### COMPULSORY TO ALL BRANCH 14PHDRM: RESEARCH METHODOLOGY

### Module 1:

Meaning, Objectives and Characteristics of research - Research methods Vs Methodology -Types of research - Descriptive Vs. Analytical, Applied Vs. Fundamental, Quantitative Vs. Qualitative, Conceptual Vs. Empirical - Research process - Criteria of good research -Developing a research plan.

### Module 2:

Defining the research problem - Selecting the problem - Necessity of defining the problem - Techniques involved in defining the problem - Importance of literature review in defining a problem - Survey of literature - Primary and secondary sources - Reviews, treatise, monographs-patents - web as a source - searching the web - Identifying gap areas from literature review - Development of working hypothesis.

### Module 3:

Research design and methods – Research design – Basic Principles- Need of research design — Features of good design – Important concepts relating to research design – Observation and Facts, Laws and Theories, Prediction and explanation, Induction, Deduction, Development of Models - Developing a research plan - Exploration, Description, Diagnosis, and Experimentation - Determining experimental and sample designs.

### Module 4:

Sampling design - Steps in sampling design - Characteristics of a good sample design - Types of sample designs - Measurement and scaling techniques - Methods of data collection - Collection of primary data - Data collection instruments

### Module 5:

Testing of hypotheses - Basic concepts - Procedure for hypotheses testing flow diagram for hypotheses testing - Data analysis with Statistical Packages – Correlation and Regression - Important parametric test - Chi-square test - Analysis of variance and Covariance

### Module 6:

IPRs- Invention and Creativity- Intellectual Property-Importance and Protection of Intellectual Property Rights (IPRs)- A brief summary of: Patents, Copyrights, Trademarks, Industrial

Designs- Integrated Circuits-Geographical Indications-Establishment of WIPO-Application and Procedures.

### Module 7:

Interpretation and report writing - Techniques of interpretation - Structure and components of scientific reports - Different steps in the preparation - Layout, structure and language of the report - Illustrations and tables - Types of report - Technical reports and thesis

### **REFERENCES:**

- 1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers.
- 2. Kothari, C.R., 1990. Research Methodology: Methods and Techniques. New Age International. 418p.
- 3. Anderson, T. W., An Introduction to Multivariate Statistical Analysis, Wiley Eastern Pvt., Ltd., New Delhi
- 4. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes.
- 5. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
- 6. Day, R.A., 1992. How to Write and Publish a Scientific Paper, Cambridge University Press.
- 7. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
- 8. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.
- 9. Intellectual Property Rights in the Global Economy: Keith Eugene Maskus, Institute for International Economics, Washington, DC, 2000
- 10. Subbarau NR-Handbook on Intellectual Property Law and Practice-S Viswanathan Printers and Publishing Private Limited.1998

# Mechanical Engineering (IP/IEM/Auto/ME and Other allied branches )

Sl.No	Subject Code	Name of the Subject
1	14PHDME001	Advanced Manufacturing Technology
2	14PHDME002	Advanced Materials and Processing
3	14PHDME003	Elements of Machine Design
4	14PHDME004	Elements of Thermal Sciences and Engineering
5	14PHDME005	Newer Joining and Metal Removal Processes
6	14PHDME006	Testing of Materials, Surface Treatment and finishing
7	14PHDAU001	Thermal Stream
8	14PHDAU002	Design Stream
9	14PHDAU003	Manufacturing Stream
10	14PHDAE001	Aerodynamics and Propulsion
11	14PHDAE002	Computational Fluid Dynamics, Combustion and
		Heat Transfer
12	14PHDAE003	Flight Dynamics and Control
13	14PHDAE004	Structural dynamics and Aero-elasticity
14	14PHDAE005	Aerospace Materials and Processes
15	14PHDAE006	Aerospace Structures and Structural Design
16	14PHDIEM001	Operations Management
17	14PHDIEM002	Total Quality Management
18	14PHDIEM003	Project Management
19	14PHDIEM004	Advanced Manufacturing Practice
20	14PHDIEM005	Supply Chain Management
21	14PHDIEM006	Human Resource Management
22	Compulsory	Research Methodology

# 14PHDME001: Advanced Manufacturing Technology

**1.Agile Manufacturing:** Definition, business need, conceptual frame work, characteristics, generic features. Four Core concepts: Strategy driven approach-integrating organization, people technology, interdisciplinary design methodology.

Developing Agile Manufacturing:Enterprise design, System concepts as the basic manufacturing theory-joint technical & Organizational design and a model for the design of agile manufacturing enterprise. Enterprise design process insights into design processes, what is interdisciplinary design, main issues, simple design example.

**2.Production Development Through CIM** : Computers in Industrial manufacturing, Product cycle & Production development cycle, Introduction of CAD/CAM & CIM, sequential and concurrent engineering, soft and hard prototyping.

Computer Integrated Manufacturing and Automation:Fundamentals of CAD/CAM, Computerized Manufacturing planning systems, shop floor control & automatic identification techniques. Computer Network for manufacturing and the future automated factory.

**3.** NC/ CNC Machine Tools: General architecture of CNC Machine, Components of the CNC Systems: Machine Control Unit, CNC Driving system components: Hydraulic, Servo Motors, Stepper Motors, Feedback Devices: Encoder, Resolver, Inductosyn, Tachometers, Counting devices, Digital to analog converters.

Constructional Features of CNC Machines:Design considerations of CNC machines for improving machining accuracy, Structural Members, Slide ways, bearings, Re-circulating ball Screws, Spindle drives, Work holding devices and tool holding devices, Automatic tool changers: Principles of Operation, Machining Centres, Tooling for CNC machines

**4.Computer Controls in NC**: CNC Technology: Functions of CNC Control in Machine Tools, Advantages of CNC, Direct Numerical Control(DNC Systems): Configuration of DNC system, , Functions of DNC, Communication between DNC computer & MCU, Advantages of DNC, Adaptive control machining systems. Adaptive control optimization system, adaptive control constraint system, applications to machining processes, Benefits of Adaptive control machining. **14 Hours** 

**Industrial Robotics** : Robotics technology : Types of Robots, Robot Technology Levels, Robot geometric configurations and Technical Features, basic robot motions, Robot control systems, robot drive systems, Work-cell control and Interlocks, robot sensors, robot safety, robot-computer interface, industrial robot applications and benefits, robot programming and programming languages. **06 Hours** 

**4.Rapid Prototyping:** Introduction, Definition of Prototype, Types of prototype, Need for the compression in product development, History of RP systems, Survey of applications, Growth of RP industry, classification of RP systems.

Stereo lithography Systems: Principle, Process parameter, process details, Data preparation, data files and machine details, Application.

**Selective Laser Sintering:** Type of machine, Principle of operation, process parameters, Data preparation for SLS, Applications, Fusion Deposition Modeling: Principle, Process parameter, Path generation, Applications.

**5.Definition of an FMS** – Types & configurations concepts – Types of flexibility & performance measures. Function of FMS host computer, FMS host and area controller function distribution.

Development and implementation of an FMS:Planning phase, Integration, System configuration, FMS layouts, Simulation, FMS Project development steps. Project management, Equipment development, Host system development, planning, Hardware & Software development.

Automated Material Handling Systems: Functions, Types, Analysis of material handling equipments, Design of Conveyor & AGV systems. Benefits of Automated material handling systems. Problems.

Automated Storages Systems:Storage system performance, AS/RS, Carousel storage system, WIP storage system, Interfacing handling storage with manufacturing, Problems.

### **Reference Books:**

- 1. Agile Manufacturing Forging Mew Frontiers', Poul T Kidd, Amagow Co. UK, ISBN-0-201-63163-6, 1994.
- 2. M. P. Grover, Automation, Production Systems & Computer Aided manufacturing, Prentice Hall.
- 3. Paul F. Jacobs: "Stereo 1ithography and other RP & M Technologies"-SME NY, 1996.
- 4. Flham D.T & Dinjoy S.S "Rapid Manufacturing"- Verlog London 2001.
- 5. Flexible manufacturing Parrish D J, Butter Worth Heinemann, Ltd Oxford, 1993.
- 6. Production Systems and Computer Integrated Manufacturing GROOVER M P, Automation, Prentice Hall India (P) Ltd, 1989.
- 7. Mikell P. Groover and Emory W. Zimmer, Jr., CAD/CAM Computer Aided Design and Manufacturing, Prentice Hall India (P) Ltd, 1992. (unit 1)
- 8. M.Koren Computer Controls of Manufacturing Systems, McGrawHill, 1983

## 14PHDME002: ADVANCED MATERIALS AND PROCESSING

**1.Classification and Characteristics:** Metals, Non ferrous Metals and Ferrous Metals, classification of Ferrous Metals and Non Ferrous Metals, Types of Ceramics, Polymers and composites and classification of composites.

