Course structure and detailed syllabus for M. Tech in Mechanical Engineering (Specialization: Manufacturing Technology)

Haldia Inst. of Technology

FIRST YEAR FIRST SEMESTER

A. Theory							
Sl. No.	**Code**	**Theory**	**Contacts Periods/Week**				**Credit**
			L	**T**	**P**	**Total**	
1.	**M 1101**	**Advanced Optimization and Statistical Methods**	**3**	**1**	**-**	**4**	**3**
2.	**ME 1101**	**Numerical Control of Machine Tools**	**3**	**-**	**-**	**3**	**3**
3.	**ME 1102**	**Advances in Manufacturing Technology**	**3**	**-**	**-**	**3**	**3**
4.	**ME 1103**	**Elective I**	**3**	**-**	**-**	**3**	**3**
5.	**ME 1104**	**Elective II**	**3**	**-**	**-**	**3**	**3**
Total of theory			**15**	**1**	**-**	**16**	**15**
B. Practical							
6.	**ME 1191**	**CAD / CAM Laboratory**	**-**	**-**	**4**	**4**	**3**
Total of practical			**-**	**-**	**4**	**4**	**3**
C. Sectionals							
7.	**ME 1192**	**Seminar**			**3**	**3**	**2**
Total of Sessional			**-**	**-**	**3**	**3**	**2**
Total of Semester			**15**	**1**	**7**	**23**	**20**

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FIRST YEAR SECOND SEMESTER

A. Theory							
Sl. No.	Code	Theory	Contacts Periods/Week				Credit
			L	T	P	Total	
1.	ME 1201	Robotics	3	-	-	3	3
2.	ME 1202	Quality and Reliability Engineering	3	-	-	3	3
3.	ME 1203	Elective III	3	-	-	3	3
4.	ME 1204	Elective IV	3	-	-	3	3
5.	ME 1205	Elective V	3	-	-	3	3
Total of theory			15	-	-	15	15
B. Practical							
6.	ME 1291	Robotics & Mechatronics Laboratory,	-	-	3	3	2
7.	ME 1292	NTM laboratory	-	-	3	3	2
Total of practical			-	-	6	6	4
C. Sessional							
7.	ME 1293	Seminar			3	3	2
Total of Sessional			-	-	3	3	2
Total of Semester			15	-	7	24	21

LIST OF ELECTIVE PAPERS

ELECTIVE I, II, III, IV and IV		
ME / E-01	Hydraulic and Pneumatic Control Systems	
ME / E-02	Manufacturing Automation	
ME / E-03	Finite Element Analysis	
ME / E-04	Rapid Prototyping and Reverse Engineering	
ME / E-05	Metal Forming Processes	
ME / E-06	Concurrent Engineering	
ME / E-07	Modeling And Simulation In Engineering	
ME / E-08	Computer Integrated Manufacturing	
ME / E-09	Statistical Process Control	
ME / E-10	Ergonomics and Work System Design	
ME / E-11	Design of Experiments	
ME/E-12	Mechatronics & Modern Control	

C. SESSIONALS							
Sl. No.	**Code**	**Theory**	**Contacts Periods/Week**				**Credit**
			L	**T**	**P**	**Total**	
1.	**ME 2191**	**Assigned Project**			**15**	**15**	**15**
2.	**ME 2192**	**Grand Viva**	**-**	**-**	**-**	**-**	**5**
Total of Semester						**20**	**20**

First Year First Semester:

Advanced Optimization and Statistical Methods

Code: M 1101

Contacts: 3L + 1T

Basic Optimization: Optimization problem & characterization of optimality, Convex-Sets & functions, Non linear optimization (Kuntheker conducting Lagrange Mutineer, principle of optimality & maximum principle). Optimization techniques: Integer programming, goral programming, geometric programming, Dynamic programming; stochastic programming.

Statistical Compilation: Sampling; Population and simple. Estimation, Statistical Inference. Testing of Hipster's and Inference. Correlation and Regression: Correlation and rank Correlation, Linear and Non-linear Regression, Multiple Regression, Least square approximation.

Statistical Quality control: Factor Analysis, ANOVA, and Test of significance: (Chi-test and F-test)

Numerical Control of Machine Tools

Code: ME 1101

Contacts: 3L

Introduction to numerical control, CNC concepts. Control system fundamentals: feedback, transfer function, system stability. Basic NC electronics: Gates, Flip-Flop and Pulse generation. System components: Transducer, actuators, MCU. Design considerations of NC and CNC machines: Lost motions in NC systems, M/C tool vibrations, Re-circulating ball screw. NC

machine control systems: Position and velocity feedback, position error, command signal and error detection, pattern error, system bandwidth and cornering error. NC part programming, CNC programming, computer assisted part programming - 2D and 3D. Integration and programming from CAD models and database. CNC Tooling, Numerical control mathematics: Analytical geometry in NC, Contour fitting procedure, Analytic and sculptured surfaces. Online condition monitoring in CNCs, Process optimization; adaptive control, DNC Concepts. Economics of NC

Advances in Manufacturing Technology

Code: ME 1102

Contacts: 3L

CAD: Co-ordinate Transformations; Three Dimensional Curve and Surface Geometry: Types and mathematical representation of curves and surfaces: Parametric description of analytic and synthetic curves, Curve and Surface Design, Composite Curves and Splines, Composite Surfaces,

Types and mathematical representation of solids: Half spaces, Boundary representation (B-Rep), Constructive Solid Modeling (CSG), sweep representation, Solid modeling based application.

