

INDUSTRIAL TRIBOLOGY, MACHINE DYNAMICS & MAINTENANCE ENGINEERING CENTRE

The Industrial Tribology, Machine Dynamics & Maintenance Engineering Centre (ITMMEC) participates in the Interdisciplinary M.Tech. Programme in Industrial Tribology & Maintenance Engineering.

COURSE DETAILS:

ITL702 Diagnostic Maintenance and Monitoring

4 credits (3-0-2)

Introduction to Condition Based Maintenance (CBM), Application and economic benefits, Signature analysis - online and off-line techniques, Various Condition Monitoring (CM) techniques - Vibration monitoring and analysis, Shock Pulse Method, Noise monitoring, Envelope detection technique, Oil analysis including wear debris and contaminant monitoring, Performance monitoring, Acoustic emission and other techniques, Non-destructive techniques, Application and choice of the method, Computer aided monitoring including expert systems. Practical applications of diagnostic maintenance, Condition monitoring of mechanical and electrical machines, Case studies.

ITL703 Fundamentals of Tribology

4 credits (3-0-2)

Introduction to tribology and its historical background. Factors influencing Tribological phenomena. Engineering surfaces - Surface characterization, Computation of surface parameters. Surface measurement techniques. Apparent and real area of contact. Contact of engineering surfaces- Hertzian and non-hertzian contact. Contact pressure and deformation in non-conformal contacts. Genesis of friction, friction in contacting rough surfaces, sliding and rolling friction, Various laws and theory of friction. Stick-slip friction behaviour, frictional heating and temperature rise. Friction measurement techniques. Wear and wear types. Mechanisms of wear - Adhesive, abrasive, corrosive, erosion, fatigue, fretting, etc., Wear of metals and non-metals. Wear models - asperity contact, constant and variable wear rate, geometrical influence in wear models, wear damage. Wear in various mechanical components, wear controlling techniques. Introduction to lubrication. Lubrication regimes. Introduction to micro and nano tribology.

ITL705 Materials for Tribological Applications

3 credits (3-0-0)

Introduction to tribological processes and tribological relevant properties of materials. An overview of engineering materials having potential for tribological application.

Characterization and evaluation of Ferrous materials for tribological requirements/applications, Selection of ferrous materials for rolling element bearings, gears, crank shafts, piston rings, cylinder liners, etc. Non-ferrous materials and their applications such as sliding bearings, piston rings, cylinder liners, etc., materials for dry friction materials.

Composite materials (PM, CMC and MMC) for tribological applications.

Surface treatment techniques with applications such as carburising, nitriding, induction hardening, hard facing, laser surface treatments, etc.

Surface coating techniques such as electrochemical depositions, anodizing, thermal spraying, Chemical Vapour Deposition (CVD), Physical Vapour Deposition (PVD), etc. and their applications.

Lubricants- Introduction, requirements, types, Evaluation and testing of lubricants.

ITL709 Maintenance Planning and Control

3 credits (3-0-0)

Objectives of planned maintenance, Maintenance philosophies, Preventive and Predictive maintenance, Emerging trends in maintenance-Proactive Maintenance, Reliability Centred Maintenance (RCM), Total Productive Maintenance (TPM), etc, Implementation of Maintenance strategy, Maintenance organization, Basis of planned maintenance system, Maintenance planning and scheduling, Maintenance control system and documentation. Spares and inventory planning, Manpower planning, maintenance auditing. Human factors in maintenance and training, maintenance costing, Maintenance performance. Repair decisions- Repair, replacement and overhaul, Computer applications in maintenance, Expert systems applications, maintenance effectiveness, Case studies.

ITL710 Design of Tribological Elements

4 credits (3-0-2)

Introduction-Tribological consideration in design, Conceptual design, Classification of tribological components, Mechanisms of tribological failures in machines, Zero wear concept, Computational techniques in design.