**General Properties and Structure:** Atoms, molecules bonds in solids,Crystalline - Defects in Metallic structure, Dislocations and plastic deformation - Strengthening mechanism - grain size, dislocation - Cold work, precipitation hardening, dispersion hardening - phase reactions, fatigue and Creep behaviour.

**2.Ferrous Alloys: iron carbon equilibrium diagrams -** Steels and cast irons - properties, structure, composition and applications transformation hardeninging steels - TIT diagrams - Heat treatment processes - Effect of alloying elements - High alloy steels, Stainless steel types, tool Steels, Manganese steels, heat resistant steels, HSLA, Managing steels.

**Non Ferrous Alloys:** Alloys of copper, Aluminium, nickel, magnesium, titanium, lead, tin, Zinc - composition, heat treatment, structure, properties and application.

**3.Polymers and Polymerizations:** Structure and properties of thermoplastics and thermo sets – characteristics and Engineering Applications - property modifications - Mechanical and thermal behaviour – processing methods for polymer materials.

**4.Ceramics:**Nature and structure of Ceramics - Refractory –clay products-Abrasives glasses - glass ceramics –cements- Advanced ceramics - Engineering Applications- processing methods for ceramic materials.

**5.Composites** : Definition - classification and characteristics of composite materials - Volume fraction - laminated composites particulate composites, fibrous composites - Types of reinforcements, their shape and size – production/processing and properties of fiber reinforced plastics, Metal Matrix composites and ceramic matrix composites –Engineering Applications.

### **REFERENCE BOOKS:**

1. Engineering Metallurgy - Raymond A Higgins - ELBS/EA

**2.** Introduction to Material Science and EngineeringJames.F.Shackleford - Mc Millan, NY -  $7^{\text{th}}$  edition.

**3.** Material science and metallurgy – by William D Callister, John Willey & Sons.(Eight edition)

- 4. Powder Metallurgy-Metals Hand Book ASM, USA Vol.7,1974.
- 5. Composite Materials Science and Engineering Chawla K.K., -Springer Verlag, Newyork 2<sup>nd</sup> edition, 1998.
- 6. Cast Metal Matrix Composites ASM Metals Hand Book P.K.Rohagti VI5.
- 7. Elements of Material Science and Engineering Van Vlack L.H.- Addison Wesley, NY 1989.

## 14PHDME003: Elements of Machine Design

### 1. Elasticity

Definition and Notation for forces and stresses. Components of stresses, Equations of Equilibrium, Specification of stress at a point. Stress invariants, Principal stresses and shear stresses and Mohr's diagram in three dimensions. Octahedral stresses, Decomposition of state of stress, Deviatoric & Spherical stress, Deformation, Strain Displacement relations, Strain components, State of strain at a point, Principal strain, Strain transformation, Compatibility equations, Cubical dilatation, Generalized Hooke's law in terms of engineering constants

## 2. Vibration

Basic concepts, Free vibration of single degree of freedom systems with and without damping, forced vibration of single DOF-systems, Natural frequency., Transient Vibration of single Degree-of freedom systems, Impulse excitation, Arbitrary excitation, Laplace transform formulation, Pulse excitation and rise time, Shock response spectrum, Shock isolation

### 3. Fatigue & Failure

High cycle and low cycle fatigue, Fatigue design models, Fatigue testing, Fatigue mechanisms, General S-N behavior, Factors influencing S-N behaviour, S-N curve representation and approximations, Constant life diagrams, Fatigue life estimation using S-N approach, Modes of mechanical failure, Review of failure theories for ductile and brittle materials including Mohr's theory and modified Mohr's theory, Yield surface for Isotropic materials

### 4. Fracture Mechanics

Fracture mechanics principles: Introduction and historical review, Sources of micro and macro cracks, Griffith's energy balance approach. Fracture mechanics approach to design. NDT and Various NDT methods used in fracture mechanics, Numerical problems, The Fracture Mechanics Approach to Design, Energy Criterion, Stress-Intensity Approach, Crack Growth and Damage Tolerance, Effect of Material Properties on Fracture, LEFM, Griffith Energy Balance, Energy Release Rate, R-Curve, Stress Intensity Factor, Crack tip plasticity, Mixed mode fracture

### 5. Plasticity

Plastic Stress-strain relations, St. Venant, von Mises, Prandtl-Roeuss equation, Isotropic and kinematic hardening, bilinear stress-strain relationship, power law hardening, Stages of plastic yielding- Incipient, elasto-plastic, fully plastic yielding, Application of plasticity to problems: Bending of beams, Torsion of rods

### **Reference Books**

- 1. Advanced Mechanics of Solids, L. S. Srinath, Tata McGraw Hill, 2009.
- 2. Applied Elasticity, T. G. Sitharam, Interline Publishing, 2004.
- 3. Mechanical Vibrations, S. S. Rao, Pearson Education, 4th edition, 2004.
- 4. Metal Fatigue in Engineering, Ralph Stephens, Ali Fatemi, Robert Stephens, Henry Fuchs, John Wiley, Second edition. 2001.
- 5. Fracture Mechanics-Fundamentals and Application Anderson T. L., CRC Press, 3rd Edition 2005.
- 6. Theory of Plasticity and Metal forming Process, Sadhu Singh, Khanna Publishers, 3 ed, 2013.

## 14PHDME004: Elements of Thermal Sciences and Engineering

**1. Thermodynamics:** Work and heat interaction, first law of thermodynamics, steady and unsteady flows with energy transaction. Second law of thermodynamics, reversibility, PMM-I, PMM-II. Available energy, availability analysis of open and closed systems. Properties of pure substances, properties of gases and gas mixtures, combined first and second laws of thermodynamics. Maxwell relations.

**Introduction and one-dimensional heat transfer:** The modes of heat transfer, the laws of heat transfer, problems Heat conduction in solids: Simple steady state problems in heat conduction, concept of thermal resistance, the critical radius problem, the differential equation of heat conduction, heat generation, two dimensional steady state heat conduction, unsteady state processes, extended surfaces- fins, other techniques for solving heat conduction problems, the finite difference method for steady state situations, the finite difference method for steady state situations, the finite difference method for steady state situations, the finite difference method for unsteady state situations, problems.

**2.Kinematics of Fluids**- Fluid properties, Methods of describing fluid motion - Lagrangian method, Eulerian method; translation, rotation and rate of deformation; stream lines, path lines and streak line; material derivative and acceleration; vorticity.

**Computational Fluid Dynamics:** Basic Concepts - Dimensionless form of equations; Simplified mathematical models; Hyperbolic, Parabolic & Elliptic systems. Properties of numerical solutions (Consistency, Stability, Conservation, Convergence and Accuracy) Finite Difference Methods - Discretisation; Boundary conditions; error propagation; Introduction to spectral methods; examples. Finite volume method - Surface & volume integrals; Interpolation & differentiation; Boundary conditions; Examples

**3.Internal Combustion Engines:** Ideal Cycle analysis, Fuel-air cycle analysis. Combustion in IC Engines: Combustion in SI Engines, Combustion in CI engines, Ignition delay period, factors affecting delay period, Knock in CI engines. Air pollution due to IC engines, Euro norms, Emission control methods – thermal converters, catalytic converters, particulate traps, Ammonia injection systems, exhaust gas recirculation.

Alternate fuels for I.C engines: Availability and Suitability and properties of Potential Alternative Fuels – Ethanol, Methanol, DEE, DME, Hydrogen, LPG, Natural Gas, Producer Gas, Bio gas and Bio- diesel, Properties, Merits and Demerits. Emission characteristics.

**4.Refrigeration System:** Types of refrigerants, their properties, Components of Refrigeration system, Tonne of Refrigeration, Various methods of Refrigeration- Vapour Compression Refrigeration system, Vapour Absorption Refrigeration system, Steam jet Refrigeration system, Dry ice refrigeration, Thermoelectric refrigeration, Vortex refrigeration. Working cycle representation, Expression for C.O.P.

**Psychometry:**Psychometry and psychometric properties. Relations, psychometric chart, psychometric processes. Requirements of comfort air conditioning, comfort chart, Design consideration. Summer air conditioning system, winter air conditioning.

**5.Turbo Machinery:** Introduction to turbo machines. Transfer of energy to fluids. Performance characteristics. Fan laws. Dimensionless parameters. Specific speed. Selection of centrifugal, axial, mixed flow, Axial flow machines.

**Steam cycles:** Carnot Cycle, **r**ankine cycle, thermal efficiency of steam power plant. Reheating of steam. Regeneration, regenerative feed water heating, feed water heaters. Layout of steam power plant. Numerical Problems.