CAM: Stock boundary definition and Generation of machining paths from CAD Database. Cutter paths for Numerical Control. CAD-CAM interface.

Flexible Manufacturing System: Management decisions, Distributed processing in FMS, Interfacing computer, M/C Tool controllers and Industrial robots. Quantitative Analysis of FMS, Social issues.

A brief overview of non-traditional machining processes: Analysis of mechanical, thermal and electrochemical type nontraditional machining processes. Analysis of micro-machining processes. Tool design for selected non-traditional machining processes. A comparative study of various processes. Application of CNC concepts to non-traditional machining processes machines. Computer aided process planning of nontraditional processes. Precision Machining and High speed machining.

First Year Second Semester:

Robotics

Code: ME 1201

Contacts: 3L

Automation & Robotics; Spatial Descriptions & Transformations. Manipulator Kinematics – Forward and Inverse; Jacobians: Velocities & Static Forces. Robot Arm Dynamics: Lagrange-Euler formulation of manipulator dynamics. Trajectory Planning: Joint-interpolated trajectories, Geometric problems with Cartesian paths, Collision-free path planning. Robot Control Systems: Feedback and Closed-loop control, Transfer Functions, Control of Second-order systems, Non-linear & time varying systems, Adaptive Control. Robotic Prehension: Dexterous manipulation;

ANN approach in prehension, Sensors in Robotics: Machine vision, Force & Torque sensors. Robot programming: simulators and languages. Tele-robotics and virtual interfaces for task specification and programming. Concept of nanorobotics; Performance analysis of industrial robots and their manufacturing applications; Economics of robotics. Social issues & future of robotics.

Quality and Reliability Engineering

Code: ME 1202

Contacts: 3L

Basic Concepts and Definition; Traditional Quality Control; Quality Policy and Objectives, Quality planning, analysis and control. On-line and off-line quality control. Quality parameter design - Taguchi method - Orthogonal arrays. Robust design - noise factors, testing conditions, quality characteristics, DFMA, identification of control factors, System optimization. Quality audit, ISO 9000.

Fundamental aspects of reliability, Reliability testing and evaluation. Failure patterns and mathematical models. Role of manufacturing processes in controlling reliability. Role of design in achieving reliability goals. Systems approach to reliability integration.

List of elective papers for both the semesters

HYDRAULIC AND PNEUMATIC CONTROL SYSTEMS

Positive displacement Pumps, Control valves – Pressure Control, Flow Control, Direction Control. Flow forces on valve spools, valve design, and Hydraulic actuators – linear and rotary. Hydraulic power packs, torque motor, electro-hydraulic Servo valves, FES, DPF, SLEW servo valves, Air Filter, Lubricators and Regulators. Pneumatic control elements; Air Cylinders and their Design, Pneumatic safety circuits Pneumatic Logic control, Fluidics.

MANUFACTURING AUTOMATION

Automation strategies, flow lines, automated assembly systems, Transfer systems; Vibratory bowl feeders, non-vibratory feeders. Part orienting, feed track, part placing and part escapement systems; Programmable automation, industrial robotics; Flexible manufacturing systems; Automation equipment.

FINITE ELEMENT ANALYSIS

Introduction: basic concept of the finite element method, comparison with finite difference method;, Methods of weighted residual techniques-Weak Formulation, Galerkin FE formulation, Rayleigh & Ritz FEM,FEM analysis of One-dimensional problems:-Second order boundary value problem, Applications in Solid mechanics, Bending of Beams, Euler-Bernoulli Beam, Truss/Frame analysis, Eigen value and Time dependent problems . MATLAB Application, Numerical Integration
Computer Implementation-Natural Co-ordinates, Interpolation Functions, Numerical Integration, Iso-parametric Formulation, Computer Implementation, Applications in two-dimensional problems-Plane Stress and plane Strain, Three Dimensional Solid, Axi-symmetric Solid, Plate and Shell structures, MATLAB Application, Special Topics, Stationary Singular elements, Quarter-Point Singular Elements, Moving singular elements, Semi-infinite elements, Buckling analysis, Non-linear analysis

RAPID PROTOTYPING AND REVERSE ENGINEERING

Classification of manufacturing processes, Different Manufacturing Systems, Introduction to Rapid Prototyping (RP), Need of RP in context of batch production, FMS and CIM and its application; Basic Principles of Generative Manufacturing Processes. Steps in RP, Process chain in RP in integrated CAD-CAM environment, Advantages of RP; Reverse Engineering: Need & Techniques, Data collection, Point-Cloud of data. Utility of Rapid Prototyping in Reverse Engineering. Classifications of different RP techniques – based on raw material, layering technique (2D or 3D) and energy sources; Process Technology and Comparative study of: - Stereo-lithography (SL) with photo-polymerization, SL with liquid thermal polymerization, Solid foil polymerization, Selective laser sintering, Selective powder binding, Ballastic particle manufacturing – both 2D and 3D, Fused Deposition Modelling, Shape Melting, Laminated Object Manufacturing, Solid Ground Curing, Repetitive Masking and deposition, Beam Inference Solidification, Holographic Interference Solidification. Special Topic on RP using metallic alloys, Programming in RP, Modelling, Slicing, Internal Hatching, Surface Skin Fills, Support Structure

