



خواجہ معین الدین چشتی لیکچوئریج یونیورسٹی، لکھنؤ، اتر پردیش (ہندوستان)  
ख्वाजा मुईनुद्दीन चिश्ती भाषा विश्वविद्यालय, लखनऊ, उत्तर प्रदेश (भारत)  
KHWAJA MOINUDDIN CHISHTI LANGUAGE UNIVERSITY, LUCKNOW, U.P. (INDIA)  
UTTAR PRADESH STATE GOVERNMENT UNIVERSITY  
(Recognised Under Section 2(f) & 12(B) of the UGC Act, 1956 & B.Tech. Approved by AICTE)

**FACULTY OF ENGINEERING & TECHNOLOGY**  
**KHWAJA MOINUDDIN CHISHTI LANGUAGE**  
**UNIVERSITY, LUCKNOW, UTTAR PRADESH**



**M.TECH (MECHATRONICS)**  
**Curriculum Structure**

**FIRST AND SECOND YEAR**  
**(I, II, III & IV Semester)**

[Effective from Session 2021-22]

STUDY & EVALUATION SCHEME											
M.TECH 1ST YEAR 1ST SEMESTER (MECHATRONICS)											
Theory Subjects			EVALUATION SCHEME								
S.No.	Subject Code	Name of the Subject	Periods			Sessional Assessment			SEE	Subject Total	Credits
			L	T	P	MST	TA	Total			
1	MTM-101	Material Characterization	3	-	-	15	15	30	70	100	3
2	MTM-102	Advanced CNC Technology	3	-	-	15	15	30	70	100	3
3	MTM-103	Sensor and Signal Conditioning	3	-	-	15	15	30	70	100	3
4	MTM-01*	Elective I	3	-	-	15	15	30	70	100	3
5	MTM-02*	Elective II	3	-	-	15	15	30	70	100	3
		<b>Total</b>	<b>15</b>	<b>-</b>	<b>-</b>	<b>75</b>	<b>75</b>	<b>150</b>	<b>350</b>	<b>500</b>	<b>15</b>
<b>Laboratory Courses</b>											
6	MTM-151	Sensor Lab	-	-	3	-	20	20	30	50	2
7	MTM-152	Advanced CNC Lab	-	-	2	-	20	20	30	50	1
		<b>Total</b>	<b>-</b>	<b>-</b>	<b>5</b>	<b>-</b>	<b>40</b>	<b>40</b>	<b>60</b>	<b>100</b>	<b>3</b>
		<b>GRAND TOTAL</b>	<b>15</b>	<b>-</b>	<b>5</b>	<b>75</b>	<b>115</b>	<b>190</b>	<b>410</b>	<b>600</b>	<b>18</b>

#### Elective I

- MTM-011 Precision Engineering
- MTM-012 Concept of Mechanism & Machines
- MTM-013 Metrology & Computer Aided Inspection

#### Elective II

- MTM-021 Control System
- MTM-022 Power electronics and Drives
- MTM-023 Internet of Things (IOT)

#### \*\*Audit Course

(Student have to pass the paper in First Semester)

- MTM-A01 Research Process and Methodology

STUDY & EVALUATION SCHEME												
M.TECH 1ST YEAR 2ND SEMESTER (MECHATRONICS)												
Theory Subjects			EVALUATION SCHEME									
S.No.	Subject Code	Name of the Subject	Periods			Sessional Assessment			SEE	Subject Total	Credits	
			L	T	P	MST	TA	Total				
1	MTM-201	Computational Fluid Dynamics	3	-	-	15	15	30	70	100	3	
2	MTM-202	Industrial Robotics	3	-	-	15	15	30	70	100	3	
3	MTM-203	Microcontroller & PLC	3	-	-	15	15	30	70	100	3	
4	MTM-03*	Elective III	3	-	-	15	15	30	70	100	3	
5	MTM-04*	Elective IV	3	-	-	15	15	30	70	100	3	
<b>Total</b>			<b>15</b>	<b>-</b>	<b>-</b>	<b>75</b>	<b>75</b>	<b>150</b>	<b>350</b>	<b>500</b>	<b>15</b>	
<b>Laboratory Courses</b>												
8	MTM-251	Applied Mechatronics Lab (Robotics, PLC, etc.)	-	-	3	-	20	20	30	50	2	
9	MTM-252	Seminar I	-	-	2	-	20	20	30	50	1	
<b>Total</b>			<b>-</b>	<b>-</b>	<b>5</b>	<b>-</b>	<b>40</b>	<b>40</b>	<b>60</b>	<b>100</b>	<b>3</b>	
<b>GRAND TOTAL</b>			<b>15</b>	<b>-</b>	<b>5</b>	<b>75</b>	<b>115</b>	<b>190</b>	<b>410</b>	<b>600</b>	<b>18</b>	