### **Reference Books:**

- 1. Bejan, A., Advanced Engineering Thermodynamics, John Wiley and Cons, 2004,
- 2. Nag.P.K, Heat Transfer, Tata McGraw-Hill, 2002,
- 3. Bansal, R.K., Fluid Mechanics, Saurabh and Co., New Delhi, 1985,
- 4. Muralidhar, K., and Sundararajan, T., "Computational Fluid Flow and Heat Transfer", Narosa Publishing House, New Delhi, 1995.
- 5. Dr. V. Ganesan, "Internal Combustion Engines", Tata McGraw-Hil, 1995,
- 6. Dr.S.S.Thipse, "Alternate Fuels for IC Engines", Jaico Publishing house, 2010,
- 7. Arora and Domkundawar, A Course in refrigeration and Air- Conditioning Danpat Rai & Co Publications, 2001
- **8.** V. Kadambi and Manohar Prasad, An Introduction to Energy Conversion, Volume III, Turbo machinery, New Age International Publishers, reprint 2008.
- 9. Holman, J.P., Thermodynamics, Fourth Edition, McGraw Hill Inc., 2006,
- **10.** Kumar, K.L., Engineering Fluid Mechanics, Eurasia Publishing House, New Delhi, 2002,
- 11. Ozisik. M.N., Heat Transfer A Basic Approach, McGraw-Hill Co., 1985,
- 12. Turbines, Compressors & Fans, S. M. Yahya, Tata McGraw Hill Co. Ltd., 2nd edition, 2002,
- **13.** Stoecker W.F., Refrigeration and Air conditioning, McGraw-Hill Book Company, 1989.
- 14. John B. Heywood, "IC Engines fundamentals", McGraw-Hill Publications, 2012,
- **15.** Ghoshdasdidar, P.S., "Computer Simulation of flow and heat transfer" Tata McGraw Hill Publishing Company Ltd., 1998,
- **16.** Subas, V.Patankar "Numerical heat transfer fluid flow",Hemisphere Publishing Corporation, 1980.

## 14PHDME005: Newer Joining and Metal Removal Processes

**1.Welding Symbols**- Need for representing the welds, Basic weld symbols, Location of Weld, Supplementary symbols, Dimensions of welds, Examples.

Distortion, methods to avoid distortion, Stresses in Joint Design, Welding and Cladding of dissimilar materials, overlaying and surfacing.

**Welding Design** - Introduction, Principles of sound welding design, Welding joint design. Welding positions, Allowable strengths of welds under steady loads, allowable fatigue strength, design of welds subjected to combined stresses, weld throat thickness, Numerical problems on welds under steady and combined loads.

**Computer–Aided Welding Design:** welding analysis, Engineering design vs welding design, perspectives in welding design, solution to welding design problem, Computer–Aided Welding Analysis(CAWA), Computer–Aided Welding Design(CAWD), use of interactive computer graphics.

### 2. Advanced Joining Methods:

Explosion Welding, Diffusion Welding, Ultrasonic Welding, Friction welding, Electron Beam Welding, Electro Slag Welding, Laser Beam Welding, Plasma arc Welding and Thermit welding: (Principle, Equipment, Advantages, limitations & applications of each method).

Welding Automation: Concept, Operations and structure analysis, classification of welding automation, machine and automatic welding, flexible automated welding, economics of welding automation.

#### **Inspection of Welds and Quality Control:**

Destructive Tests, Non Destructive techniques like 'X' rays, Ultrasonic, Magnetic particle, Dye penetrant, Gamma ray inspection.

**Quality Control in Welding** - Introduction, Quality assurance v/s Quality control, Weld quality, Discontinuities in welds, their causes and remedies and Quality conflicts .

**3. Thermal Metal Removal Processes:** Electric discharge machining, Principle of operation, mechanism of metal removal, basic EDM circuitry, spark erosion generators, Analysis of relaxation type of circuit, material, removal rate in relaxation circuits, critical resistance parameters in Ro Circuit, Die electric fluids, Electrodes for spark erosion- surface finish, applications.

**Electro Chemical machining (ECM)**: Classification of ECM process, Principle of ECM, Chemistry of the ECM process, parameters of the process, Determination of the metal removal rate, dynamics of ECM process, Hydrodynamics of ECM process, polarization, Tool Design, advantages and disadvantages-applications. Electro Chemical grinding, Electro Chemical honning, Electrochemical deburring.

### **14 Hours**

**4. Chemical Machining:** Introduction, fundamental principle types of chemical machining, Maskants, Etchants, Advantages and disadvantages, applications, chemical blanking,

chemical milling (contour machining), Hydrogen embrittlement.

**Plasma arc Machining:** Introduction, Plasma, Generation of Plasma and equipment, Mechanism of metals removal, PAM parameters, process characteristics, types of torches, applications.

**Electron beam machining(EBM):** Introduction, Equipment for production of Electron beam, Theory of electron beam machining, Thermal & Non thermal type, Process characteristics, applications.

**5. Laser Beam Machining:** Introduction, principles of generation of lasers, Equipment and Machining Procedure, Types of Lasers, Process characteristics, advantages and limitations, applications of laser beam machining.  $CO_2$  Laser: Principle, Equipment, Applications. **Ion Beam Machining:** principle, equipment, working, sputtering rate, applications.

**High Velocity forming processes:** Introduction, development of specific process, selection, comparison of conventional and high velocity forming methods.

Types of high velocity forming methods: explosion forming process, electro-hydraulics forming, magnetic pulse forming. Applications, Advantages and limitations.

### **Reference Books:**

- 1. Modern Machining Process -P.C Pandy & H.S Shan Tata Mc Graw Hill.
- 2. Thermal Metal Cutting Processes-Dr.B.J.Ranganath, I K International, New Delhi.
- 3. Welding Technology by O. P. Khanna, Dhanppat Rai publications.
- 4. Welding Engineering Handbook by American Welding Society (AWS)
- 5. Advanced Welding processes Nikodaco & Shansky MIR Publications.

## 14PHDME006: TESTING OF MATERIALS, SURFACE TREATMENT AND FINISHING

**1. Testing machines and sensors**: types of Universal Testing machines and principles of operations, Machine stiffness, load and strain measurement. Calibration and verification of UTM.

**Friction, wear and surface testing:** Testing of sliding contact, damage, abrasive wear, adhesive wear, erosive wear. Testing and determination of surface characteristics of solid materials.(Surface roughness measurements)

**Importance of calibration of Testing Instruments:** Calibration methods and standards .Tests / experiments based on methods with active reference to various codes and standard for each test.

2. Failure Analysis: Principles and Approaches of Failure analysis, objectives, scope, planning, preparation. Failure Analysis procedures. examination of damages and materials evaluation. Tools and Techniques in FA – An overview. Appearances of fracture in common conditions like unit axial loads, tensional and shear loads, fatigue and creep loading.

**Microscopy :** Optical microscope, scanning electron microscope. Preparation of Specimens for microscopic study.

**Speed & Control of Testing** Background, Developments in testing Machine Technology, Effects of testing rates on properties ,Results before servo control ,Results from servo controlled machines.

**3. Strain Rate Testing** Aim of Recommendations ,Abbreviations and Symbols ,Test Machine Requirements ,Specimens Measurements , Data Processing , General Definitions Strength Hardening Constitutive Relations to Model Material Strain Rate Dependency.

**Lubrication & Determination of characteristics of lubricants:** Introduction, Types of lubricants, characteristics of lubricants Methods of lubrication, four ball testing.

4. Fundamentalsof Electroplating, galvanizing, Hot dip metal coating, thin coating, thin coating, chromiumplating, Nickel plating. Vacuum coating, FVD & CVD metal spraying - Methods, surface preparation, mechanical. Properties of sprayed metals: Various types and plasma coating.

**Plasticcoatingofmetal**-PVCcoatingSpherodisingprocessdetails,phosphatecoating-mechanismof formation.Testingof surfacecoating- Various methods used.

5. Heattreatmentmethods, Aneleaing, Normalizing, Tempering, Casehardeningmethods, flamehardening sub zerotreatment.Heattreatmentmethodsforgears,spindles,cuttingtools.Advancedcoatingte chnologies:Hardfacing,electrodepositiontechnique,nanocoatings,coating characterization

### **REFERENCEBOOKS:**

- 1. Surfacepreparations&finishesforMetals-JamesAMurphy-McGrawHill.
- Principlesofmetalsurfacetreatmentandprotection-PergamonPressGabe,DavidRussell-Description,Oxford;NewYork-2ded.,1978.
  Handbookofmetaltreatmentandtesting-Johnwiley& sons.
- 4. HeatTreatmentofMetals–Zakrov-MIRPublications.
- 5. MetalsHandBook-ASM.
- 6. Testing of Metallic Materials A.V.K. Suryanarayan, Prentice Hall of India.
- 7. ASM Vol Testing of materials
- 8. Inspection of Materials, Vol. II Destructive Methods, R.C. Andersen, ASM 1988.
- 9. Workability Testing Techniques, G.E. Dieter, ASM 1984.

