Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur

Syllabus for B.E. (Seventh Semester) Aeronautical Engineering

Aircraft Systems and Instrumentation (BEAE-701T)

(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week

Examination Scheme
Theory
T (U): 80 Marks T (I): 20 Marks
Duration of University Exam: 03 Hours

Unit I: Airplane Control Systems **8 Hours**

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.

Unit II: Aircraft Hydraulic Systems **6 Hours**

Hydraulic systems - Study of typical workable system - components - Hydraulic system controllers - Modes of operation

Unit III: Pneumatic & Hybrid Systems **8 Hours**

Pneumatic systems - Advantages - Working principles ,Typical Air pressure system – Brake system - Typical Pneumatic power system - Components, Landing Gear systems - Classification – Shock absorbers,Retraction mechanism.

Unit IV: Engine Systems **7 Hours**

Fuel systems for Piston and jet engines, - Components of multi engines. lubricating systems for piston and jet engines - Starting and Ignition systems - Typical examples for piston and jet engines.

Unit V: Auxilliary System **8 Hours**

Basic Air cycle systems - Vapour Cycle systems, Boost-Strap air cycle system - Evaporative vapour cycle systems - Evaporative air cycle systems - Oxygen systems - Fire protection systems, Deicing and anti icing systems.

Unit VI: Aircraft Instruments **8 Hours**

Flight Instruments and Navigation Instruments – Gyroscope - Accelerometers, Air speed Indicators
– TAS, EAS- Mach Meters - Altimeters - Principles and operation - Study of various types of engine instruments - Tachometers - Temperature gauges - Pressure gauges - Operation and Principles.

Total No of periods: 45

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 Administation, The English Book Store, New Delhi1995.

REFERENCES

1. Mekinley, J.L. and Bent, R.D., "Aircraft Power Plants", McGraw-Hill, 1993.
2. Pallet, E.H.J., "Aircraft Instruments & Principles", Pitman & Co., 1993.
3. Treager, S., "Gas Turbine Technology", McGraw-Hill, 1997.

Syllabus for B.E. (Seventh Semester) Aeronautical Engineering

Design of Machine Elements (BEAE-702T)

(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week

Examination Scheme
Theory
T (U): 80 Marks T (I): 20 Marks
Duration of University Exam: 03 Hours

Unit I: Fundamentals of Design **4 Hours**

Design Process – Computer aided design – Optimum design – Mechanical properties of materials – Types of loads – Stresses –Static, varying, thermal, impact and residue – Factor of safety – Stress concentration factors –Preferred numbers.

Unit II: Design of Basic Machine Elements and Joints **10 Hours**

Design of shafts, keys, couplings. Design of riveted and welded joints, Bolted Joints & Applications to Aircraft.

Unit – III: Design of Springs and Bearing **8 Hours**

Design of Helical compression & Tension springs for static & fatigue loading. Design of design of journal bearings for radial and thrust loads, selection of ball & roller bearings for radial and thrust loads

Unit IV: Design of Gears **10 Hours**

Design of gears – Spur and Helical gears – Design of multistage speed reducers.

Unit V: Design of Drives **5 Hours**

Belt Drives - Flat belt drive :- Types of belts & belt material, analysis of belt tension, condition for transmitting maximum power, design of flat belt, flat belt pulley. V Belt drive: - Types of V-belt, analysis of V-belt tension, design of V-belt pulley.

Unit VI: Design Of Engine Parts **8 Hours**

Design of Cylinder – piston – connecting rod – crank shaft

Flywheel - Coefficient of fluctuation of energy and coefficient of fluctuation of speed, energy store in flywheel, stresses in flywheel, design of flywheel.

Total No of periods: 45

Text Books:

1. Mechanical Design of Machine by Maleev Hartman.
2. Machine Design by P. H. Black.
3. Mechanical Engineering Design by J. E. Shigley.
4. Design of Machine Elements by B. D. Shiwalkar.
5. Design of Machine Elements by V.B. Bhandari.
6. Design of Data for Machine Elements by B. D. Shiwalkar.
7. PSG Data Book

Reference Books:

1. Hand Book of Machine Design by Shigley & Mischke.

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Syllabus for B.E. (Seventh Semester) Aeronautical Engineering

Space Flight Mechanics (BEAE-703T)

(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**
Duration of University Exam: 03 Hours

Unit-I: Basic Concepts **8 Hours**

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.

