Scheme & Syllabi

for

Pre-Ph.D
(Mechanical Engineering)

(Total Credits =12)

Department of Mechanical Engineering

Guru Jambheshwar University of Science & Technology,
Hisar-125001
January, 2020

Pre-Ph.D. (*Scheme*)

Code	Subject	L	T	P	Credit
PPD-101	Research Methodology	4	-	-	4.0
PPD-102	Review of Literature and Seminar (In the relevant research area)	2	-	-	2.0
PPD-104	Research and Publication Ethics	2	-	-	2.0
PPD-	Departmental Elective Course (In relevant research area)	4	-	-	4.0
	Total	**12**	**-**	**-**	**12**

LIST OF DEPARTMENTAL ELECTIVE

Code	Subject	L	T	P	Cr.
PPD-103	Lubrication	4	-	-	4
PPD-105	Heat Transfer and Design of Thermal Systems	4	-	-	4
PPD-106	Computer Numerical Control Machining	4	-	-	4
PPD-107	Robotics	4	-	-	4
PPD-108	Advanced Production Technology	4	-	-	4
PPD-109	Biomaterials/ Biomedical Materials	4	-	-	4
PPD-110	Computer Aided Design And Manufacturing (CAD/CAM)	4	-	-	4

Pre-Ph.D. (*Syllabi*)

PPD-101: RESEARCH METHODOLOGY

Assessment during Semester:	30 marks	**L**	**T**	**P**	**Credit**
Assessment at the end of Semester:	70 marks	4	--	--	4.0

Research Methodology: Nature, objectives and motivation of research, types of research, research approaches, significance of research, scope and formulation of hypothesis, research and scientific method, important of research methodology, research process, criteria of good research, problems encountered by researches in India, benefits to the society in general, Defining the research problem: definition of research problem, problem formulation, necessity of defining the problem, technique involved in defining a problem.

Statistical analysis and probability distribution: Measure of central tendency and dispersion, mean, median, mode, range, mean deviation, standard deviation and problems, discrete, continuous and mixed random variable, definition of probability, addition rules and condition probability, binomial, poisson, sampling and geometric distributions, sample tests: Chi square test

Research Design and Modeling: Meaning of research design, need of research design, feature of a good design, important concepts related to research design, different research designs, basic principles of experimental design, developing a research plan, design of experimental set-up, use of standards and codes, type of models, model building and stages, need and types of simulation

Research Report Writing: Format of the research report, synopsis, dissertation, thesis its differentiation, references/bibliography, technical paper writing/journal report writing, making presentation, use of visual aids, Research proposal preparation: writing a research proposal and research report, writing research grant proposals. Computer Application for presentation: basic presentation skills for documentation and presentation tools: PowerPoint, Microsoft office, and knowledge of online tools.

Recommended Books:

1. C.R. Kothari, Research Methodology, Methods and Techniques, New Age International Publishers 2004
2. R. Ganesan, Research Methodology for engineers, MJP Publishers, 2011.
3. Ratan Khananabis and Suvasis Saha, Research Methodology, University Press, Hyderabad, 2015

4. Y.P. Agarwal, Statistical Methods: Concepts, Application and Computation, Sterling Publs. Pvt. Ltd., New Delhi, 2004
5. Vijay Upagade and Arvind Shende, Research Methodology, S. Chand & Company ltd., New Delhi 2009
6. Y.K. Singh, Fundamentals of Research Methodology, New Age International Publishers 2006
7. Ranjit Kumar, A step by step guide for beginners, Pearson Education 2005.
8. Meyer, P.L. Introductory Probability and Statistical Applications, Addison Wesley (1970).
9. Research Methodology; Integration of Principles, Methods and Techniques (Pearson Education, New Delhi)

Note: Paper setter will set eight questions taking at least one from each unit. Students are required to answer five questions.

PPD-102: REVIEW OF LITERATURE & SEMINAR

		L	T	P	Credit
Assessment during Semester:	30 marks				
Assessment at the end of Semester:	70 marks	2	--	--	2.0

The student will be required to do the review of literature work (ranging between 20-30 papers) under the guidance of the senior faculty member(s)/supervisor concerned and to present their work in form of seminar before the committee constituted by Dean, FET for evaluation.

Detailed Contents

Literature survey: Overview – What is literature survey, Functions of literature survey, maintaining a notebook, developing a Bibliography, Searching for publications – Publication databases, search engines and patent databases, Find some/all of the references for a given paper, including those that are not on the web.