## 14PHDAU001: Thermal Stream

### 1. Advanced Heat & Mass Transfer

Conduction Equation Derivation, internal energy generation, Extended Surfaces, (Fins), 2D Conduction – Laplace's equation, Separation of Variables, Numerical (finite difference) techniques, Transient Conduction – lumped capacitance model, Transient Conduction – Numerical solutions, Heisler Charts and semi-analytical solutions, Boundary Layer Equations, Flat Plate Solution, External Flow, Internal Flow, Natural Convection, Heat Exchangers, Boiling & Condensation HT, Radiation, Spectral Directional Intensity, Directional Behavior, Non-gray surface Properties, Band Emission/Absorption, Heat transfer in combustion processes, Specular Surfaces, Gas Radiation – optically thin assumption, Gas Radiation – path line method, discrete ordinates method, CFD Demo on Fluent, Mass Transfer – Diffusion, Mass Transfer with evaporation

### **Textbooks:**

- A. F. Mills, Heat and Mass Transfer, 2<sup>nd</sup> edition, Prentice-Hall, 1999
- B. Incropera and DeWitt, "Fundamentals of Heat and Mass Transfer,", Fifth Edition, Wiley

### **Reference Books:**

- C. Heat Transfer A Basic Approach Ozisik M.N., McGraw-Hill Publications, 1985.
- D. Heat Transfer Holmon J.P., McGraw-Hill Publications, 2002.
- E. Principles of Heat Transfer Frank Kreith & M. S. Bohn, Thomson Publications, 2001.

### 2. Computational Fluid Dynamics

**INTRODUCTION:** Finite difference method, finite volume method, finite element method, governing equations and boundary conditions, Derivation of finite difference equations.

**Solution methods:** Solution methods of elliptical equations — finite difference formulations, interactive solution methods, direct method with Gaussian elimination. Parabolic equations-explicit schemes and Von Neumann stability analysis, implicit schemes, alternating direction implicit schemes, approximate factorization, fractional step methods, direct method with tri-diagonal matrix algorithm.

Hyperbolic equations: explicit schemes and Von Neumann stability analysis, implicit schemes, multi step methods, nonlinear problems, second order one-dimensional wave equations. Burgers equations: Explicit and implicit schemes, Runge-Kutta method.

**FORMULATIONS OF INCOMPRESSIBLE VISCOUS FLOWS:** Formulations of incompressible viscous flows by finite difference methods, pressure correction

methods, vortex methods.

**Treatment of compressible flows:** potential equation, Euler equations, Navier-stokes system of equations, flow field-dependent variation methods, boundary conditions, example problems.

**FINITE VOLUME METHOD**: Finite volume method via finite difference method, formulations for two and three-dimensional problems.

**STANDARD VARIATIONAL METHODS:** Linear fluid flow problems, steady state problems, Transient problems.

### **REFERENCES:**

- A. Computational fluid dynamics/ T. J.C'hung/ Cambridge University press,2002.
- B. Text book of fluid dynamics/ Frank Choriton/ CBS Publishers & distributors, 1985
- C. Numerical heat transfer and fluid flow / Suhas V. Patankar/ Hema shava Publishers corporation & Mc Graw Hill.
- D. Computational Fluid Flow and Heat Transfer/ Muralidaran/ Narosa Publications
- E. Computational Fluid Dynamics: Basics with applications/John D. Anderson/ Mc Graw Hill.
- F. Fundamentals of Computational Fluid Dynamics/Tapan K. Sengupta / Universities Press.
- G. Introduction to Theoretical and Computational Fluid Dynamics/C. Pozrikidis /Oxford University Press/2nd Edition

# 14PHDAU002: Design Stream

### 1. Advanced Theory of Vibrations

**Single degree of freedom systems, two degree of freedom systems:** spring coupled, mass coupled, vibration absorbers, and vibration isolation.

**Multi degree of freedom systems:** Lagrange's equation, close couples and far coupled systems, dunker ley's approximation method, rayleigh method, matrix method, matrix iteration, orthogonality principle, orthogonality, expansion theorem and modal analysis, stodola method, holzer method, galerkin method, rayleigh- ritz method, myklested – prohl method for far coupled systems, transfer matrix method

**Experimental methods in vibration analysis:** vibration instruments, vibration exciters, transducers and measurement devices, analyzers, vibration tests:- free and forced vibration tests.

**Vibration of continuous systems:** Transverse, flexural, torsional vibration of beams, timoshenko beam, Hamilton principle, vibration of plates, collocation method, myklested – prohl method.

**Transient vibrations:** Duhamel's integral, method of step input, phase plane method, method of laplace transformation, drop test spectra by laplace transformations.

**Non linear vibrations:** Non-linear vibrations and superposition principle, examples of non linear vibrations, method of dealing with non linear vibrations, phase plane trajectories, method of direct integration, perturbation method, iteration method, Fourier series.

### **Reference books:**

1. Theory of vibration with applications:- W. T. Thomson (PHI)

2. Theory and practice of mechanical vibrations:- J. S. Rao & K. Gupta (Wiley eastern)

- 3. Mechanical vibration :- S. S. Rao (Addison Wesley)
- 4. Vibration and noise for Engineers :- Kewal Pujara (Dhanpat Rai and Co.)
- 5. Mechanical vibrations :- G. K. Grover and Nigam (Nem chand and sons)
- 6. An introduction to mechanical vibrations :- Steidel (John Wiley)
- 7. Elements of vibration analysis :- Meirovitch (TMH)

### 2. Acoustics, Noise and Control

Nature of sound , The wave equation , Plane waves and spherical waves, Impedance, power, intensity, directivity , Microphones, sound level meters, sound intensity probes, spectrum analyzers, Data processing: analog to digital conversion, FFT, windowing, sampling , Sound transmission and control , Human response to noise (OSHA standards), Room acoustics, Environmental noise, noise legislation

### Text book:

1. Colin Hansen, Noise Control, from Concept to Applications, Taylor and Francis, 2005.

### Reference book:

2. Lawrence E. Kinsler, Austin R. Frey, Alan B. Coppens, and James V. Sanders, *Fundamentals of Acoustics*, John Wiley & Sons, 1982.

# 14PHDAU003: Manufacturing Stream

1. Advanced Materials and Processing

### Introduction and classification of structural and functional materials;

**High Temperature Materials:** Structure, Processing, mechanical behaviour and oxidation resistance of Stainless Steels, Ni- and Co- Based Superalloys, Aluminides and Silicides, Carbon-Carbon and Ceramic Composites;

**Shape-Memory Alloys:** Mechanisms of One-way and Two-way Shape Memory Effect, Reverse Transformation, Thermoelasticity and Psuedoelasticity, Examples and Applications;Bulk

**Metallic Glass:** Criteria for glass formation and stability, Examples and mechanical behaviour; **Nano-materials:** Classification, size effect on structural and functional properties, Processing and properties of nanocrystalline materials, thin films and multilayered coatings, single walled and multiwalled carbon nanotubes; Soft and hard magnetic materials for storage devices: Design and Processing;

**Piezoelectric Materials:** Crystal structure and mechanism, converse piezoelectricity, constitutive equation, examples and applications;

Bio-materials: Materials Selection for specific applications, Processing and Properties;

Advanced Processes applied for Advanced Materials: Single Crystal Growth, Rapid Solidification, Physical and Chemical Vapour Deposition of Thin Films, Laser Processing Methods.

### **Text Books:**

**A**. G.W. Meetham and M.H. Van de Voorde: Materials for High Temperature Engineering

Applications, Springer, Berlin, 2000.

**B**. C. C. Koch (ed.): Nanostructured Materials â "Processing, Properties and Potential Applications, Noyes Publications, New York, 2001.

### 2. Mechatronics Product Design

Introduction to Mechatronics systems and components, Principles of basic electronics - Digital logic, number system logic gates, Sequence logic flip flop system, JK flip flop, D-flip flop.

Microprocessors and their applications - Microcomputer computer structure/rnicrocontrolles, Integrated circuits - signal conditioning processes, various types of amplifiers, low pass and high pass filters.

Sensors -sensors and transducers. Displacement, position proximity sensors, velocity, force sensors. Fluid pressure temperature, liquid level and light sensors. Selection of sensors.

Actuators, Pneumatic and hydraulic systems, Mechanical actuation system. Electrical actuation system. Other Electrical/Electronic hardware in Mechatronic system.

Principles of Electronic system communication, Interfacing, A.D. and D.A.converters. Software and hardware principles and tools to build mechatronic systems., Basic system models mathematical models, mechanical and other system Building blocks.