Unit-II: The General N-Body Problem **8 Hours**

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.

Unit-III: Satellite Injection and Satellite Orbit Perturbations **8 Hours**

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.

Unit-IV: Interplanetary Trajectories **7 hours**

Two dimensional interplanetary trajectories - Fast interplanetary trajectories - Three dimensional interplanetary trajectories - Launch of interplanetary spacecraft - Trajectory about the target plant.

Unit-V: Ballistic Missile Trajectories **7 hours**

The boost phase - The ballistic phase - Trajectory geometry - Optimal flights - Time of flight - Re-entry phase - The position of the impact point - Influence coefficients.

Unit-VI: Materials For Spacecraft **7 hours**

Space environment - Peculiarities -Effect of space environment on the selection of materials of spacecraft.

Total No of periods: 45

References Books:

1. Sutton, G.P & Oscar Bilbraz,., "Rocket Propulsion Elements", John Wiley & Sons Inc., New York, 7th Edition,2004.
2. Van de Kamp, P., "Elements of Astromechanic", Pitman, 1979.
3. Cornelisse, J.W., "Rocket propulsion and space dynamics", W.H. Freeman & Co., 1984.
4. Parker, E.R., "Materials for Missiles and Spacecraft" , McGraw Hill Book Co., Inc., 1982. Wiesel, W.E., “Spaceflight Dynamics”, 2nd Edition, McGraw Hill, 1997
5. Thompson, W.T., “Introduction to Space Dynamics”, Dover, New York, 1986

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Syllabus for B.E. (Seventh Semester) Aeronautical Engineering

Control Engineering (BEAE-704T)

(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**
Duration of University Exam: 03 Hours

Unit I **7 Hours**

Review of Mathematical Modeling, Time Domain Response Analysis under transient input, Steady stare error analysis and error constants

Unit II **7 Hours**

Stability of control systems, condition of stability, characteristics equation .Routh Hurwitz criterion-special cases for determining relative stability. Frequency Domain analysis Root - Locus techniques

Unit III **7 Hours**

Bode plot, gain Margin and phase margin, transportation lag, System Identification from Bode plot.

Unit IV **9 Hours**

Polar Plot, Nyquist Plot and Stability criterion, Feed Back, Compensation and Pole -Zero placement. Concept of PI, PD and PID controller

Unit V **7 Hours**

Closed loop performance specifications, gain and phase margin as design specifications, use of root locus, bode plots in design, design rules for lag-lead compensation

Unit VI **8 Hours**

State Variable approach and state equations, Transfer function from state models state transition matrix and solution of state equations controllability and observability test through test model.

Total No of periods: 45

TEXT BOOKS:-

1. Ogata Katsuhika, "Modern Control Engineering", Printice Hall of India, New Delhi, Second Edition, No. of Copies: 40
2. Kuo B.C. and Golnaraghi F. " Automatic control systems",John Wiley and sons,8th edition, 2003
3. Nise Normal, "Control System Engineering", California Benjamin Cumming Publication
   ,Willey, Second Edition, No. of Copies: 12
4. NagrathI.J. & Gopal M., "Control Systems" , Tata McGraw Hill Publication, New Delhi, Revised Edition,2004. No. of Copies: 03
5. Dorf Richard C., "& Bishop Robert H. , "Modern Control Systems", Addision Wesley, New York, Eighth Edition.No. of Copies: 12
6. Gopal M., "Digital Control & State Variable Methods", Tata McGraw Hill Publication, New Delhi, Second Edition,2004. No. of Copies:10

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Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur

Syllabus for B.E. (Seventh Semester) Aeronautical Engineering

Aircraft General Engineering and Maintenance Practices (BEAE-705T)

(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week
Duration of University Exam: 03 Hours

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**

Unit I **8 Hours**

Aircraft ground handling and support equipment,Mooring, jacking, levelling and towing operations - Preparation - Equipment and precautions - Engine starting procedures - Piston engine, turboprops and turbojets - Engine fire extinguishing - Ground power units.