How to study a scientific paper: Summarizing papers already published: – Reading abstracts and finding ideas, conclusion, Advantages of their approach, the drawbacks of the papers (What is lacking – can be found in the sections such as future work) Generalize results from a research paper to related research problems, Comparing the approach - Identify weaknesses and strengths in recent research articles in the subject.

Publishing a paper: How to write a scientific paper, Structure of a conference and journal paper, abstract writing, chapter writing, discussion, conclusion, references, bibliography and In-class discussion of technical writing examples, Poster papers, review paper, Research ethics – Legal issues, copyright, plagiarism, General advice about writing technical papers in English - Tips for writing correct English.

NOTE: *Every student will be required to collect minimum 20-30 research papers related to the broad area of research. The area of research will be decided by the course coordinator of the Departmental Elective subject and the relevant research papers should be from the reputed journals. A report consisting of the summary of these research papers is required to be submitted at the end of the semester. The final evaluation shall be done on the basis of Seminar and report submitted. The continuous assessment will be done by the Course Coordinator on the basis of efforts made by the candidate for collecting the relevant quality research papers.*

Reference:

1. Lecture Notes and presentations

PPD-103: LUBRICATION

Assessment during Semester:	30 marks	**L**	**T**	**P**	**Credit**
Assessment at the end of Semester:	70 marks	4	--	--	4.0

Physical Properties of Lubricants: Introduction, Oil viscosity, Viscosity temperature relationship, Viscosity index, Viscosity pressure relationship, Viscosity-shear rate relationship, Viscosity measurements, Viscosity of mixtures, Oil viscosity classification, Lubricant density and specific gravity, Thermal properties of lubricants, Temperature characteristics of lubricants, Other lubricants characteristics, Optical properties of lubricants, Additive compatibility and solubility, Lubricant impurities and contaminants, Solubility of gases in oils.

Lubricants and Their Composition: Introduction, Mineral oils, Synthetic oils, Emulsions and aqueous lubricants, Greases, Lubricant additives.

Hydrodynamic Lubrication: Introduction, Reynolds equation, Pad bearings, Converging-diverging wedges, Journal bearings, Thermal effects in bearings, Limits of hydrodynamic lubrication, Hydrodynamic lubrication with non-Newtonian fluids, Reynolds equation for squeeze films, Porous bearings.

Computational Hydrodynamics: Introduction, Non-dimensionalization of the Reynolds equation, The Vogelpohl parameter, Finite difference equivalent of the Reynolds equation, Numerical analysis of hydrodynamic lubrication in idealized journal and partial arc bearings, Numerical analysis of hydrodynamic lubrication in a real bearing.

Hydrostatic Lubrication: Introduction, Hydrostatic bearing analysis, Generalized approach to hydrostatic bearing analysis, Optimization of hydrostatic bearing design, Aerostatic bearings, Hybrid bearings, Stability of hydrostatic and aerostatic bearings.

Elastohydrodynamic Lubrication: Introduction, Contact stresses, Contact between two elastic spherical or spheroidal bodies, Elastohydrodynamic lubricating films, Micro-elastohydrodynamic lubrication and mixed or partial EHL, Surface temperature at the conjunction between contacting solids and its effect on EHL, Traction and EHL.

Boundary and Extreme Pressure Lubrication: Introduction, Low temperature-low load lubrication mechanisms, Low temperature-high load lubrication mechanisms, High temperature-medium load lubrication mechanisms, High temperature-high load lubrication mechanisms, Boundary and EP lubrication of non-metallic surfaces.

Solid Lubrication and Surface Treatments: Introduction, Lubrication by solids, Wear resistant coatings and surface treatments.

Books Recommended:

1. Principles of Lubrication by A. Cameron, Longmans
2. Engineering Tribology by Gwidon W. Stachowiak and Andrew W. Batchelor, Elsevier
3. Introduction to Tribology of Bearings by B.C. Majumdar
4. Principles of Tribology by J. Halling, Macmillan
5. Applied Tribology by Michael M. Khonsari and E. Richard Booser, *John Wiley & Sons.*
6. Mechanics and Chemistry in lubrication by Dorinson and Ludema, Elsevier
7. Principles and applications of Tribology, Bharat Bhushan, *John Wiley & Sons Inc.*

Note: Paper setter will set eight questions. Students are required to answer five questions.

PPD 105: HEAT TRANSFER AND DESIGN OF THERMAL SYSTEMS

		L	T	P	Credit
Assessment during Semester:	30 marks				
Assessment at the end of Semester:	70 marks	4	---	--	4.0

Basic Concepts and Thermo-physical Properties of Fluids: heat transfer fundamentals, coordinate systems, continuity equation, momentum and momentum theorem, conservation of energy, dimensional analysis, units, thermal conductivity, specific heat, thermal diffusivity, thermal expansion.