System models - Engg. Systems, rotational, translation, elected mechanical, Hydraulic mechanical system., System Transfer functions. First-second order system in series.

Design and selection of Mechatronics systems namely sensors line encoders and revolvers, stepper and servomotors Ball screws, solenoids, line actuators and controllers with application

to CNC system, robots, consumer electronics products etc, Design of a Mechatronic Product using available software CAD packages MATLAB and SIMULINK.

### **Reference Books:**

- 1. Mechatronics by W.Bolton, published by Addison Worley Longman Pvt. Ltd., India Brander, Delhi.
- 2. Automation Production System System and CIMS by Mikel P Grooer, Phentice Hall of India Pvt. Ltd, New Delhi.

## 14PHDAE001: Aerodynamics and Propulsion

### UNIT I

**Aerodynamics of airfoils and wings:** Airfoil nomenclature and classification, Low speed aerodynamic characteristics of symmetric and cambered airfoils, Centre of pressure, aerodynamic centre and aerodynamic moment, Concept of point vortex, line vortex and vortex sheet, Kutta condition, Kelvin circulation theorem and starting vortex, Classical thin airfoil theory and symmetric airfoil. Finite wing nomenclature. Incompressible flow over wing, vortex filament, bound vortex, horse shoe vortex, downwash, induce angle of attack and drag. Type of drag. Biot-Savart law and Helmholtzs vortex theorem. Prandtls lifting line theory and limitations. Elliptic lift distributions, expression for induced angle of attack and induce drag. Two dimensional and three dimensional wings lift curve slope and effect of aspect ratio. High lift devices.

### **UNIT II**

**High speed Aerodynamics:** Fundamentals of thermodynamic concepts, conservation of energy. Speed of sound, Mach wave and Mach angle. Normal shock wave, Oblique shock wave, Expansion fan, Prandtl-Meyer expansion. Family of shocks. Flow through convergent divergent nozzle. Hodograph and pressure turning angle. Rankine- Hugoniot relation.

### **UNIT III**

**Compressible flow over airfoil**: Full velocity potential equation. Small perturbation theory. Linearized velocity potential equation and boundary conditions. Pressure coefficient for small perturbation. Prandtl- Glauret compressibility correction. Critical Mach number, Drag Divergence Mach Number, Sound barrier. Transonic area rule, supercritical airfoil, swept wing and delta wing. Introduction to hypersonic aerodynamics.

#### **UNIT IV**

**JET PROPULSION CYCLES AND ANALYSIS:** Introduction, Prime movers, simple gas turbine, energy equation, Dimensional analysis of rotating machine, Ram jet engine, pulse jet engine, turboprop engine, turbojet engine, thrust and thrust equation, specific thrust of turbojet engine, efficiencies, parameters affecting performance, thrust augmentation, problems. **Ideal cycles and their analysis:** Introduction, assumptions, Brayton Cycle, reheat cycle, reheat and regenerator, inter cooled cycle with heat exchanger, inter cooled and reheat cycle, comparison of varies cycles. Ericsson cycle, compressor and turbine efficiency, performance of

comparison of varies cycles, Ericsson cycle, compressor and turbine efficiency, performance of actual cycle.

#### UNIT V

**Gas turbine engines:** turbojet, Turbofan, Turboprop, Turbo-shaft engine Construction and Nomenclature, theory and performance, dump diffusers for modern aircraft engines. Gas turbine engine fuel and fuel systems :Nomenclature, Operation and Control system. Description &Analysis of rotating components, Compressors, Turbines & matching. **Engine performance:** Design & off-design Performance. Transient performance. Qualitative characteristics quantities. Transient working lines .Starring process & Wind milling of Engines. Thrust engine start envelope. Calculations for design and off-design performance from given test data – (case study for a Jet Engine).

### **Text Books:**

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

**Gas turbines - V Ganesan** Tata McGraw-Hill Publishing company limited. **REFERENCE BOOKS:** 

Aircraft Gas Turbine Engine Technology, 3rd Edition - E. Irwin Treager, 1995 ISBN-002018281.

Aerodynamics for Engineering students: E L Houghton and P W Carpenter, Edward Arnold publication, 1993

**P.P Walsh and P. Fletcher**, Gas Turbine Performance, Blackwell Science, 1998, ISBN 0632047843.

### 14PHDAE002: Computational Fluid Dynamics, Combustion and Heat Transfer

### Unit-I

Introduction to Computational Fluid Dynamics (CFD) and modeling of flow; Summary of governing equations; Conservation form of equations; Well-posed and ill-posed problems. Discretization of the equations; Truncation and Round-off error; Explicit and Implicit approaches; Concepts of numerical or artificial viscosity; Different boundary conditions. Application of Finite Difference methods to wave equations, Laplace equations and Burgers equation; Stability considerations.

### Unit-II

Numerical methods for boundary layer type equations, Navier-Stokes equations; Outline of MAC and SIMPLE algorithms. Grid generation; Concepts of Finite volume methods. Solution of Flow with coupled heat transfer (forced and natural convection); Outline of Reactive flow (combustion) and multi-phase flow. Introduction of a commercial CFD package (FLUENT)

### Unit-III

Turbulent Combustion, Effect of turbulence on combustion, Velocity, time, and length scales, Energy and scalar spectrum, non-premixed flames, Flamelet concept and Damhohler number, Regime diagram of non-premixed turbulent flames Theory of probability density function (PDF), premixed flames, Modeling of turbulent flames, Direct Numerical simulations, RANS, LES, Models for turbulence-chemistry interactions.

### Unit -IV

Basic concepts. Fourier's law, Newton's law of cooling, Stefan-Boltzmann law. Conservation of energy, heat flux, boundary and initial conditions. One-dimensional steady-state conduction with and without heat generation; heat transfer from extended surfaces. Two and three dimensional steady-state conduction; numerical solutions. Transient conduction: lumped capacitance method; semi-infinite media. Fundamentals of thermal radiation: black and gray surfaces, surface properties.

#### Unit -V

Forced convection external flows: laminar and turbulent boundary layers on flat surfaces; heat transfer to cylinders, spheres, tube banks and packed beds; impinging jets. Forced convection internal flows: laminar and turbulent flow through circular and noncircular ducts, fully developed flow, hydrodynamically and thermally developing flows, Free convection boundary layer equations, Heat exchangers: overall heat transfer coefficient; cocurrent and countercurrent flow

#### **TEXT BOOKS:**

- 1. Computational Fluid Mechanics and Heat Transfer by D. A. Anderson, J. C. Tannehill and R. H. Pletcher.
- 2. Numerical Heat transfer and and Fluid Flow by S. V. Patankar
- 3. Heat transfer: a basic approach, Volume 1<u>Heat Transfer: A Basic Approach</u>, <u>M. Necati</u> <u>Öz1şık</u>, McGraw-Hill, 1985.

### **REFERENCE BOOKS:**

- 1. Computational Fluid Dynamics by P. J. Roache4. Computational Methods for Fluid Flow by R. Peyret and T. D. Taylor.
- 2. Fundamentals of Heat and Mass Transfer, By Frank P. Incropera, John Wiley & Sons, 7<sup>th</sup> Edition 2011

## 14PHDAE003: Flight Dynamics and Control

### Unit -I

Basic concepts of stability and control. Static longitudinal stability and control ,Equations of equilibrium and stability. Contributions of major components, Stick - fixed stability, Control, effectiveness, hinge moments and effect of freeing the stick. Control forces and gradients, Effect of manoeuvres, Critical conditions for longitudinal stability and control

### Unit-II

Static directional and lateral stability and control, Contributions of major components to directional stability and its desirable level, Directional control. Critical conditions for rudder design., Dihedral effect and contributions of major components to it. Lateral control. Design of control surfaces and aerodynamic balancing.

### Unit-III

Dynamic stability, Equations of motion of a disturbed airplane, stability derivatives, Characteristic equation for stick-fixed case.

#### **Unit-IV**

Modes of motion and simplification, Effect of freeing the stick, Characteristic equation for lateral and direction of dynamic stability, Spiral divergence and Dutch roll, Miscellaneous topics. Stability after stall. Response. Automatic control

#### Unit-V

Characteristic roots of a jet airplane, Longitudinal, Lateral and self-adaptive autopilots-General philosophy and orientational control systems, Non-linear Effects.

#### **TEXTBOOKS**

- 1. Nelson, R.C. "Flight stability and automatic control", McGraw Hill 2nd Edition 1998.
- 2. Perkins, C.D. & Hage, R.E., "Aircraft performance, stability and control", John Wiley 1949.
- 3. John H Blakelock, "Automatic control of Aircraft and Missiles", 2<sup>nd</sup> edition, John Wiley 2011.