Unit II **6 Hours**

Ground servicing various sub systems, Air conditioning and pressurisation - Oxygen and oil systems - Ground units and their maintenance.

Unit III **7 Hours**

Shop safety - Environmental cleanliness - Precautions. Hand tools - Precision instruments – Special tools and equipments in an airplane maintenance shop – Identification terminology

Unit IV **9 Hours**

Inspection Process - Purpose - Types - Inspection intervals - Techniques - Checklist - Special inspection - Publications, bulletins, various manuals - FAR Air worthiness directives – Type certificate Data Sheets - ATA specifications

Unit V **9 Hours**

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.

Unit VI **6 Hours**

Plumbing connectors Cables Swaging procedures, tests, Advantages of swaging over splicing.

Total No of periods: 45

REFERENCES:

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.

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Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Syllabus for B.E. (Seventh Semester) Aeronautical Engineering

Aircraft Design Project(BEAE-706P)
(Total Credits: 02)

Teaching Scheme	**Examination Scheme**	
Practical: 2 Hours/ Week	**Practical**	
	T (U): 25 Marks	**T (I): 25 Marks**

OBJECTIVE

To enhance the knowledge in continuation of the design project given in project–I. To introduce and develop the basic concept of aircraft design. Each student is assigned with the design of an Airplane for given preliminary specifications. The following are the assignments to be carried out:

Task list for the project

1. Comparative configuration study of similar airplanes
2. Selection of main parameters for the design
3. Preliminary weight estimations
4. Power plant selection, Aerofoil selection, Wing tail and control surfaces
5. Preparation of layouts of balance diagram and three view drawings
6. Estimation of various Drag components.
7. Performance calculations and stability estimates
8. V-n diagram for the design study
9. Load estimation of wings
10. Load estimation of fuselage.
11. Balancing and Maneuvering loads on tail plane, Aileron and Rudder loads.
12. Preliminary structural design of wing/fuselage

13. Preparation of a detailed design report

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Syllabus for B.E. (Seventh Semester) Aeronautical Engineering

Aircraft System (BEAE-707P)

(Total Credits: 02)

Teaching Scheme	**Examination Scheme**	
Practical: 2 Hours/ Week	**Practical**	
	T (U): 25 Marks	**T (I): 25 Marks**

OBJECTIVE

To train the students "ON HAND" experience in maintenance of various air frame systems in aircraft and rectification of common snags.

List of Experiment for Aircraft Systems and Instrumentation

1. Aircraft "Jacking Up" procedure
2. Aircraft "Levelling" procedure
3. Control System "Rigging check" procedure
4. Aircraft "Symmetry Check" procedure
5. "Flow test" to assess of filter element clogging
6. "Pressure Test" To assess hydraulic External/Internal Leakage
7. "Functional Test" to adjust operating pressure
8. "Pressure Test" procedure on fuel system components
9. "Brake Torque Load Test" on wheel brake units
10. Maintenance and rectification of snags in hydraulic and fuel systems.

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Syllabus for B.E. (Seventh Semester) Aeronautical Engineering
Project Work Phase- I(BEAE708P) (Total Credits: 02)

Teaching Scheme	Examination Scheme
Practical: 2 Hours/ Week	Practical
	T (I): 50 Marks

OBJECTIVE

The objective of the phase – I of the students project work is to prepare themselves to undertake lively project which will found end application to the industry / society.

Preparation for the project work involve

1. Form a team of likeminded students (not more than 8 in numbers) to carry out the project.
2. Make a preliminary survey and data collection or literature review of the project proposed in the next semester.
3. Conduct a thorough literature survey and publish or present a paper of the proposed work in any one of the forthcoming National seminars.
4. Plan for necessary supports, facilities, analytical tools and fixation of faculties / supervisors for the final semester project work.