### Elective III

Reliability Engineering  
 Simulation, Modeling and Manufacturing System  
 Intelligent Manufacturing System

### Elective IV

Optimization Techniques and Design of experiments  
 Autotronics and Vehicle Intelligence  
 Computer Aided Metrology & Machine Vision  
 Machine Learning

STUDY & EVALUATION SCHEME

M.TECH 2ND YEAR 3RD SEMESTER (MECHATRONICS)

Subjects			EVALUATION SCHEME								
S.No.	Subject Code	Name of the Subject	Periods			Sessional Assessment			SEE	Subject Total	Credits
			L	T	P	MST	TA	Total			
1	MTM-351	Seminar II	-	-	6	-	100	100	-	100	3
2	MTM-352	Dissertation	-	-	30	-	200	200	300	500	15
Total			-	-	36	-	300	300	300	600	18

STUDY & EVALUATION SCHEME

M.TECH 2ND YEAR 4TH SEMESTER (MECHATRONICS)

Subjects			EVALUATION SCHEME								
S.No.	Subject Code	Name of the Subject	Periods			Sessional Assessment			SEE	Subject Total	Credits
			L	T	P	MST	TA	Total			
1	MTM-451	Dissertation (Final)	-	-	36	-	200	200	400	600	18
Total			-	-	36	-	200	200	400	600	18

Handwritten signatures in blue ink, including names like "Rashid", "Sheem", and "Bijon".



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## SEMESTER : I



## MTM 101: MATERIAL CHARACTERIZATION

### **UNIT-I:**

Importance of Material characterization. Classification of techniques for characterization. Vacuum systems: Vacuum range, Vacuum Pumps: Rotary, Sorption, Turbomolecular, Diffusion, Ion, Cryo. Vacuum measurement gauge: Pirani, Penning, Ionization etc. Use of Vacuum systems in Material Characterization techniques

### **UNIT-II:**

Thermal Analysis techniques: Principle, Working and application of DTA, TGA, TMA and DSC. Optical microscopy techniques: Metallurgical Microscopes, Aberration in Optical microscopy & its remedies, Polarized light in microscopy, Differential Interference Contrast Illumination, Hot Stage Microscopy, color metallography, and image analysis techniques.

### **UNIT -III:**

Electron microscopy: Electron beam, Principle, Construction and Working of TEM, SEM, STEM, with their merits, limitations and applications. Techniques of replica preparation. Atomic Microscopy: Field Ion Microscope, Working of AFM and STM with their merits, limitations and applications.

### **UNIT-IV:**

Spectroscopic Techniques for chemical analysis:, UV-Visual(UV-VIS), IR, FTIR, EDS & WDS, X-ray Fluorescopy (XRF), Atomic absorption spectrometer(AAS), Atomic Emission spectroscopy (AES), Secondary Ion mass spectrometry (SIMS), Rutherford backscattering spectroscopy (RBS)

### **UNIT-V:**

Diffraction method: Brags Law, X-ray diffraction methods, determination of crystal structure, lattice parameter, crystallite size, merits and demerits. Surface characterization: XPS (ESCA), UPS, Auger Electron Spectroscopy, Electron Probe Micro Analysis (EPMA), LEED.

### **REFERENCE BOOKS:**

1. F. Weinberg Editor, Tools & Techniques in Physical Metallurgy, Vol. I & II, Marcel Dekker
2. John P. Sibilis, A guide to Material Characterization & Chemical Analysis, VCH Publishers, 1988.
3. J.M. Walls, Editor, Methods of Surface Analysis : Techniques & Applications, Cambridge University Press, 1990.
4. B.D. Cullity, Elements of X-ray diffraction, Addison-Wesley Publishing Company, INC., 5. Bernhard Wunderlich, Thermal Analysis, Academic Press, INC, 1990.
6. B.L. Gabriel, SEM : A user's manual for materials Science, American Society for Metals
7. An Introduction to Materials Characterization by P. R. Khangaonkar, Penram International Publishing (India) Pvt. Ltd.



## MTM-102 ADVANCED CNC TECHNOLOGY

### UNIT I:

**Features of NC Machines :** Fundamentals of numerical control, advantage of NC systems, classification of NC systems, point to point, NC and CNC, incremental and absolute, open and closed loop systems, Features on N/C Machine Tools, design consideration of NC machine tool, methods of improving machine accuracy.