Conduction Heat Transfer: introduction, basic equations, special functions, steady one- dimensional conduction, extended surfaces, two dimensional steady conduction, transient conduction.

Natural and Forced Convection: basic mechanism and governing equations, laminar natural convection flow over flat surfaces, external laminar natural convection flow in other circumstances, internal natural convection, turbulent flow, empirical correlations, forced convection: internal flows, forced convection: external flows.

Boiling and Condensation: boiling curve**,** boiling nucleation, bubble dynamics, pool boiling heat transfer, introduction to flow boiling, two phase flow patterns, flow boiling in horizontal and vertical tubes, boiling on tube bundles, enhanced boiling, film condensation on low fins, film condensation on single horizontal finned tubes, condensation in smooth tubes, enhanced in tube condensation, film condensation on tube bundles, condensation in plate heat exchangers.

Heat Exchangers and Heat Transfer Enhancement: Governing relationships, heat exchanger analysis methods, shell and tube heat exchanger, compact heat exchanger, plate and frame heat exchanger, regenerators, fouling, treated surfaces, rough surfaces, extended surfaces, displaced enhancement devices, swirl flow devices, coiled tubes, additives for liquids, active techniques, compound enhancement.

Heat Transfer in Electronic Equipment and Experimental methods: thermal resistances, jet impingement cooling, natural convection heat sinks, phase change phenomenon, thermoelectric coolers, Fundamentals, measurement error, calculation error, curve fitting, equipments.

Thermal modeling and Energy Analysis for Solar Dryer and Distiller: Identification of problem, basic energy balance equations, exergy analysis, parametric studies, additional energy requirements, design of experimental solar dryer and distiller, experimentation, mathematical modeling.

Economic Analysis and Optimization Techniques for Thermal Systems: Cost analysis, payback time, benefit-cost analysis, Lagrange multipliers, geometric programming, system simulation and optimization.

Books recommended:

1. Heat Transfer a practical approach by Cengel.
2. Heat transfer by Holman.
3. Fundamentals of heat and mass transfer by Incropera and Dewitt.
4. Design of thermal systems by Stoecker.
5. Design and optimization of thermal systems by Jaluria.
6. Heat transfer handbook by Bejan and Kraus.
7. Greenhouse technology for controlled environment by Tiwari.

Note: Paper setter will set eight questions. Students are required to answer five questions.

PPD 106: COMPUTER NUMERICAL CONTROL MACHINING

Assessment during Semester:	30 marks	**L**	**T**	**P**	**Credit**
Assessment at the end of Semester:	70 marks	4	---	--	4.0

Introduction to CNC: Computer numerical control, types of CNC machines, CNC operations, type of cutting tools.

Coordinate Geometry for CNC: Cartesian coordinate system, polar coordinates, coordinate planes, axes and quadrants, Euclidean distance formula, mid-point theorem, slope calculation angle formula, problems.

Fundamentals of Machining: mechanics of cutting, chip formation and type of chips, cutting forces, temperatures in cutting, surface finish, machinability, problems.

Cutting Tools: Cutting tools geometry, tool materials, tool life - wear and failure, cutting fluids, cutting speed, feed rate and spindle speed, problems.

Machine Setup: Safety features and precautions, home position, work offset, tool offset, work holding devices, tool holders.

Manual Part Programming: G-codes, part program syntax, part programming with G-codes, programming for milling and lathe machines, problems.

Part Programming with CAM: Work setup, cutting tool selection, CAM cycles, cutting plane selection, toolpath setup, post-processing of CL data, file import/export, problems.

Process Planning: Material selection, selection of manufacturing processes, computer integrated manufacturing, quality management, manufacturing costs, problems.

Books recommended:

1. Machining and CNC technology by Fitzpatrick, Michael.
2. CNC programming techniques by Smid, Peter.
3. CNC programming: principles and applications by Mattson, Michael.
4. CNC programming by Sinha, S.K.
5. Theory and design of CNC systems by Suh, Sul-Hwan.
6. CNC machines by B.S. Pabla.
7. Macchine tool practices by Kibbe, Richard R.

Note: Paper setter will set eight questions. Students are required to answer five questions.

PPD 107: ROBOTICS

		L	T	P	Credit
Assessment during Semester:	30 marks				
Assessment at the end of Semester:	70 marks	4	---	--	4.0

Introduction to Robotics: What are robots, types of robots, robotic manipulation, mobile robots, application of robots.

Robotics control: Robot control schemes, programmed robots, tele-operated robots, robotics and artificial intelligence.