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Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur

Syllabus for B.E. (Eighth Semester) Aeronautical Engineering

Air Transportation (BEAE-801T)

(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**
Duration of University Exam: 03 Hours

Unit I: Introduction **8 Hours**

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.

Unit II: Airline Economics **7 Hours**

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.

Unit III: Fleet Planning **8 Hours**

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.

Unit IV Principles of Airlines Scheduling **7 Hours**

Equipment maintenance, Flight operations and crew scheduling, Ground operations and facility limitations equipments and types of schedule - hub & spoke scheduling, advantages / disadvantages & preparing flight plans- Aircraft scheduling in line with aircraft maintenance practices.

Unit IV: Aircraft Reliability **8 Hours**

Aircraft reliability - The maintenance schedule & its determinations - Condition monitoring maintenance - Extended range operations (EROPS) & ETOPS - Ageing aircraft maintenance production.

Unit VI: Technology in Aircraft Maintenance **7 Hours**

Airlines scheduling (with reference to engineering) - Product support and spares - Maintenance sharing - Equipments 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.

Total No of periods: 45

REFERENCES:

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.

Engineering and Technology

Rashtrasant Tukadoji Maharaj Nagpur University, Nagpur
Syllabus for B.E. (Eighth Semester) Aeronautical Engineering
Vibration and Aero- elasticity (BEAE-802T)
(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**
Duration of University Exam: 03 Hours

Unit I: Basic Notions **6 Hours**

Simple harmonic motion – Terminologies – Newton's Law – D' Alembert's principle – Energy Methods

Unit II: Single Degree of Freedom Systems **9 Hours**

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.

Unit III: Multi Degrees of Freedom Systems **7 Hours**

Two degrees of freedom systems – Static and Dynamic couplings - vibration absorber - Principal co-ordinates, Principal modes and orthogonality condition – Eigen value problems.

Unit IV **6 Hours**

Generalized Co-ordinates - Hamilton's principle- Lagrange's equation and application

Unit V: Continuous Systems **10 Hours**

Vibration of strings - Longitudinal, Lateral and Torsional vibrations of beams - forced response of beams

Unit VI: Elements of Aero elasticity **7 Hours**

Concepts – Coupling – Aero elastic instabilities – Basic ideas on wing divergence, loss and reversal of aileron control, Flutter.

Total No of periods: 45

TEXT BOOKS:

1. P.Srinivasan, Mechanical Vibration Analysis, Tata Mc Graw Hill, New Delhi
2. J.P.Den Hartog Mechanical Vibration (4^{th} 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.

Engineering and Technology

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Syllabus for B.E. (Eighth Semester) Aeronautical Engineering

Theory of Elasticity (BEAE-803T)

(Total Credits: 04)

Teaching Scheme
Lectures: 3 Hours/ Week
Tutorial: 1 Hours / Week
Duration of University Exam: 03 Hours

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**

Unit I: Assumptions in Elasticity **6 Hours**

Definitions, notations and sign conventions for stress and strain in 3D. stress/strain transformation, Mohr's circle, Principal stresses and principal strains.

Unit II: Basic Equations of Elasticity **8 Hours**

Strain-displacement relations, Stress-strain relations, Lame's constant-cubical dilatation, Compressibility of material, bulk modulus, Shear modulus, Equations of equilibrium. Compatibility equations for stresses and strains, Saint Venant's principle, Theories of failure.

Unit III: Plane Stress and Plane Strain Problems **8 Hours**

Airy's stress function, Biharmonic equations, Polynomial solutions, Simple two dimensional problems in cartesian coordinates like bending of cantilever and simply supported beams etc.

Unit IV: POLAR COORDINATES **7 Hours**

Equations of equilibrium, Strain displacement relations, Stress-strain relations, Axi-Symmetric problems, Kirch, Michell's, problems.

Unit V: CURVILINER COORDINATES: **8 Hours**

Displacement, strain & stress field components in curvilinear co-ordinates. Elasticity equations in curvilinear co-ordinates. Stress functions in terms of harmonic & complex functions, displacement from given stress function, stress & displacement in terms of complex potentials, resultant of a stress on a curve, Boundary conditions.