CONCURRENT ENGINEERING

Concurrent engineering tools for collaborative work environment. Framework for virtual teams. Multimedia conferencing systems. Principles of object oriented and distributed databases. Object oriented concurrent programming for design and analysis. Participatory design. Common product design concepts, design rationale and causal process descriptions. Product concept development, Analytical Prototyping for kinematic and dynamic validation of constraints in displacements and forces. Virtual reality tools and techniques for product development and interactive modeling and visualization.

MODELLING AND SIMULATION IN ENGINEERING

Model testing: Stochastic vs. Deterministic models. Principles of Simulation, Discrete event Simulation, Generation of Pseudo Random Numbers, Monte Carlo simulation - Examples, Queuing model, Inventory Control models, Simulation Worksheet, Simulation Languages such as GPSS, CNC Languages, Planning for NC Path Generation using software, Robotic Languages; Robot Programming: PTP and CP, Path Generation of Robots and Obstacle Avoidance, Hydraulic and Pneumatic circuit simulation, Simulation of ladder logic and SFG. ANN, Manufacturing examples, Fuzzy logic and examples in manufacturing, use of Petrinet in Assembly.

COMPUTER INTEGRATED MANUFACTURING

Definition & Concept, CIM wheel, External and Internal challenges, World-class order winning criteria. Product Development Cycle. Concurrent Engineering and Design for Manufacturing & Assembly. Design Automation & Computer Aided Design: Hardware & Software platform, Computer aided Design Analysis. Computer Aided Manufacturing: Group Technology, Clustering Techniques, Computer Aided Process Planning: Feature Recognition, Feature-Process co-relation. Operations Management: Manufacturing Planning & Control. Material requirement Planning (MRP), MRP II, Shop loading, Master Production Schedule, Inventory Management, Product Data management, Just-in-Time Manufacturing, Synchronized Production, Lean & Agile Manufacturing. Flexible Manufacturing System: Distributed Processing in FMS. Interfacing computers, machine tools controllers and robots. FMS design issues. Quantitative analysis of FMS. Social and human aspects of FMS. Various CIM systems.

STATISTICAL PROCESS CONTROL

History of statistical process control, quality and quality management techniques, basic principles of statistics and probabilities (application of set theories and modern methods of determination of probabilities); normal, student's -t, X^2 (chi-square), exponential and Poisson's distributions; HYPOTHESIS TESTING, concept of type I and II error; sampling techniques;

Causes of variations of jobs produced from a process (with examples), parameter selection to control a process, different types of control charts, preparation of control charts for variables (X and R bar charts), control charts for attributes (p-and n.p-chart, c-chart, u-chart, U-chart), general patterns of plots to determine the assignable causes, control charts for standard deviation and mean, control charts for individual items, trend chart, moving average control chart, cumulative control chart, acceptance control chart;

Introduction to process capability, specification and control limits, natural tolerance limits, process capability indices, process capability analysis procedure, setting tolerances on assemblies and components, estimation of natural tolerance;

Introduction to Acceptance sampling, producer's and consumer's risk, O.C curve, types of sampling plans, sampling plans for continuous production, lot by lot attribute sampling plans, variable sampling plans for a process parameter.

ERGONOMICS AND WORK SYSTEM DESIGN

Work Study Fundamentals: Productivity and Work Study, Definitions, Scope, and History of Work Study, Analysis of Work Content. Method Study: Process Analysis, Process and Activity Charts, Operation Analysis, Basic procedure, Micro Motion Study, Principles of Motion Economy. Work Measurement: Purposes and uses, Basic procedure, Techniques – Work Sampling, Stop-Watch Time Study, Rating and Allowances, Setting Standard Times for Jobs, Standard Data, Predetermined Time Standards.

Ergonomics: Fundamental Concepts, Issues in Work system Design, Measuring Work by Physiological means, Work Posture, Fatigue Measurement and Evaluation, Environmental Factors and Work Systems,

Job Evaluation: Basic concepts, Objective and Subjective methods, Compensation Schemes, Relationship of Work Study to Incentive Schemes, Wage Incentive Plans.

DESIGN OF EXPERIMENTS

History of design of experiment; strategy, principle and application of DOE; basic statistical concepts, sampling techniques and distributions; inferences about means and standard deviations and considerations of different hypothesis; Experiments with single factorial design and application of ANOVA; randomized blocking and Latin squares.

Factorial design, 2^k and 3^k factorial design; blocking and confounding techniques in 2^k factorial design; Concept of fractioning of factorial design; Response surface method; Introduction to robust design, robust parameter design for single response system; Experiments with non-normal data.