on wake formation of bluff shapes, Vortex induced vibrations, Galloping and stall flutter, Vibration of stay cables under wind load.	9

Total: 45 Hours

Reference Books:

1. Wind Effects on Civil Engineering Structures (Studies in Wind Engineering & Industrial Aerodynamics) by Vladimir Kolousek,M. Pirner , O. Fischer,J. Naprstek.
2. Aero-hydrodynamics and the Performance of Sailing Yachts,by Fabio Fossati · 2009
3. Portable Parallelization of Industrial Aerodynamic Applications byVieweg+Teubner Verlag 2013.
4. Journal of Industrial Aerodynamics Elsevier Scientific Publishing Company, 1975.

RTM Nagpur University Syllabus (Theory)									
Semester	**Course Title (Subject)**	**Hours / Week**			**Credits**	**Maximum Marks**			**Exam Duration (Hrs.)**
		L	**T**	**P**		**Continual Assessm**	**University Exami**	**Total**	
VIII	**Aviation Logistics and Supply Chain Management** {BTAE 803T(E) -4}	3	0	0	3	30	70	100	3

Sr. No.	**Course Objective** **The objective of this course is–**
1	To study the basic concepts and get familiarize with concepts of practices and procedures in logistics operations and logistics management in particular context to the Aviation Industry.
2	To gather the knowledge about management concepts with a view to prepare them to face emerging challenge of managing business supply chain.
	Course Outcomes
After successful completion of this course the student will be able to:	
CO1	Understand the basics of travel and logistics products and can explain various transportation modes in the logistics network
CO2	Ability to develop and understand about the Logistics Management
CO3	Describe the processes of SCM, Identify the key supply chain business processes
CO4	Define the information technology and its application in logistics
CO5	Explain the information technology and its application in supply chain

SYLLABUS	
Contents	**No of hours**
Unit I: Introduction to Logistics Logistics- Definition - History and Evolution-Goals- Objectives-Elements-activities importance. The work of logistics-Logistics interface with marketing-retails logistics- Emerging concept in logistics. Concept of Logistics .Introduction – Components, Advantage & Growth-Logistics in Global Organisation .Marketing and Logistics Channel – Environmental and Marketing Issue .Inventory Management- Purpose, Type, Objective and Cost- Model of Inventor Management – MRP, DRP & JIT	9

Unit II : Logistics Management Logistics Management-Definition-Achievement of competitive advantage through logistics Framework-Role of Logistics management-Integrated Logistics Management. Evolution of the concept- model - process-activities (in brief).	9
Unit III : Supply Chain Management An Introduction — Concept – Evolution and Development – Difference – Role – Scope – Functions and Importance – The new Manufacturing and Distribution Practices in the light of Globalized Economy – Local and International Supply Chains – Benefits and Issues – Types of Supply Chains and examples – Strategic, tactical, operational decisions in supply chain – SCM building blocks – Supply Chain Drivers and Obstacles – International Logistics and Supply Chain Management – The Total Cost Concept and Logistics and SCM Trade-Offs.	9
Unit IV : Information Technology and Logistics Logistics Information-Meaning & Need Forms-LIS-Definition-Information functionality - activities involved in transaction system-Principles of designing or evaluating LIS applications. Electronic Data Interchange - Personal Computers –Artificial Intelligence/Expert system - Communications Bar coding and scanning – Electronic. Data Interchange standards – Communication - Information and Future directions.	9
Unit V : Information Technology for Supply Chain Management Bull whip effect - IT in supply chain- Business Process Reengineering - Enterprise Resource Planning – EDI Problems with EDI - Impact of Internet on SCM. LIS Architecture components- Two forms of activities; Planning & co-ordination flows & operating flows - Flow and use of integrated logistics information.	9

Total: 45 Hours

REFERENCES:

1. Donald F. Wood et.al., International Logistics
2. Donald J. Bowersox and David J. Closs. Integrated Logistics Management
3. Douglas Lambert and James R. Stock, Strategic Logistics Management
4. Donald F. Wood et.al., International Logistics
5. David J. Bloomberg, Stephen Lemay & : Logistics, Prentice-Hall of India Pvt Ltd.,Joe B.
6. Hanna New Delhi, 2003.

RTM Nagpur University

Syllabus (Theory)

Semester	Course Title (Subject)	Hours / Week			Credits	Maximum Marks		
		L	T	P		Continual Assessment	University Examination	Total
VIII	**Project Work Phase- II** (BTAE 804P)	0	0	12	6	100	100	200

Sr. No.	Course Objective The objective of this course is–
1	To prepare themselves to undertake lively project which will found end application to industry / society.

Course Outcomes	
After successful completion of this course the student will be able to:	
CO1	Develop leadership quality to effectively manage and work in team.
CO2	Apply engineering knowledge gained to develop Industry/Society welfare projects

SYLLABUS	
Contents	**No of hours**
Preparation for the project work involve 1. In depth study of the topic assigned in the light of the Report prepared under Project Work Phase-I; 2. Review and finalization of the Approach to the Problem relating to the assigned topic; 3. Preparing an Action Plan for conducting the investigation, including team work; 4. Detailed Analysis/Modelling/Simulation/Design/Problem Solving/Experiment as needed; 5. Final development of product/process, testing, results, conclusions and future directions; 6. Preparing a paper for Conference presentation/Publication in Journals, if possible; 7. Preparing a Dissertation in the standard format for being evaluated by the Department. 8. Final Seminar Presentation before a Departmental Committee.	90

Total: 90 Hours