Unit VI: TORSION **8 Hours**

Navier's theory, St.Venant's theory, Prandtl's theory on torsion, The semi-inverse method and applications to shafts of circular, elliptical, equilateral triangular and rectangular sections.

Total No of periods: 45

REFERENCES:

1. Timoshenko,S., and Goodier, T.N. "Theory of Elasticity", McGraw-Hill Ltd., Tokyo, 1990.
2. Enrico Volterra & J.H.Caines, "Advanced Strength of Materials", Printice Hall, New Jersey, 1991.
3. Wang, C.T., " Applied Elasticity", Mc Graw-Hill Co., New York, 1993.
4. Sokolnikoff, I.S., "Mathematical Theory of Elasticity", McGraw-Hill New York, 1978.

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Syllabus for B.E. (Eighth Semester) Aeronautical Engineering

Optimization Techniques (BEAE-803T)

(Total Credits: 04)

Teaching Scheme
Lectures: 3 Hours/ Week
Tutorial: 1 Hours / Week
Duration of University Exam: 03 Hours

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**

Unit I: Introduction **9 Hours**

General characteristics of engineering design problems, design variables objective function, Design constraints, mathematical statement of optimization problems, feasible & optimal design, local and global optimum, principles of optimization, necessary and sufficient conditions for optimal solution.

Unit II: Optimization Techniques – I **9 Hours**

Unconstrained minimization methods, single & multivariable gradient search methods – steepest gradient, conjugate harmonic and Newton's methods, random search techniques.

Unit III: Optimization Techniques – II **9 Hours**

Minimization procedure with equality and inequality constraints, penalty functions, concept of multicriterion Optimization

Unit IV: Optimization Techniques – III **6 Hours**

Linear programming problems, Optimality criterion, Simplex method and its variants

Unit V: Application – I **6 Hours**

Design of simple axial and transversely loaded members, torsionally loaded members, shafts for minimum weight, maximum torque, Design of springs, hydraulic cylinders

Unit VI: Application – II **6 Hours**

Optimum design of single & two degree of freedom system, Vibration absorbers, optimum design of simple machine/structural members under dynamic loads.

Total No of periods: 45

REFERENCES

1. Rao S.S. optimization Theory & Applications, Wiley Eastern Limited,New Delhi , 1978.
2. Fox Richard L. Optimizations methods for Engg. Design, Addision Wesley ,1971 .
3. Haug,E.J.and Arora, J.S. Applied optimal design. Wiley Inter Science Publication ,New York ,1979.

4. Douglas J. Willde, Globally optimal design Jhon Wiley & Sons, New York, 1978
5. Johnson Ray C. optimum design of mechanical elements, John Wiley & Sons 1981.
6. Mischke, Charles R., An introduction to Computer Aided Design, Prentice Hall Inc, 1968.

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Syllabus for B.E. (Eighth Semester) Aeronautical Engineering

Reliability Centered Maintenance (BEAE-803T)

(Total Credits: 04)

Teaching Scheme
Lectures: 3 Hours/ Week
Tutorial: 1 Hours / Week
Duration of University Exam: 03 Hours

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**

Unit 1: Introduction to Reliability: **7 Hours**

Definition of reliability, Failure data Analysis, Mean Time to Failure (MTTF), Mean Time between Failure (MTBF), Hazard Rate and Failure density

Unit 2: System Reliability: **7 Hours**

Reliability in series and Reliability in Parallel, combined series - parallel system, Standby redundancy.