### UNIT II:

**NC part Programming:** Manual programming-Basic concepts, Point to Point contour programming, canned cycles, parametric programming. Tooling for CNC Machines: Interchangeable tooling system, preset and qualified tools, coolant fed tooling system, modular fixturing, quick change tooling system, automatic head changers.

### UNIT III:

**DNC Systems and Adaptive Control:** Introduction, type of DNC systems, advantages and disadvantages of DNC, adaptive control with optimization, Adaptive control with constraints, Adaptive control of machining processes like turning, grinding.

### UNIT IV:

**Rapid Prototyping:** Introduction, Stereo-lithography, Selective Laser Sintering, Fusion Deposition Modeling (FDM), LOM, Rapid Tooling.

### UNIT V:

**Post Processors for CNC: Introduction to Post Processors:** The necessity of a Post Processor, the general structure of a Post Processor, the functions of a Post Processor, DAPP-based-Post Processor: Communication channels and major variables in the DAPP-based Post Processor, the creative of a DAPP Based Post Processor.

### TEXT BOOKS:

1. Computer Control of Manufacturing Systems / Yoram Korem / Mc Graw Hill Int.1983.
2. Machine Tools Hand Book vol 3, (Automation & Control) / Manfred Weck / John Wiley and Sons, 1984.



## MTM-103 SENSORS AND SIGNAL CONDITIONING

### UNIT I: INTRODUCTION

Basics of Measurement – Classification of errors – Error analysis – Static and dynamic characteristics of transducers – Performance measures of sensors – Classification of sensors – Sensor calibration techniques – Sensor Output Signal Types

### UNIT II: MOTION, PROXIMITY AND RANGING SENSORS

Motion Sensors – Brush Encoders, Potentiometers, Resolver, Encoders – Optical, Magnetic, Inductive, Capacitive, LVDT – RVDT – Synchro – Microsyn, Accelerometer, – GPS, Range Sensors – RF beacons, Ultrasonic Ranging, Reflective beacons, Laser Range Sensor (LIDAR)

### UNIT III: FORCE, MAGNETIC AND HEADING SENSORS

Strain Gage, Load Cell Magnetic Sensors –types, principle, requirement and advantages: Magneto resistive – Hall effect – Current sensor Heading Sensors – Compass, Gyroscope, Inclinometers

### UNIT IV: OPTICAL, PRESSURE AND TEMPERATURE SENSORS

Photo conductive cell, photo voltaic, Photo resistive, LDR – Fiber optic sensors – Pressure – Diaphragm, Bellows, Piezoelectric, Temperature – IC, Thermistor, RTD, Thermocouple,

### UNIT V: SIGNAL CONDITIONING

Need for Signal Conditioning – DC and AC Signal conditioning – Filter and Isolation Circuits – Operational Amplifier Specifications, Characteristics and Circuits – Voltage and Current Amplifiers – Transmitting Circuits – Fundamentals of Data Acquisition System.

### REFERENCES:

1. Patranabis D., Sensor and Actuators, Prentice Hall of India (Pvt) Ltd, 2005.
2. Ernest O. Doebelin, Measurement system, Application and design, Tata McGraw Hill Publishing Company Ltd., Fiftieth Edition, 2004
3. Bradley D.A., and Dawson, Burd and Loader, Mechatronics, Thomson Press India Ltd., 2004
4. Renganathan S., Transducer Engineering, Allied Publishers (P) Ltd., 2003.
5. Bolton W., Mechatronics, Thomson Press, 2003.





## ELECTIVE - I

### MTM-011 PRECISION ENGINEERING

#### UNIT I:

**Concepts of Accuracy :** Introduction – Concept of Accuracy of Machine Tools – Spindle and Displacement Accuracies – Accuracy of numerical Control Systems – Errors due to Numerical Interpolation Displacement Measurement System and Velocity Lags. Geometric Dimensioning and Tolerancing Tolerance Zone Conversions – Surfaces, Features, Features of Size, Datum Features – Datum Oddly Configured and Curved Surfaces as Datum Features, Equalizing Datums –Datum Feature of Representation – Form Controls, Orientation Controls – Logical Approach to Tolerancing.

#### UNIT II:

**Datum Systems:** Design of freedom, Grouped Datum Systems – different types, two and three mutually perpendicular grouped datum planes; Grouped datum system with spigot and recess, pin and hole; Grouped Datum system with spigot and recess pair and tongue – slot pair – Computation of Transnational and rotational accuracy, Geometric analysis and application.