Linear Algebra: Vectors, dot product, cross product, norm, orthogonality, matrices and matrix operations, problems.

Transformations: 2D transformations, homogeneous coordinates, 3D transformations, transform inverse, rotation representation, Euler angles, quaternions, Rodrigues formula problems.

Forward Kinematics: Kinematic chain, links, type of joints, degrees of freedom, analytical forward kinematics, Denavit-Hartenberg (D-H) parameters, problems.

Inverse Kinematics: Analytical inverse kinematics, robot workspace, inverse kinematics solutions, problems.

Differential Kinematics: Jacobian definition, analytical Jacobian computation, singularities, cartesian control, numerical Jacobian computation, problems.

Motion Planning: Robot configuration space, stochastic motion planning, sampling-based algorithms - Rapidly-exploring Random Trees (RRT), Probabilistic Roadmaps (PRM); graph-based motion planning, Dijkstra's algorithm, A* algorithm, differential drive robots, non-holonomic robots.

Books recommended:

1. Introduction to robotics: mechanics and control by John J. Craig.
2. Robotics: modeling, planning and control by Siciliano, Bruno.
3. Foundations of robotics: analysis and control by Yoshikawa, Tsuneo.
4. Fundamentals of robotics: analysis and control by Roberts J. Schilling.
5. Theory of applied robotics: Kinematics, dynamics and control by Jazar, Reza N.
6. Robotics: fundamental concepts and analysis by Ghosal, Ashitava.
7. Industrial robotics: technology, programming and applications by Groover, Mikell P.

Note: Paper setter will set eight questions. Students are required to answer five questions.

PPD 108: ADVANCED PRODUCTION TECHNOLOGY

		L	T	P	Credit
Assessment during Semester:	30 marks				
Assessment at the end of Semester:	70 marks	4	---	--	4.0

Metal cutting: Mechanics of chip formation, cutting forces, cutting power, tool life, selection of cutting tool materials and cutting fluids, machining and turning centres, machining, economics. Advanced Machining Processes: Electro discharge machining, electro chemical grinding, electron beam machining, abrasive jet machining and other machining methods, nanofabrication, micromachining, rapid prototyping operations, applications.

Newer casting and welding techniques: Expendable pattern casting, permanent mold casting, directional solidification, die casting and other casting methods, powder metallurgy process, Advance welding process- laser welding, ultrasonic welding, electron beam welding, submerged arc welding and other welding methods, welding defects, testing-destructive and NDT, weldability of plain carbon steels, SS, Al and its alloys.

Forging, extrusion and sheet metal work: Forging, different forging dies, extrusion and its applications, punching, blanking, bending, deep drawing.

Processing of ceramics, plastics and composites: Production, compaction, sintering of powders, design considerations, shaping of ceramics, processing methods for plastics and composites.

Simulation of manufacturing systems: Objectives of simulation in manufacturing, simulation software for manufacturing applications, simulation of different types of shops and manufacturing systems for performance measurement.

Books recommended:

1. Ramana Rao, T. V., Metal Casting: Principles and Practice, New Age International Pvt. Ltd. (2003).
2. Rao, P. N., Manufacturing Technology, McGraw Hill (2008).
3. Campbell, J., Castings, Butter Worth, Heinemann Publishers (2003).
4. Nadkari, S. V., Modern Arc Welding Technology, Oxford & India Book House Pvt. Ltd. (2005).
5. Boljanovic, V., Sheet Metal Forming Processes and Die Design, Industria Press (2014).
6. Charles A. Harper, Handbook of Plastics, Elastomers, and Composites, Fourth Edition, The McGraw-Hill Companies Inc, (2002).
7. Averill M. Law and W. David Kelton, Simulation Modeling and Analysis, McGraw Hill International Editions (1997).

Note: Paper setter will set eight questions. Students are required to answer five questions.

PPD 109: BIOMATERIALS/ BIOMEDICAL MATERIALS

		L	T	P	Credit
Assessment during Semester:	30 marks				
Assessment at the end of Semester:	70 marks	4	---	--	4.0

Fundamental properties of the biomaterials: Introduction of biomaterials, Historical perspective on the development of biomaterials, Types of biomaterial, Basic properties of materials, Glass and Glass-Ceramics, Bone Morphogenetic Proteins.

Metallic biomaterials: Stainless Steel, Co-based alloy, Cast CoCrMo, Wrought CoCrMo, Porous Coating for bone in growth, Ti-based alloys, Zr-Nb alloy, Ni-Ti alloy(Nitinol), Tantalum, Platinum-Iridium, Dental alloys, Biodegradable biomaterials.