Unit 3: History Reliability Centered Maintenance: **8 Hours**

Definition of RCM, Evolution of RCM, RCM Achievements, RCM Methodologies- Systems Analysis
Process

Unit 4: Functional Failure of RCM **7 Hours**

Failure Mode and Effect Analysis (FMEA), Analysis & Categories of failure Modes

Unit 5: RCM Maintainability: **8 Hours**

RCM Maintenance Policies, Proactive Maintenance - Predictive Task, Proactive Maintenance - Preventive Task, Proactive Vs. Predictive and Preventive Maintenance

Unit 6: Application of RCM: **8 Hours**

Application of RCM to Airlines industry, US military, Nuclear Power industry

Total No of periods: 45

REFERENCES:

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”

Engineering and Technology

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Syllabus for B.E. (Eighth Semester) Aeronautical Engineering

Aircraft Mechanisms- Analysis and Synthesis (BEAE-803T)

(Total Credits: 04)

Teaching Scheme
Lectures: 3 Hours/ Week
Tutorial: 1 Hours / Week

Examination Scheme
Theory
T (U): 80 Marks T (I): 20 Marks
Duration of University Exam: 03 Hours

Unit 1: Synthesis of Mechanisms **8 Hours**

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.

Unit 2: Balancing of linkages **7 Hours**

Force & moment balancing of four bar Mechanisms, Quantitative analysis of effect of unbalance,
Treatment of Berkof & Oven.

Unit 3: Kinematics of 3D Mechanisms **8 Hours**

D-H notation, Application of D-H Notation of RSSR, RSSS, PSC PSR Mechanisms, Forward and
reverse kinematics

Unit 4: Dynamics of 3D Mechanisms **8 Hours**

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.

Unit 5: Motion Analysis of Mechanisms of Aircraft I **7 Hours**

Kinematic Analysis, Dynamics & design of Mechanisms for operating Flaps & Aileron, Rudder, and Elevator

Unit 6: Motion Analysis of Mechanisms of Aircraft :II **7 Hours**

Kinematics Analysis, Dynamics & Design of Mechanisms for Landing Gear, Conveyor for luggage Transport in Cargo

Total No of periods: 45

REFERENCES:

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.

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

Engineering and Technology

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur

Syllabus for B.E. (Eighth Semester) Aeronautical Engineering

Finite Element Method (BEAE-804T)

(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week
Duration of University Exam: 03 Hours

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**

Unit-I **6 Hours**

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.

Unit-II **11 Hours**

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 discritization of body into elements, degrees of freedom, bandwidth, Basic types of 2-D & 3-D elements, displacement models, convergence requirements, shape function.

Unit-III **7 Hours**

Finite element modeling 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

Unit-IV **7 Hours**

Two dimensional problem using CST & LST – formulation of CST & LST elements, elemental stiffness matrix, assembly, boundary conditions, load vector, stress calculation,
Temperature effect.

Unit-V **7 Hours**

Introduction to Isoparametric & 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.

Unit-VI **7 Hours**

Extention of the method to other engineering problems – For example: Steady state one dimensional heat conduction problems using 1-D element, Introduction to programming

aspects of
FEM, Pre & Post processing in FEA, Commercial F E Software's.

Total No of periods: 45

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.

Engineering and Technology

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur
Syllabus for B.E. (Eighth Semester) Aeronautical Engineering
Airframe Maintenance and Repair (BEAE-804T)
(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week
Duration of University Exam: 03 Hours

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**

Unit-I: **Sheet Metal Repair And Maintenance** **8 Hours**

Inspection of damage - Classification - Repair or replacement - Sheet metal inspection - N.D.T. Testing – Riveted repair design, Damage investigation - reverse technology WELDING IN AIRCRAFT STRUCTURAL COMPONENTS:

Equipments used in welding shop and their maintenance - Ensuring quality welds - Welding jigs and fixtures - Soldering and brazing.

Unit- II: Plastics and Composites in Aircraft **7 Hours**

PLASTICS IN AIRCRAFT: Review of types of plastics used in airplanes - Maintenance and repair of plastic components - Repair of cracks, holes etc., and various repairs schemes - Scopes. ADVANCED COMPOSITES IN AIRCRAFT: Inspection - Repair of composite components – Special precautions - Autoclaves

Unit- III: Aircraft Jacking, Assembly and Rigging **7 Hours**

Airplane jacking and weighing and C.G. Location, Balancing of control surfaces - Inspection maintenance, Helicopter flight controls. Tracking and balancing of main rotor.