#### REFERENCES

- 1. Houghton, E.L. & Carruthers, N.B., "Aerodynamics for Engineering students" Arnold 1982
- 2. McCormick, B.W. "Aerodynamics, aeronautics and flight mechanics", John Wiley 1995.
- 3. Pamadi, B. "Performance, stability, dynamics and control of airplanes", AIAA 2004.
- 4. Etkin , B. and Reid L.D. "Dynamics of Flight-Stability and Control" 3rd edition, John Wiley (1996).
- 5. Roskam, J. (a) "Methods for estimating drag polars of subsonic airplanes" and (b) "Methods for Estimating stability and control derivatives of conventional subsonic airplanes" published by author 1973.
- 6. Stengel, R.F. "Flight dynamics "Princeton University Press, Princeton , N.J., USA, 2004.

## **14PHDAE004: Structural Dynamics and Aero-elasticity**

### Unit-I

Introduction to Aircraft Structural Dynamics, Oscillatory Motion and Vibration Terminology, Undamped Single-Degree-of-Freedom System, Damped Single-Degree-of-Freedom System, Forced Response of Undamped Single-Degree-of-Freedom System, Forced Response of Damped Single-Degree-of-Freedom System

### Unit-II

Effect on the Support of a Vibrating Structure, Determination of Damping Ratio, Response to General Dynamic Loading-Impulsive Loading and Duhamel's Integral, Laplace Transformation, Numerical Methods Related to General Dynamic Loading, Introduction to Multi-Degree of Freedom System

### **Unit-III**

Forced harmonic Oscillation of Multi-Degree of Freedom System, Modal Response Analysis, Normal Mode Vibration of Continuous System - Vibrating String, Longitudinal Vibration of Rods, Torsional Vibration of Rods, Euler Equation of Beam, Approximate Methods Related to Structural Dynamic – Rayleigh Method, Rayleigh-Ritz Method, Galerkin's Method.

#### **Unit-IV**

Introduction Aero elastic Problems, Deformation of Structures and Influence Coefficients, Energy Method, Classification and Solution of Aero elastic Problems, Static Aero elasticity, Divergence of 2-D airfoil and Straight Wing, Aileron Reversal, Control Effectiveness, Wing loading and deformations, Swept Wing.

#### Unit-V

Dynamic Aero elasticity, Dynamic/Flutter model of 2-D Airfoil, Unsteady Aerodynamics,2-D and 3-D Supersonic flow, Subsonic flow (Kernal Function Approach), Theodorsen Theory, Finite State Model, Flutter Calculation, U-g Method, P-k Method. Exact Treatment of Bending - Torsion Flutter of Uniform Wing, Flutter Analysis by Assumed Mode Method, Panel Flutter.

#### **TEXT BOOKS:**

- 1. W. T. Thomson, "Theory of Vibration with Applications", CBS Publishers & Distributors.
- 2. Leonard Meirovitch, "Elements of Vibration Analysis", Tata McGraw-Hill Publishing Company Limited.
- 3. E.H. Dowell et.al., "A Modern Course in Aero elasticity", Sijthoff & Noordhoff, 1980.
- 4. R.L. Bisplinghoff, H. Ashley and R.L. Halfman, "Aero elasticity", Addison-Wesley, 1955.

### **REFERENCE BOOKS:**

- 1. Roy R. Craig, Jr., "Structural Dynamics-An introduction to Computer Methods", John Wiley & Sons.
- 2. Mario Paz, "Structural Dynamics-Theory and Computation", CBS Publishers & Distributors.
- 3. D.H. Hodges and G.A. Pierce, "Introduction to Structural Dynamics and Aeroelasticity" Cambridge Aerospace Series, 2002.
- 4. V.V. Bolotin, "Nonconservative Problems of the Elastic Theory of Stability", Pergamon Press, 1963.
- 5. R.L. Bisplinghoff and H. Ashley, "Principles of Aeroelasticity", Dover, 1962.
- 6. R.H. Scanlan and R. Rosenbaum, "Introduction to the study of Aircraft Vibration and Flutter" Macmillan, 1951.

## **14PHDAE005:** Aerospace Materials and Processes

### UNIT I

#### Introduction:

Aircraft Materials: Desirable properties, Metallic, non-metallic materials and alloys, Composites and Introduction to smart materials, Aerospace super Alloys, comparison of material properties and applications in aircraft components, experimental material characteristics under various loading conditions- tension test, compression test, flexure test, hardness test, fracture test, drop-weight impact test, fatigue, shear and creep test.

### UNIT II:

Theory of metal cutting, Shaping and Planing Machines, Broaching process, Finishing and other processes: lapping and honing operations principles, super finishing process, Polishing, buffing operation and applications, operation of laser beam, plasma arc machining ultrasonic machining abrasive jet machining water jet machining electron beam machining, electron discharge machining and plasma arc machining.

### UNIT III

Principle of numerical control in manufacturing, CNC-programming based machining procedure and software coding.

Sheet Metal and welding: Sheet metal operations, shearing, punching, routing and forming, diffusion bonding. Welding Technology: Types of welding processes, resistance welding, submerged arc welding, atomic hydrogen welding, electron beam welding and special purpose welding processes. Weld jigs

### UNIT IV

Heat Treatment Processes: Purpose of heat treatment and theory of heat treatment processes, heat treatment of alloys of aluminum, magnesium, titanium, steel and case hardening, stress relieving techniques

Surface Treatment & Finishing Processes: Purpose of surface treatment, typical surface finish / treatment cycle for commonly used aircraft materials, protective treatment for aluminium alloys, steel, titanium.

### UNIT V

Fabrication of Pipe Lines and Tubular Conduits: Types of pipelines and tubular conduits, routing of pipelines, fabrication processes including forming, cleaning and inspection. Plastic Technology: Thermoplastics, thermosetting plastics, cast acrylic sheets forming processes, Composite Materials and Honeycomb Structures: Fiber reinforced plastics, Composite Manufacturing processes, NDT methods and quality control, sandwich structures and adhesive bonding.

#### **TEXT BOOKS:**

1. Handbook of Aircraft Materials - CGK Nair, Interline Publishing, Bangalore, 1993.

2. Aircraft Production Technology and Management –ChennaKeshu S and Ganapathy K K, Interline Publishing, Bangalore, 1993

3. F.C. Campbell, "Manufacturing Technology for Aerospace Structural Materials", Elsevier Ltd

#### **REFERENCE MATERIALS:**

1. Andrian P . Mouritz, "Introduction to Aerospace Materials", Woodhead Publishing Ltd, UK

2. Aircraft Production Technology - Horne, DF., Cambridge university press, Cambridge, London, 1986.

3. Aircraft Materials and Manufacturing Process - George F.Titterton, published by Himalayan books, New Delhi, 1968.

# 14PHDAE006: Aerospace Structures and Structural Design

### Unit-I

Introduction to Aircraft Structures: Structural components, materials, Loads on an aircraft; V-n diagram,

Basic elasticity: Static equilibrium, Planar and space trusses, Concept of stress and strain,

Stress resultants for slender members, Bending of symmetrical sections, Bending of unsymmetrical sections, Sectional properties, Bending of slender structures: Deflection analysis, Temperature effects.

### Unit II

. Shear of beams: Shear of open sections, Shear centre, Shear of closed section beams, Torsion of solid and hollow circular sections, Concept of shear flow, Torsion of open sections, Concept of warping, Torsion of single-celled and multi-celled closed sections, Stress state in slender members: Combined state of stress, Idealized sections, Analysis of idealized sections, Deflection analysis.Tapered sections

### Unit-III

Design awareness: Philosophies of design against fatigue: i.e. safe-life, fail-safe and damage tolerance. Fatigue analysis: The traditional S-N curve approach: calculation of crack initiation life; mean stress effect, notch effect, and other influential factors; Palmgren-Miner's cumulative damage rule and fatigue analysis under variable amplitude loadings.

### **Unit-IV**

Aircraft fatigue loads: Atmospheric turbulence, manoeuvre, landing and ground loads; determination of cumulative frequency load distribution; typical aircraft load spectra, Basic Theory of Linear Elastic Fracture Mechanics (LEFM): fracture toughness, energy release rate; plastic zone at the crack tip, calculation of residual strength for a component containing cracks; prediction of fatigue crack growth using the Paris law and Forman's formula.

### Unit -V

Damage tolerant design methods; fatigue monitoring in flight/service; inspection methods: CAA and FAA Regulations and their relationship to Airworthiness Certification.