#### UNIT III:

**Tolerance Analysis:** Process Capability, Mean, Variance, Skewness, Kurtosis, Process Capability Metrics, Cp, Cpk, Cost aspects, Feature Tolerances, Geometric Tolerances. Tolerance Charting Techniques - Operation Sequence for typical shaft type of components, Preparation of Process drawings for different operations, Tolerance worksheets and centrally analysis, Examples. Design features to facilitate machining; Datum Features – functional and manufacturing. Components design – Machining considerations, Redesign for manufactured. Examples

#### UNIT IV

Surface finish, Review of relationship between attainable tolerance grades and different machining process. Cumulative effect of tolerances sure fit law, normal law and truncated normal law.

#### UNIT V:

**Fundamentals of Nanotechnology:** System of nanometer accuracies – Mechanism of metal Processing – Nano physical processing of atomic bit units. Nanotechnology and Electrochemical atomic bit processing.

**Measuring Systems Processing :** In processing or in-situ measurement of position of processing point- Post process and on-machine measurement of dimensional features and surface-mechanical and optical measuring systems.

#### TEXT BOOKS:

1. Precision Engineering in Manufacturing/Murthy R. L./New Age International(P) Ltd, 1996.
2. Geometric Dimensioning and Tolerancing / James D.Meadows / Marcel Dekker Inc.1995.

#### REFERENCE BOOKS:

1. Nano Technology / Norio Taniguchi / Oxford University Press, 1996.
2. Engineering Design – A systematic Approach / Matousek / Blackie & Son Ltd, London.



## MTM-012 CONCEPT OF MECHANISMS AND MACHINES

### **UNIT I: MECHANISMS**

Definition – Machine and Structure – Kinematic link, pair and chain – classification of Kinematic pairs – Constraint & motion - Degrees of freedom – Slider crank – Single and double – Crank rocker mechanisms – Inversions – applications. Kinematic analysis and synthesis of simple mechanisms – Determination of velocity and acceleration of simple mechanisms.

### **UNIT II: FRICTION**

Types of friction – friction in screw and nuts – pivot and collar – thrust bearings – collar bearing – plate and disc clutches – belt (flat & vee) and rope drives – creep in belts – Jockey pulley – open and crossed belt drives – Ratio of tensions – Effect of centrifugal and initial tension – condition for maximum power transmission – basics of brakes, journal and rolling element bearings hydrostatic and aerostatic bearings – recirculating ball screw and nut assembly.

### **UNIT III: GEARING AND CAMS**

Gear profile and geometry-nomenclature of spur and helical gears – law of gearing – interference requirement of minimum number of teeth in gears-gear trains-simple and compound gear trains-determination of speed and torque in epicyclic gear trains-Cam profile-different types of followers.

### **UNIT IV: VIBRATION**

Free, forced and damped vibrations of single degree of freedom systems – force transmitted to supports – vibration Isolation – vibration absorption – torsional vibration of shafts – single and multirotor systems – geared shafts – critical speed of shafts.

### **UNIT V: MACHINE TOOLS**

Machine tool construction-features – operations of lathe, milling machine, drilling machine – Drive system for machine tools – mechanical, hydraulic and electric stepped and variable speeds – spindle speeds and feed drives-linear and reciprocation motion generation.

### **REFERENCES:**

1. Dr.R.K.Bansal "Theory of Machines" Laxmi Publications (P) ltd., New Delhi. 2011.
2. G.C.Sen . and A. Bhattacharya, "Principles of machine tools" , New Central book Agency, 1999.
3. Joseph Edward Shigley, Charles R.Mischke, "Mechanical Engineering Design" Mcgraw Hill International Edition, 2008 .
4. Malhotra .D.R. and Gupta .H.C. "The Theory of machines" SatyaPrakasam, Tech. India Publications, 1989.
5. R.S.Khurmi and Gupta . " Theory of Machines" Eurasia Publishing House Pvt Ltd. 2012

## MTM-013 METROLOGY & COMPUTER AIDED INSPECTION

### UNIT I:

**Metrology and Techniques:** Standards in metrology, definitions, Traceability, Characteristics Length & Angular measurements-Review of standard instruments, GD and tolerance procedure-Review of dimension & form tolerance and methods of measurement, Tolerance analysis, Surface metrology- Instruments, Methods and new approaches.