Unit- IV Review Of Hydraulic And Pneumatic System 8 Hours

Trouble shooting and maintenance practices - Service and inspection - Inspection and maintenance of landing gear systems. - Inspection and maintenance of air-conditioning and pressurisation system, water and waste system.

Unit- V 8 Hours

Installation and maintenance of Instruments - handling - Testing – Inspection, Inspection and maintenance of auxiliary systems - Fire protection systems - Ice protection system - Rain removal system -Position and warning system - Auxiliary Power Units (APUs).

Unit – VI: Safety Practices 7 Hours

Hazardous materials storage and handling, Aircraft furnishing practices – Equipments, Trouble shooting

Total No of periods: 45

REFERENCES:

1. Larry Reithmeir, " Aircraft Repair Manual ", Palamar Books, Marquette, 1992.
2. Brimm D.J. Bogges H.E., " Aircraft Maintenance ", Pitman Publishing corp., New York, 1940.
3. Kroes, Watkins, Delp, " Aircraft Maintenance and Repair ", McGraw Hill, New York, 1992

Engineering and Technology

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur

Syllabus for B.E. (Eighth Semester) Aeronautical Engineering

Aero- Engine Maintenance and Repair (BEAE-804T)

(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week
Duration of University Exam: 03 Hours

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**

(A) OPERATION, INSPECTION, MAINTENANCE AND TROUBLE SHOOTING OF PISTON ENGINES:

Unit – I **10 Hours**

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.

Unit – II **5 Hours**

Classification of propellers - General Inspection procedures - Checks on constant speed propellers - Pitch setting – Installation and maintenance checks.

Unit- III **8 Hours**

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.

(B) OPERATION, INSPECTION, MAINTENANCE AND TROUBLE SHOOTING OF JET ENGINES:

Unit – IV **10 Hours**

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.

Unit – V **5 Hours**

Engine Testing and Storage : Gas turbine testing procedures - test schedule preparation - Storage of Engines - Preservation and de-preservation procedures.

Unit – VI **7 Hours**

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

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

Engineering and Technology

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Syllabus for B.E. (Eighth Semester) Aeronautical Engineering

Flight Dynamics (BEAE-804T)

(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week
Duration of University Exam: 03 Hours

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**

Unit I **4 Hours**

Introduction: Equilibrium, static and dynamic stability, control.

Unit II **10 Hours**

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.

Unit III **8 Hours**

Lateral -directional stability and control: Directional equilibrium, stability and rudder as control. Lateral stability, dihedral angle, aileron control.

Unit IV **10 Hours**

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 linearised equations of motion.

Unit V **8 Hours**

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.

Unit VI **5 Hours**

Effect of winds. Flight simulation.

REFERENCES

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

3. Nelson, R. C., Flight Stability and Automatic Control, Mc Graw Hill International, 1990.
4. Etkin, B. and Duffy, L. D., Dynamics of Flight: stability and control, John Wiley, NY 1995.
5. Perkins, C. D. and Hage, R. E., Airplane Performance Stability and Control, Wiley, New York, 1949.

Engineering and Technology

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Syllabus for B.E. (Eighth Semester) Aeronautical Engineering

Experimental Stress Analysis (BEAE-805T)

(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week

Examination Scheme
Theory
T (U): 80 Marks T (I): 20 Marks
Duration of University Exam: 03 Hours

Unit I **6 Hours**

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

Unit II Measurements & Extensometer **7 Hours**

Principles of measurements, Accuracy, Sensitivity and range of measurements, Mechanical, Optical Acoustical and Electrical extensometers and their uses, Advantages and disadvantages

Unit III: Electrical Resistance Strain Gauges **10 Hours**

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

Unit IV: Photoelasticity **8 Hours**

Two dimensional photo elasticity, Concept of light – photo elastic effects, stress optic law, Interpretation of fringe pattern, Compensation and separation techniques, Photo elastic materials

Unit V: Brittle Coating and Moire Methods **7 Hours**

Introduction to Moire techniques, brittle coating methods and holography

Unit VI: Non – Destructive Testing **7 Hours**

Fundamentals of NDT, Radiography, ultrasonic, magnetic particle inspection, Fluorescent penetrant technique, Eddy current testing, Acoustic Emission Technique

Total Number of Periods: 45

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.