Design of Dry Frictional Elements-Dry friction concepts, Brakes and Clutches, Friction belts and Dry rubbing bearing. Design of Fluid Frictional Elements-Fluid friction concepts, Design of hydrodynamically loaded journal bearings, externally pressurized bearings, Oscillating journal bearings, Externally pressurized bearings, Design of oil groove, Design of elliptical, multilobe and titled pad bearings, Rolling elements bearings, Performance analysis of bearings, gears, seals, piston rings, machine tool slide ways, cams and follower and wire rope.

Design exercises using TK-Solver, Finite Elements analysis software.

ITL711 Reliability, Availability and Maintainability Engineering

3 credits (3-0-0)

System concepts in RAM Engineering, Fundamentals of reliability, Failure distributions, Statistical analysis of failure data, Weibull analysis, Monte Carlo simulation, System reliability assessment. Reliability of repairable and non-repairable systems. Point, mission and steady state availability. Availability assessment. Maintainability and its assessment. Design for reliability and maintainability', Practical applications of RAM Engineering to systems, products and processes.

ITL714 Failure Analysis and Repair

4 credits (3-0-2)

Introduction, need for failure analysis, Classification of failures, Fundamental causes of failures, influence of type of loading (e.g. static, fatigue, shock, etc.) on nature of failures, Role of stress; processing and fabrication defects, Effect of residual stresses induced during fabrication processes, Influence of temperature and environment on failure, Crack and subsurface crack like defects and their significance in failure.

Micro mechanisms of failures; Ductile and brittle fracture, Fracture initiation and propagation, Fatigue failures, Wear

related failures, High temperature failures, low temperature failures, etc., Studies and analysis of failed surfaces.

Identification of failures, Techniques of failure analysis, Microscopic methods, Fracture mechanics techniques, Prediction of failures, Residual life assessment and life extension, Typical case studies in failure analysis, Logical fault finding and its application, Inspection and safety measures, Repair techniques and economic considerations, Failure analysis for design improvement and proactive maintenance, Design for repairability, Case Studies.

ITL716 Computer Application in Maintenance Management

3 credits (2-0-2)

Role of computer in maintenance management. Maintenance overview. Basics of software engineering. System analysis and design. Fundamentals of programming with specific emphasis of object oriented paradigms. Study of various available software and their implementation for maintenance. System analysis of various maintenance strategies, activities / modules and their implementation. Evaluation and optimum selection of computerised maintenance management system (CMMS), Knowledge based approach to maintenance management. Neural network for CMMS, Software consideration for design of CMMS, Maintenance through internet based technology. Case studies.

ITL717 Corrosion and its Control

3 credits (3-0-0)

Importance of corrosion control in industrial practices. Thermodynamics of corrosion.

Broad forms of corrosion - uniform, uneven, pitting, cracking, etc. Influencing factors on corrosion. Surface film. Polarisation and effects. Theory of passivity. Kinetics of corrosion.

Various types of corrosion along with case studies - Galvanic, Thermo-galvanic, High temperature corrosion. Intergranular, Pitting, Selective attack (leaching). Fretting corrosion-erosion, Cavitation, Stress corrosion cracking. Hydrogen embrittlement.

Corrosion fatigue and Corrosive wear.

Application of Non Destructive Techniques (NDT) for corrosion evaluation and monitoring.

Corrosion Control- Design improvement.

Selection of material, fabrication processes for corrosion control. Role of residual stresses. Changes in operating conditions. Use of inhibitors. Anodic and cathodic protection. Corrosion resistant coatings. Case studies.

ITL730 Lubricants

3 credits (2-0-2)

Overview of friction, wear and lubrication, Primary role of lubricants in mitigation of friction and wear & heat transfer medium, Composition and properties of lubricant, Fundamentals - Mineral oil based liquid lubricants, Synthetic liquid lubricants, Solid lubricants, greases and smart lubricants, Characteristics of lubricants and greases, Rheology of lubricants, Lubricants for industrial machinery - I.C. Engines, turbines, Hydraulic control systems, Lubricants for tribological components - sliding and rolling bearings, gearing, wire ropes and chains, etc., Metal working lubricants, Maintenance and conservation of lubricating oils, Storage and Handling of lubricants, Used lubricating oil - Environment and health hazards, and Disposability and Recycling, Technical regulation for lubricants - Test specifications, and standards for maintenance management of industrial lubricants including greases and used oils, Selection of optimum lubricant for given application.