### UNIT II:

**Laser Applications in Metrology:** LASER light source, LASER interferometer, LASER alignment telescope, LASER micrometer, On-line and in-process measurements of diameter, Roundness and surface roughness using LASER, Micro holes and topography measurements.

### UNIT III:

**Special Measuring Instruments and Techniques:** Optoelectronic devices, contact and non-contact types, Applications in on-line and in-process monitoring systems, Tool wear measurement, Surface measurement, Machine vision, shape identification, Edge detection techniques, Normalization, gray scale correlation, Template Techniques, Surface roughness using vision system, Interfacing robot and image processing system.

### UNIT IV:

**Co-ordinate Measuring Machine:** Types of CMM, Probes used, Applications, Non-contact CMM using electro optical sensors for dimensional metrology, Non-contact sensors for surface finish measurements, statistical evaluation of data using computer, Data integration of CMM and data logging in computers.

### UNIT V:

**Sensors in Inspection:** Manufacturing applications of photo detectors, deflection methods-beam detection, Reflex detection, & Proximity detection, Applications of Inductive and Capacitive proximity sensors, Understanding microwave sensing applications laser sensors and limit switches, Advanced sensor technology-Bar code systems, Principles and applications of Colour sensors, electro-magnetic identifier, Tactile sensors, Ultrasonic sensors, Odour sensors.

### Books:

1. Fundamentals of dimensional Metrology T. Busch and R. Harlow Delmar, 3e
2. Engineering Metrology G. Thomas and G. Butter Worth PUB
3. Sensors and Control systems in Manufacturing Sabne Soloman McGraw Hill Book
4. Measurement systems: Applications & Design Doebelin International Student Edition
5. Optoelectronics for Technology and Engineering Robert G. Seippel Prentice Hall India
6. Interface Technology for Computer Controlled Manufacturing processes Ulrich-Rembold, Armbruster and Ulzmann Marcel Dekker Publications, NY
7. Optoelectronics J. Watson Van Nostrand Rein Hold (UK) Company





## ELECTIVE - II MTM-021 CONTROL SYSTEM

### UNIT-I

**Mathematical Model For Physical Systems** - Open loop – closed loop control – Differential equations of physical systems – Transfer functions – Block diagram algebra – Signal flow graphs – Reduction using Mason's gain formula.

**Industrial Automatic Controls** - Classification – Proportional derivative and integral control actions – Liquid level control systems with proportional and integral control – Pneumatic, hydraulic and electronic controllers

### UNIT-II

**Transient Response Analysis** - Standard signals – transient response of first and second order systems – Steady state errors and error constants.

### UNIT-III

**Transfer Function Representation:** Transfer function of DC servomotor – AC servomotor – Synchronous transmitter and receiver. Block diagram representation of systems – Representation by signal flow graph.

### UNIT-IV

**Stability Analysis:** Concepts of Stability - Necessary conditions for stability – Hurwitz stability criterion – Routh's stability criterion – Relative stability. Frequency Response Analysis - The root locus concept – Frequency response, polar plot, Bode plot – Nyquist stability criterion.

### UNIT-V

**State Variable Model and Analysis** - Concepts of state & state variables – Derivation of state models from Block diagrams - State space representation of systems – Transfer matrix - Solution of state equation – State transition matrix – Concepts of controllability and observability.

### TEXT BOOKS

1. Control systems, Principles and Design / M Gopal / TMH.
2. Modern Control Engineering/ K.Ogata / Prentice Hall.
3. Control Systems /Anand Kumar / Prentice Hall.

### REFERENCES:

1. Control Systems Engineering /Nagrath & M.Gopal/ Wiley Eastern.
2. Automatic control systems/ B.C.Kuo/John Wiley & Sons\ Modern Control Systems/ Richard, C.Dorf and Robert H.Bishop.

## MTM-022 POWER ELECTRONICS AND DRIVES

### UNIT-I

**Introduction :** Introduction to Power electronics- Power electronics versus linear electronics- Review of thyristors- Power FETS – Turn on and off circuits- Microprocessor based firing circuits- Series and Parallel operation –protection circuits- Design of snubber circuits- rating and protection.

### UNIT-II

**Converters and Inverters:** Analysis of half controlled and fully controlled converters- Dual converters- Analysis of voltage source and current source- Current source and series converters.

### UNIT-III

**Industrial Motor Control :** Methods of controlling speed – Introduction and DC Motor controls- use of Microcontroller for speed control- Feedback and Feed forward control- Step-Up and Step- Down Choppersuse of Choppers- Frequency converters and cyclo converters.