Potential Energy methods for structures and their use in Finite Elements, FE method for continua illustrated with membrane and shell elements, Accuracy considerations: higher order elements, Isoparametric elements,

### **TEXT BOOKS**

1. T.H.G.Megson, 'Aircraft structures for engineering students', fourth edition, Butterworth-Heinemann, USA, 2007.

2. E.F.Bruhn, 'Analysis and design of flight vehicle structures', Jacobs Publishing, Inc, USA, 1973.

3. Michael Chun-Yung Niu, 'Airframe structural design', Lockheed Aeronautical

systems company, Burbank, California, Hong Kong Conmilt Press Ltd, USA, February 2002.

### REFERENCES

- 1. Analysis of Aircraft Structures: An Introduction, B. Donaldson, Cambridge Univ. Press.
- 2. Energy and Finite element methods in structural mechanics: IH Shames, New Age International Publishers Ltd.

# **14PHDIEM001: Operations Management**

**1. Operations Planning Concepts**: Introduction, Operations Functions in Organizations, Historical development, Framework for managing operations, The trend: Information and Non-manufacturing systems, Operations management, Factors affecting productivity, International dimensions of productivity, The environment of operations, Production systems decisions- a look ahead.

**2. Operations Decision Making :** Introduction, Management as a science, Characteristics of decisions, Framework for decision making, Decision methodology, Decision Tree Problems, Economic models-Break Analysis in operations, P/V ratio, Statistical models.

**System Design and Capacity :**Introduction, Manufacturing and service systems, Design and systems capacity, Capacity planning.

**3. Forecasting Demand:** Forecasting objectives and uses, Forecasting variables, Opinion and Judgmental methods, Time series methods, Moving Average methods , Exponential smoothing, Trend adjusted Exponential Smoothing, Regression and correlation methods, Application and control of forecasts-Mean Absolute Deviation, BIAS, Tracking Signal.

**4. Aggregate Planning and Master Scheduling:** Introduction- planning and scheduling, Objectives of aggregate planning, Three Pure Strategies, Aggregate planning methods, Master scheduling objectives, Master scheduling methods.

**Material and Capacity Requirements Planning :**Overview: MRP and CRP, MRP: Underlying concepts, System parameters, MRP logic, System refinements, Capacity management, CRP activities.

**5. Scheduling and Controlling Production Activities:** Introduction, PAC, Objectives and Data requirements, Loading –Finite and Infinite Scheduling methodology, priority sequencing, capacity control.

**Single Machine Scheduling :**Concept, measures of performance, SPT rule, Weighted SPT rule, EDD rule.

**Flow** –**Shop Scheduling**: Introduction, Johnson's rule for 'n' jobs on 2 and 3 machines, CDS heuristic.

**Job-Shop Scheduling**: Types of schedules, Heuristic procedure, scheduling 2 jobs on 'm' machines.

# **Text Books:**

- 1. Monks, J.G., Operations Management, McGraw-Hill International Editions, 1987.
- 2. Productions & operations management by Adam & Ebert.
- 3. Pannerselvam. R., Production and Operations Management, PHI.
- 4. Chase Jacobs Aquilano, Operations Management for Competitive Advantages,10<sup>th</sup>

Edition, TMH

# **References:**

- 1. Buffa, Modern Production/Operations Management, Wiely Eastern Ltd.
- 2. Chary, S.N., Production and Operations Management, Tata-McGraw Hill.
- 3. Operations management by James Dilworth.
- 4. Lee J Karjewski and Larry P Ritzman, Operations Management strategy and Analysis, 6<sup>th</sup>Edn, Pearson Education Asia
- 5. B J Ranganath , System Dynamics by I K International Publishing house Pvt. Ltd.

# 14PHDIEM002: Total Qualitty Management

## 1. Introduction: BUSINESS EVOLUTION

The Evolution of the Customer Satisfaction Concept: Evolution of Customer Satisfaction Methods, Evolution of Company Integration, Continuing Evolution

Survival in a Rapidly Changing World: Practice Systematic Development of Skill, Treat Management as a Coherent System, Focus on People and Their Purposes, Integrate Best Practices, Financial Benefit

Developing a Unique Organizational Capability : Four Practical Revolutions in Management , Evolution of Our Understanding, Four Levels of Practice

## 2. The First Revolution: CUSTOMER FOCUS

Change in the Work Concept: Market-in, Customers, Philosophy-in and Philosophy-out

Evolution of Customer Focus and Its Challenges: Three Stages of Customer Focus, Customer Concerns, Integration of Concerns, Individualizing Customers

## The Second Revolution: CONTINUOUS IMPROVEMENT

Improvement as a Problem-Solving Process : Management by Process , WV Model of Continuous Improvement , Continuous Improvement of Processes for All Types of Work, Continuous Improvement and the Scientific Method

## **3. Managing Existing Processes**

Process Discovery and Management : Thinking In Terms of Process, Process DiscoveryProcess Control and Variation : A Typical Example of (Mishandling) Variation, Making the Most of Variation, Process Control and Process Improvement Reactive Improvement and the 7 Steps Method ; Identifying the Problem , Standard Steps and Tools , The 7 Steps: A Case Study , The 7 QC Tools

Management Diagnosis of the 7 Steps of Reactive Improvement: General Guidelines for Managers Diagnosing a QI Story, Step-by-Step Guidelines for Managers Diagnosing a QI Story, Case Study for Diagnosis of the 7 Steps, Run PDCA and Develop Skill

Process Management Mobilization Case Study: Introduction to the Teradyne Mobilization story, Introduction of the 7 Steps, Experience Using the 7 Steps, Improving Mobilization, Process Discovery and Process Control

Planning Projects or Tasks: The 9 Steps Compared with the 7 Steps, The 9 Steps Mobilization at Teradyne, A Teradyne Illustration of the 9 Steps Use, Relationship of the 9 Steps to Other Methods

Proactive Improvement: Collecting Data for Proactive Improvement, Language Data and Use of Semantics, Toward Standard Tools and Steps for Proactive Improvement, Customer Visitation as a Method of Collecting Proactive Improvement Data

Applying Proactive Improvement to Develop New Products; Develop Understanding of Customers' Needs and Environment, Convert Understanding Into Requirements, Operationally Define Requirements for Downstream Development, Generating Concepts and Selecting the Concept,Expanding View of WV Model and Proactive Improvement

## 4. The Third Revolution: TOTAL PARTICIPATION

Engagement and Alignment of Organization Members : Engaged Employees for a Rapidly Changing World, Explicit Joining of Improvement and Routine Work , Processes and People

Coordinating Behavior; Societal Networking Case Study of the CQM Study Group on Conversation, Expansion of the Principles of Semantics, Some Types and Models of Conversations Leading Change: Technical Skill, Human Skill, Conceptual Skill Self-Development: Lessons from the Non-business World , Local Improvement in Absence of a Supportive Environment, The Bottom Line

Team Skill Development: Teamwork Skill, Some Fundamentals, Some Types of Teams substantially, Models for Team Development

Phase-In: Orientation Phase, Empowerment Phase, Alignment Phase, Evolution of the Parallel Organization, Common Patterns of Phase-In

U.S. Focused Strategies for Phase-In : Benchmarking , Six Sigma , Cycle-Time Reduction

Hoshin Management: Hoshin Management and Its Parts, Management by Objectives and Conventional Business Planning, Hoshin Management at Analog Devices

Leading Process Improvement : Modeling Personal Improvement , Employee Development at NIMS , Company Strategies ,Individual Practice of CAPD by Managers' case studies

The Practice of Breakthrough ; Process versus Business Breakthrough , Case Studies and a Model of Business Breakthrough , Biggest Obstacle to Business Breakthrough , Integration of Ideas

# 5. The Fourth Revolution: SOCIETAL NETWORKING

Networking and Societal Diffusion: Regional and National Networking The Japanese Model, Taking a Lesson from Japan—CQM, Comparison of National Methods, Use of Indirect Influence

Ongoing Integration of Methods: Applying Idealized Design to HoshinManagement, Structural Process Improvement Case Study, SerVend Case Study

# **Reference Books:**

- **"Four Practical Revolutions in Management:systems for creating unique organizational capability"** -Shoji Shiba and David Walden,– Productivity Press & Center for Quality Management, (USA), 2001, ISBN-9781563273889/9781563272172/9781563272318
- **"Management for Total Quality"** -N Logothetis- Prentice Hall of India, New Delhi, 2003, ISBN-81-203-1137-X
- **"Total Quality Management**"- *Besterfield*, Pearson Education, 2011. ISBN, 817758412X, 9788177584127.