ITL740 Risk Analysis and Safety

3 credits (2-1-0)

Introduction, Typical Hazards, Tools for hazard identification and analysis in plants and machinery, Accident indices, Check lists, Preliminary Hazard Analysis (PHA), Failure mode and effects analysis (FMEA) and Failure mode, effects and criticality analysis (FMECA), Hazard and operability studies (HAZOP), Fire and explosion hazards, Dow's fire and explosion index, Hazard analysis-Fault tree analysis (FTA), Event tree analysis (ETA), Cause consequence analysis (CCA), Mathematical models for cause consequence analysis, Risk evaluation and acceptance criteria, Human factors in safety, safety management, Disaster management plan, Safety aspects of lubricants, Safety codes, Case studies.

ITL752 Bulk Materials Handling

3 credits (2-0-2)

Nature of bulk materials, Flow of gas-solids in pipelines, Mechanical

Handling equipments like screw conveyors and belt conveyors, Pneumatic conveying systems- Components, Design and Selection, Troubleshooting and Maintenance of pneumatic conveying systems, Performance evaluation of alternative systems, Bend erosion-influencing factors, materials selection and potential solutions, Case studies, and Design exercises.

ITL760 Noise Monitoring & Control

3 credits (2-0-2)

Introduction to noise, Properties of noise, Loudness and weighting networks, Octave and FFT analysis, Impulsive noise, Instrumentation for noise measurement and analysis, Sound power, Sound intensity technique, Noise source location, Noise diagnostics, Noise monitoring of machines with examples, Cepstrum analysis, Noise control methods, Maintenance and noise reduction, Vehicle and Machinery noise, Noise standards, Case studies.

ITL770 Design for Maintenance

3 credits (2-0-2)

Introduction: Overview of maintenance, Systems approach for maintenance, Modular design, Assembly and disassembly consideration for maintainability design, Accessibility of critical components, Optimisation of maintenance efforts, Evaluation, comparison and optimum selection of maintenance systems, Design for condition monitoring, Design of plant and machinery for a given maintenance strategy, Design for environment friendly maintenance Standardisation and interchangeability, Life cycle costing for optimum design and selection, Maintenance Logistics (facilities and resources), Human and safety factors, Design for maintenance through internet based technology (on-site and off-site), Developing reliable maintenance system, Design for simplicity and ease of maintenance, Design complexity versus maintenance complexity for enhanced availability, Built in diagnostics for fault detection, Fail safe design, Case studies.

ITL810 Bearing Lubrication

3 credits (2-0-2)

Prerequisite : ITL 703

Introduction-Historical background, Bearing concepts and typical applications.

Viscous flow concepts-Conservation of laws and its derivations: continuity, momentum (N-S equations) and energy, Solutions of Navier-Stokes equations. Order of magnitude analysis, General Reynolds equation-2D and 3D (Cartesian and Cylindrical), Various mechanisms of pressure development in an oil film, Performance parameters.

Boundary Layer Concepts-Laminar and turbulent flow in bearings, mathematical modeling of flow in high-speed bearings.

Elastic Deformation of bearing surfaces-Contact of smooth and rough solid surfaces, elasticity equation, Stress distribution and local deformation in mating surfaces due to loadings, methods to avoid singularity effects,

Estimation of elastic deformation by numerical methods-Finite Difference Method (FDM), Governing equation for evaluation of film thickness in Elasto Hydrodynamic Lubrication (EHL) and its solution, Boundary conditions.

Development of computer programs for mathematical modeling of flow in bearings, Numerical simulation of elastic deformation in bearing surfaces by FDM.