### UNIT-IV

**Relays, Heat and Welding :** Standard Eigen value problems- properties of Eigen values and Eigen Vectors- Generalized Eigen value problems- Strum sequence- Jacobi, Givens and Householders transformations.

### UNIT-V

**Process Controllers :** Elements of process control- Process Characteristics- ON/OFF control- Proportional and Derivative control- electronic controllers – Pneumatic controller- Temperature, flow and pressure control voltage regulations- principle of digital control.

### TEXT BOOK:

1. R.Ralph Benediet and Nathan Weiner- "Industrial electronics circuits and applications" – prentice hall of India New Delhi, 1996.

### REFERENCE BOOKS:

1. P.C Sen, "Principles of Electric Machines and Power Electronics", John Wiley & Sons Inc 2nd edition, 1997.
2. Harrott. P " Process Control"- Tata McGraw Hill 1991.
3. Joseph Vithayathil, "Power Electronics": Principle and Application McGraw Hill 1st edition 1995.



## MTM-023 INTERNET OF THINGS (IOT)

### UNIT I:

Internet of Things (IoT): Vision, Definition, Conceptual Framework, Architectural view, technology behind IoT, Sources of the IoT, M2M Communication. IoT Examples . Design Principles for Connected Devices: IoT/M2M systems layers and design standardization, communication technologies, data enrichment and consolidation, ease of designing and affordability

### UNIT II:

Hardware for IoT: Sensors, Digital sensors, actuators, radio frequency identification (RFID) technology, wireless sensor networks, participatory sensing technology. Embedded Platforms for IoT: Embedded computing basics, Overview of IOT supported Hardware platforms such as Arduino, NetArduino, Raspberry pi, Beagle Bone, Intel Galileo boards and ARM cortex.

### UNIT III:

Network & Communication aspects in IoT: Wireless Medium access issues, MAC protocol survey, Survey routing protocols, Sensor deployment & Node discovery, Data aggregation & dissemination

### UNIT IV:

Programming the Arduino: Arduino Platform Boards Anatomy, Arduino IDE, coding, using emulator, using libraries, additions in arduino, programming the arduino for IoT.

### UNIT V:

Challenges in IoT Design challenges: Development Challenges, Security Challenges, Other challenges IoT Applications : Smart Metering, E-health, City Automation, Automotive Applications, home automation, smart cards, Communicating data with H/W units, mobiles, tablets, Designing of smart street lights in smart city.

### REFERENCES:

1. Olivier Hersent, David Boswarthick, Omar Elloumi "The Internet of Things key applications and protocols", Willey
2. Jeeva Jose, Internet of Things, Khanna Publishing House
3. Michael Miller "The Internet of Things" by Pearson
4. Raj Kamal "INTERNET OF THINGS", McGraw-Hill, 1st Edition, 2016
5. Arshdeep Bahga, Vijay Madisetti "Internet of Things (A hands on approach)" 1st edition, VPI publications, 2014
6. Adrian McEwen, Hakin Cassimally "Designing the Internet of Things" Wiley India



**AUDIT COURSE**  
**MTM-A01 RESEARCH PROCESS & METHODOLOGY**

**UNIT I:**

Introduction to Research and Problem Definition Meaning, Objective and importance of research, Types of research, steps involved in research, defining research problem

**UNIT II:**

Research Design Research design, Methods of research design, research process and steps involved, Literature Survey

**Unit III:**

Data Collection Classification of Data, Methods of Data Collection, Sampling, Sampling techniques procedure and methods, Ethical considerations in research

**Unit IV:**

Data Analysis and interpretation Data analysis, Statistical techniques and choosing an appropriate statistical technique, Hypothesis, Hypothesis testing, Data processing software (e.g. SPSS etc.), statistical inference, Interpretation of results

**Unit V:**

Technical Writing and reporting of research Types of research report: Dissertation and Thesis, research paper, review article, short communication, conference presentation etc., Referencing and referencing styles, Research Journals, Indexing and citation of Journals, Intellectual property, Plagiarism

**Text Books:**

1. C. R. Kothari, Gaurav Garg, Research Methodology Methods and Techniques , New Age International publishers, Third Edition.
2. Ranjit Kumar, Research Methodology: A Step-by-Step Guide for Beginners, 2nd Edition, SAGE, 2005
3. Business Research Methods – Donald Cooper & Pamela Schindler, TMGH, 9th edition
4. Creswell, John W. Research design: Qualitative, quantitative, and mixed methods approaches. Sage publications, 2013.