## **14PHDIEM003: Project Management**

- Introduction: Projects, types of projects- public and private projects, project organization, structure and processes. Identification of Investment Opportunities, Market and Demand Analysis – Technical Analysis – Investment Outlay.
- 2. Means of Financing: Profitability and Breakeven Analysis Cash Flows of Projects Tax factor in investment Analysis Interest Compounding and Discounting.
- **3. Appraisal Criteria and Selection of Investment:** Cost of Capital Analysis of Risk Financial Projection, Social Cost Benefit Analysis.
- 4. Manpower Management in Projects: Functional Approach to Manpower Management – The Element of decision Process – Project Team Concepts – Field Autonomy – Policies Governing Projects.
- **5. Networks Technique in Project Management:** PERT/CPM Analysis Administrative aspects of Capital Investment.

## **REFERENCE BOOKS:**

- 1. **Projects**\"– Appraisal, preparation, budgeting and implementation Prasannachandra Tata McGraw Hill.
- 2. Hand book of Project Management– Dennis Lock.
- 3. **Project Management** Dennis lock.

# 14PHDIEM004: Advanced Manufacturing Practice

**1. JIT – Introduction** – The spread of JIT Movement, some definitions of JIT, core Japanese practices of JIT, Creating continuous Flow Manufacture, Enabling JIT to occur, Basic elements of JIT, Benefits of JIT.

**Just in Time Production** – Primary purpose, profit through cost reduction, Elimination of over production, Quality control, Quality Assurance, Respect for Humanity, Flexible work Force, JIT Production Adapting to changing production Quantities, process layout for shortened lead Times, Standardization of operation, Automation.

**2. Sequence and scheduling used by suppliers:** Monthly and daily Information. Sequenced withdrawal system by sequenced schedule table, problems and counter measures in applying the Kanban system to sub contractors.

**Toyota Production System**-The philosophy of TPS, Basic Frame work of TPS, Kanban, Determining the Number of Kanban in Toyota Production System.

- Kanban Number under Constant Quantity Withdrawal System.
- Constant Cycle, Non-constant Quantity Withdrawal System.Supplier Kanban and the Sequence Schedule for Use by Suppliers.
- Later Replenishment System by Kanban.
- Sequenced Withdrawal System.
- Circulation of the Supplier Kanban within Toyota.

Production Smoothing in TPS, Production Planning, Production Smoothing

Adaptability to Demand Fluctuations, Sequencing Method for the Mixed Model Assembly Line to Realize Smoothed Production of Goal.

**3. Just-in-Time Production** with Total Quality Control just in time concept, cutting lot sizes, cutting set-up times, cutting purchase order costs, the JIT cause-Effect chain, Scrap/Quality Improvements, Motivational effects, Responsibility effects, small Group improvement Activities, withdrawal of Buffer Inventory, the total Quality Control Concept.

**4. Total Quality Control-Introduction**-Total Quality Control concepts, responsibility, learning from the west, TQC concepts categorized, Goals, Habit of improvement, perfection, Basics, process control, Easy to see Quality control as facilitator, small lot sizes, Housekeeping, Less than full capacity scheduling, Daily machine checking, Techniques and Aids, Exposure of problems, Fool proof Devices, Tools of Analysis, QC Circles, TQC in Japanese-owned US Electronics plant, TQC in Japanese-owned Automotive plants.

**5. Plant Configurations: Introduction**-ultimate plant configuration, job shop Fabrication, Frame Welding, Forming Frame parts from Tubing, Dedicated production lines, overlapped production, the daily schedule, Forward Linkage by means of Kanban, physical merger of processes, Adjacency, mixed Models, Automated production Lines, Pseudo Robots, Robots, CAD and Manufacturing, Conveyors and stacker Cranes, Automatic Quality Monitoring.

# **REFERENCE BOOKS:**

- 1. Japanese manufacturing techniques- RichardSchonberger.
- 2. Toyota Production system An integrated approach to just in time Yasuhiro Monden
- 3. Lean Thinking By James Womack.
- 4. The machine that changed the World The story of Lean production James P. Womack, Daniel T Jones, and Daniel Roos Harper Perennial edition published 1991.
- 5. Just in time manufacturing Kargoanker
- 6. **Wind**-chill reference manual.

## 14PHDIEM005: Supply Chain Management

**1.Building a Strategic Frame Work to Analyze Supply Chains:** Supply chain stages and decision phases process view of a supply chain. Supply chain flows. Examples of supply chains.Competitive and supply chain strategies.Achieving strategic fit.Expanding strategic scope. Drivers of supply chain performance. Framework for structuring drivers – Inventory, Transportation, Facilities, Information. Obstacles to achieving fit. Case discussions.

**2. Designing the Supply Chain Network:** Distribution Networking – Role, Design. Supply Chain Network (SCN) – Role, Factors, Framework for Design Decisions.

**Facility Location and Network Design:** Models for facility location and capacity allocation. Impact of uncertainty on SCN – discounted cash flow analysis, evaluating network design decisions using decision using decision trees. Analytical problems.

**3 Planning and Managing Inventories in a Supply Chain:** Review of inventory concepts. Trade promotions, Managing multi-echelon cycle inventory, safety inventory determination. Impact of supply uncertainty aggregation and replenishment policies on safety inventory.Optimum level of product availability; importance factors. Managerial levers to improve supply chain profitability.

**Sourcing, Transportation and Pricing Products:** Role of sourcing, supplier – scoring & assessment, selection and contracts. Design collaboration.

**4.Sourcing, Transportation and Pricing Products:** Role of transportation, Factors affecting transportation decisions. Modes of transportation and their performance characteristics.Designing transportation network.Trade-off in transportation design.Tailored transportation, Routing and scheduling in

transportation.International transportation.Analytical problems. Role Revenue Management in the supply chain, Revenue management for: Multiple customer segments, perishable assets, seasonal demand, bulk and spot contracts.

**5. Coordination and Technology in the Supply Chain:** Co-ordination in a supply chain: Bullwhip effect. Obstacles to coordination. Managerial levers to achieve co-ordination, Building strategic partnerships.

**Coordination and Technology in the Supply Chain:** The role of IT supply Chain, The Supply Chain IT framework, CRM, Internal SCM, SRM. The role of E-business in a supply chain, The E-business framework, E-business in practice.Case discussion.

**Emerging Concepts:** Reverse Logistics; Reasons, Activities, Role. RFID Systems; Components, applications, implementation. Lean supply chains, Implementation of Six Sigma in Supply Chains.

# **REFERENCE BOOKS:**

- Supply Chain Management– Strategy, Planning & Operation. Sunil Chopra & Peter Meindl; Pearson Education Asia, ISBN: 81-7808-272-1. – 2001
- Supply Chain Redesign Transforming Supply Chains into Integrated Value Systems -Robert B Handfield, Ernest L Nichols - Jr., 2002, Pearson Education Inc, ISBN: 81-297-0113-8
- 3. **Modelling the Supply Chain** -Jeremy F Shapiro, Duxbury -Thomson Learning -2002, ISBN 0-534-37363.
- 4. **Designing & Managing the Supply Chain** -David Simchi Levi, Philip Kaminsky& Edith Simchi Levi - Mc Graw Hill.

**Going Backwards Reverse Logistics Trends and Practices** -Dr. Dale S. Rogers, Dr. Ronald S. Tibben-Lembke, University of Nevada, Reno, Center for Logistics Management

## **14PHDIEM006: Human Resource Management**

**1.Introduction to Human Resources:** Importance of Human Resources – Human Resource Planning, Job Analysis and Methods

**2.Recruitment – Recruiting Sources:** Recruiting Efforts with possible constraint – ability to attract incumbents.

**The Selection Process:** Cost of Selection – Discrete Selection Process – The Comprehensive Approach – Key Elements in successful Predictors – Selection Devices – Employment Tests and Interviews – Job 'Previews and Background Investigation – Socializing the New Employee..

**3.Employee Training:** Determination of Training Needs and Priorities – Formal Employee Training Methods – Methods for Training Managers Evaluating Training Effectiveness.

**Career Development:** Value of Effective Career Development – External versus Internal Dimensions to a career – Career Stages.

**4.Motivating the Employees:** Different Theories and Approaches to work Motivation – Job Design. Work scheduling and Motivation – Performance Appraisals – Rewarding the Productive Employee.

**Compensating the Work Force:** Compensation Administration – Factors influencing the Compensation Administration – Job Evaluation and Pay Structure – Incentive Compensation Plans – Benefits and Services.

**5.Maintaining the Work Force:** Labor Relations – some Legislation governing Labor Relations – Safety and Health of Workers – Combating Stress and Burnout Problems – Employee Discipline – disciplinary Actions – collective bargaining process.

### **REFERENCE BOOKS:**

- 1. Principles of personnel management Flippo Mc Graw Hill.
- 2. **Personnel principles and policies for modern manpower** Yoder Prentice Hall India.
- 3. **Personnel/Human Resource Management** Terry Leap & Michael Crinocollier Macmillan publishers.
- 4. **Personnel and Human Resource Management** Memoria Himalaya publishing Company.