Biomaterials processing, characterization, and application: Bone Biomechanics, Cartilage biomechanics, Tendon and Ligament Biomechanics, Joint Biomechanics, Biomechanical Properties.

Metal Corrosion: Interaction of metallic biomaterials with the human body environment, Electro-chemical reactions on metallic biomaterials, Types of corrosion of biomaterials, Corrosion testing of biomaterials, Tribocorrosion, Biotribology.

Wear: Introduction of bio-friction, Lubrication and Wear, Wear classification and fundamental wear mechanisms, Wear in biomedical devices and biomaterials

Biocompatibility of biomaterials: Cell culture, Cell morphology, Cyto-toxicity testing, Hemo-compatibility, Hypersensitive, Carcinogenicity, Hypersensitivity, Protein adsorption, Surface topography, Surface energy, Stress shielding, Genotoxity, Animal experimentation.

Surface modification: Abrasive blasting, Plasma glow discharge treatment, Thermal spraying, Physical vapor deposition, Chemical vapor deposition (CVD), Electrical discharge machining, Powder and nano-particles mixed machining, LASER machining.

Characterization of biomaterials: Surface energy, contact Angle, Infrared spectroscopy, E-ray photo-electron spectroscopy, Atomic force microscopy, Scanning electron microscopy (SEM), FESEM, Transmission electron microscopy (TEM), X-ray diffraction (XRD), Micro-hardness, surface roughness

Books recommended:

1. Biomedical materials by Roger Narayan: Springer
2. Biomaterials: An Introduction by Joon Park, R.S. Lakes: Springer
3. Introduction to Biomaterials by C. Mauli Agarwal, Joo L. Ong Combridge university press
4. Biomaterial Science : An Introduction to materials in medical by Buddy Ratner, Frederick J. , Society for biomaterials
5. Biomedical instrumentation and measurements by R. Anandanatarajan PHI

Note: Paper setter will set eight questions. Students are required to answer five questions.

PPD-110: COMPUTER AIDED DESIGN AND MANUFACTURING (CAD/CAM)

Assessment during Semester:	30 marks	**L**	**T**	**P**	**Credit**
Assessment at the end of Semester:	70 marks	4	---	--	4.0

COMPUTER AIDED DESIGN

3D Modeling
Modeling approaches, types and methods; Constraint based modeling; Parametric modeling; Feature based modeling.

Computer Graphics
Transformations and Projections; curves surfaces and solids

Product data Exchange
Standardization in graphics; Exchange of CAD modeling data; IGES, PDES, STEP graphics standards

CAD Customization
Controlling the CAD environment; Creating and editing CAD entities; Customizing toolbars and menus; read and write access to modify the models; Developing customized tools and applications with programmatic manipulation of features, assemblies and drawings.

COMPUTER AIDED MANUFACTURING

Part Programming
NC part programming, coordinate systems, NC programming languages, G & M codes, Part program for simple parts, CNC part programming, axes of CNC machines, computer aided part programming using APT.

Integration of CAD and CAM for Product Development
Automatic CNC program generation from CAD data, Cutter Location data from 3-D CAD Model for CNC system, Tools for product development--Rapid prototyping, Reverse Engineering.

Incremental Sheet Forming (ISF) –A die-less CNC controlled process
History and Development of ISF, working Principle of ISF, Benefits and Limitations, Challenges and Applications of ISF, Classifications of ISF: Single Point ISF, Two Point ISF, Double Sided ISF, Hybrid ISF, Friction Assisted ISF , Laser Assisted ISF, ISF Process Parameters.

Books Recommended:

1. Computer Graphics, D Hearn & M P Baker, Prentice Hall.
2. CAD/CAM Theory and Practice, Ibrahim Zeid & R Sivasubramanian, Tata McGraw-Hill.
3. Mathematical Elements for Computer Graphics, D F Rogers and J A Adams, McGraw-Hill International.
4. Computer Aided Engineering & Design, Jim Browne, New ATC International.
5. Principles of CAD, J Rooney &P Steadman, Longman Higher Education.

6. CAD/CAM, H P Groover and E W Zimmers, Prentice Hall.
7. Computer Integrated Design and Manufacture, D Bedworth, M Henderson & P Wolfe, MacGraw Hill Inc.
8. CAD/CAM Principles and Applications, P. N. Rao, McGraw–Hill.
9. CAD/CAM Concepts and Applications, C R Alavala. PHI.
10. Customizing Pro/ENGINEER with Pro/TOOLKIT, FELCO Solutions, Inc www.felcosolutions.com

Note: Paper setter will set eight questions. Students are required to answer five questions