## MTM-151 SENSOR LAB

### LIST OF EXPERIMENTS:

1. Familiarization of MATLAB package.
2. Familiarization of LABVIEW package.
3. Familiarization of VEE package.
4. Temperature & Optical transducers Characterization.
5. Strain gage, Load cell characterization & applications
6. Torque transducer characterization & applications
7. LVDT, Acoustics Ranging and Hall effect sensor applications.

## MTM-152 ADVANCED CNC LAB

### LIST OF EXPERIMENTS:

1. Exercises on Manual CNC Part programming using G& M codes.
2. Machining of parts on CNC Machines including preparation of part program. after simulation of tool path using suitable CAM software package.
3. Part Programming using CAM software like MASTERCAM
4. CNC programming on Turning and Milling process
5. Experiments on micro-machining
6. Study and experimentation with CMM
7. Experiments with NDT techniques
8. Experiments with non conventional machining processes such as EDM, USM, Abrasive Machining etc...
9. Use of Surface roughness meter and related experiments





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## SEMESTER : II



## MTM-201 COMPUTATIONAL FLUID DYNAMICS

### UNIT I:

Introduction, Conservation equation, Mass Momentum and Energy equations, Convective form of the equation and general description.

### UNIT II:

Clarification into various types of equation, Parabolic, Elliptic, Boundary and initial conditions, Overview of numerical methods.

### UNIT III:

Finite difference methods; Different means for formulating finite difference equations, Taylor series expansion, Integration over element, Local function method; Finite volume methods; Central, upwind and hybrid formulations and comparison for convection-diffusion problem, Treatment of boundary conditions; Boundary layer treatment; Variable property, Interface and free surface treatment, Accuracy of F.D. method.

### UNIT IV:

Solution of finite difference equations; Iterative methods; Matrix inversion methods, ADI method, Operator splitting, Fast Fourier Transform applications.

### UNIT V:

Phase change problems, Rayleigh-Ritz, Galerkin and Least square methods; Interpolation functions, One and two dimensional elements, Applications. Phase change problems; Different approaches for moving boundary; Variable time step method, Enthalpy method.

### Books:

1. Computational Methods for Fluid Dynamics Ferziger Joel H Springer-Verlog
2. Principles of Heat Transfer Kaviany M Wiley-International
3. Radiative Heat Transfer Modest Michael Academic Press
4. Middleman Stanley John Wiley.



## MTM-202 INDUSTRIAL ROBOTICS

### **UNIT I: INTRODUCTION**

Types of Industrial Robots, definitions – classifications based on work envelope – Generations configurations and control loops, co-ordinate system – need for robot – basic parts and functions – specifications.

### **UNIT II: MECHANICAL DESIGN OF ROBOT SYSTEM**

Robot motion – Kinematics of Robot motion – Direct and Indirect kinematics Homogeneous transformations – linkages and joints – mechanism – method for location and orientation of objects – drive systems – end effectors – types, selection, classification and design of grippers – gripper force analysis.

### **UNIT III: SENSORS**

Functions of Sensors – Position and proximity's sensing – tactile sensing – sensing joint forces – vision system – object recognition and image transformation – safety monitoring sensor systems – image analysis – application of image processing.

### **UNIT IV: ROBOT PROGRAMMING & AI TECHNIQUES**

Types of Programming – Teach pendant programming – Basic concepts in AI techniques – Concept of knowledge representations – Expert system and its components.

### **UNIT V: ROBOTIC WORK CELLS AND APPLICATIONS OF ROBOTS**

Robotic cell layouts – Inter locks – Humanoid robots – Micro robots – Application of robots in surgery, Manufacturing industries, space and underwater.

#### **Text Books:-**

1. Groover.M.P. Industrial Robotics, technology, programming and application Mc-Graw Hill book and co. 2012
2. Fu.K.S , Gonzalac R.C ,Lee C.S.G, Robotics Control, sensing ,vision and intelligence, Mc- Graw Hill book co 2011.
3. Yoram Koren , Robotics, McGraw Hill 2006
4. Janakiraman P.A. Robotics and Image Processing, Tata McGraw Hill, 2002



## MTM-203 MICROCONTROLLER & PLC

### **UNIT I: INTRODUCTION TO MICRO CONTROLLER**

Microprocessors and Microcontrollers – CISC and RISC - Fundamentals of Assembly language Programming – Instruction to Assembler – C Programming for Microcontrollers – Compiler and IDE – Introduction to Embedded systems - Architecture 8051 family - PIC 18FXXX – family – Memory organization

### **UNIT II: PROGRAMMING OF 8051 MICROCONTROLLER**

Instruction set – Addressing modes – I/O Programming-Timer/Counter - Interrupts – Serial communication of 8051.