Engineering and Technology

Rashtrasant Tukdoji Maharaj Nagpur University, Nagpur

Syllabus for B.E. (Eighth Semester) Aeronautical Engineering

Fatigue and Fracture (BEAE-805T)

(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**
Duration of University Exam: 03 Hours

Unit I: Fatigue of Materials **8 Hours**

S.N. Curves - Endurance limit - Effect of mean stress, Goodman, Gerber and Sodeberg relations and diagrams - Notches and stress concentrations -Neuber's stress concentration factors - Plastic stress concentration factors - Notched S.N. curves

Unit II: Statistical Aspects of Fatigue Behavior **8 Hours**

Low cycle and high cycle fatigue - Coffin - Manson's relation - Transition life - Cyclic strain hardening and softening - Analysis of load histories - Cycle counting techniques - Cumulative damage - Miner's theory – Rainflow counting technique.

Unit III: Physical Aspects of Fatigue **7 Hours**

Phases in fatigue life - Crack initiation - Crack growth - Final fracture -Dislocations - Fatigue fracture surfaces

Unit IV: Fracture Mechanics **10 Hours**

Strength of cracked bodies - Potential energy and surface energy - Griffith's theory - Irwin - Orwin extension of Griffith's theory to ductile materials - Stress analysis of cracked bodies - Effect of thickness on fracture toughness - Stress intensity factors for typical geometries.

Unit V: Fatigue Design and Testing **6 Hours**

Safe Life and Fail safe design philosophies, Importance of Fracture Mechanics in aerospace structure - Application to aircraft materials and structures.

Unit VI: Case Studies **6 Hours**

Case studies to be discussed regarding fatigue and fracture induced in all components of propulsion system, Aircraft structure, Landing Gear.

REFERENCES:

1. Barrois, W., and Ripley, E.L., "Fatigue of Aircraft Structures", Pergamon Press, Oxford, 1983.
2. Sih, C.G., "Mechanics of Fracture", Vol.1 Sijthoff and Noordhoff International

Publishing Co., Netherlands, 1989.
3. Knott, J.F., "Fundamentals of Fracture Mechanics", Butterworth & Co., (Publishers) Ltd., London, 1983.

Engineering and Technology

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Syllabus for B.E. (Eighth Semester) Aeronautical Engineering

Computational Fluid Dynamics (BEAE-805T)

(Total Credits: 05)

Teaching Scheme
Lectures: 4 Hours/ Week
Tutorial: 1 Hours / Week
Duration of University Exam: 03 Hours

Examination Scheme
Theory
T (U): 80 Marks **T (I): 20 Marks**

Unit- I **7 Hours**

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.

Unit- II **7 Hours**

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.

Unit- III **8 Hours**

Application of Finite Difference method to 1D & 2D steady and unsteady conduction problems. Central and backward difference schemes. Explicit & Implicit schemes, Crank-Nicholson scheme.

Unit- IV **7 Hours**

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.

Unit-V **8 Hours**

Conduction and convection problems. Navier Stokes equations. Application to incompressible flow. Pressure correction scheme, staggered grid, SIMPLE and SIMPLER schemes.

Unit-VI **8 Hours**

Finite Volume method for compressible flow. Schemes like Jameson, MacCormack. Acceleration devices, Grid independent studies, Grid Generation

Total No of periods: 45

PRACTICAL:

Based on above syllabus minimum eight practical to be performed

REFERENCES:

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

Engineering and Technology

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Syllabus for B.E. (Eighth Semester) Aeronautical Engineering

Project Work Phase- II
(BEAE-806P)
(Total Credits: 05)

Teaching Scheme	Examination Scheme
Practical: 5 Hours/ Week	Practical
	T (U): 75 Marks T (I): 75 Marks

OBJECTIVE

This should be the extension of the partial work already done in Phase-I in earlier semester