### **UNIT III: PROGRAMMING OF PIC18FXXX MICROCONTROLLER**

Instruction set – Addressing modes – I/O Programming-Timer/Counter - Interrupts – Serial communication, CCP, ECCP PWM programming of PIC18FXXX.

### **UNIT IV: PERIPHERAL INTERFACING**

Interfacing of Relays, Memory, key board, Displays – Alphanumeric and Graphic, RTC, ADC and DAC, Stepper motors and DC Motors, I2C, SPI with 8051 and PIC family

### **UNIT V: PLC PROGRAMMING**

Fundamentals of programmable logic controller – Functions of PLCs – PLC operations – Evaluation of the modern PLC – Memory– Selection of PLC – Features of PLC – Architecture – Basics of PLC programming – Developing Fundamental wiring diagrams – Problem solving using logic ladder diagrams – communication in PLCs – Programming Timers – Programming counters – Data Handling.

### **REFERENCES**

1. Muhammad Ali Mazidi and Janice GillispieMazdi, "The 8051 Microcontroller and Embedded Systems" Pearson Education, Inc 2006.
2. John B. Peatman, PIC proگرامing, McGraw Hill International, USA, 2005.
3. John B. Peatman, Design with Micro controllers, McGraw Hill International, USA, 2005.
4. Kenneth J. Aylala, "The 8051 Micro controller, the Architecture and Programming applications":2003..
5. James W. Stewart, "The 8051 Micro controller hardware, software and interfacing, regents Prentice Hall, 2003.
6. Frank D. Petro Zella, "Programmable logic controller" McGraw – Hill Publications, 1998



## ELECTIVE - III

### MTM-031 RELIABILITY ENGINEERING

#### UNIT I:

**Reliability Engineering:** System reliability - series, parallel and mixed configuration, Block diagram, r-out-of-n structure, Solving problems using mathematical models, Reliability improvement and allocation-Difficulty in achieving reliability, Method of improving reliability during design, different techniques available to improve reliability, Reliability – Cost trade off, Prediction and analysis, Problems.

#### UNIT II:

**Maintainability, Availability & Failure Analysis:** Introduction, Techniques available to improve maintainability & availability, trade off among reliability, maintainability & availability and analysis.

Defect generation – Types of failures, defects reporting and recording, Defect analysis, Failure analysis, Equipment down time analysis, Breakdown analysis, TA, FMEA, FMECA.

#### UNIT III:

**Maintenance Planning and Replacement:** Maintenance planning – Overhaul and repair: Meaning and difference, Optimal overhaul/Repair/Replace maintenance policy for equipment subject to breakdown, Replacement decisions – Optimal interval between preventive replacements of equipment subject to breakdown, group replacement.

**Maintenance Systems:** Fixed time maintenance, Condition based maintenance, Opportunity maintenance, design out maintenance, Total productive maintenance, Inspection decision – Optimal inspection frequency, non-destructive inspection, PERT & CPM in maintenance, Concept of terrotechnology.

#### UNIT IV:

**Condition Monitoring:** Techniques-visual monitoring, temperature monitoring, vibration monitoring, lubricant monitoring, Crack monitoring, Thickness monitoring, Noise and sound monitoring, concept of S/N ratio, Condition monitoring of hydraulic system, Machine diagnostics - Objectives, Monitoring strategies, Examples of monitoring and diagnosis.

#### UNIT V:

**Safety Aspects:** Importance of safety, Factors affecting safety, Safety aspects of site and plant, Instruments for safe operation, Safety education and training, Personnel safety, Disaster planning and measuring safety effectiveness, Future trends in industrial safety.

#### Books:

1. Concepts in Reliability Engineering L.S. Srinath Affiliated East West Press
2. Failure Diagnosis and Performance Monitoring L.F. Pau Marcel Dekker
3. Industrial Maintenance Management S.K. Srivastava S. Chand & Co Ltd.
4. Management of Industrial Maintenance Kelly and M.J. Harris Butterworth and Co.
5. Maintenance, Replacement and Reliability A.K.S. Jardine Pitman Publishing



## MTM-032 SIMULATION, MODELING OF MANUFACTURING SYSTEM

### UNIT I:

System – ways to analyze the system – Model - types of models – Simulation – Definition – Types of simulation models – steps involved in simulation – Advantages & Disadvantages. Parameter estimation – estimator – properties – estimate – point estimate – confidence interval estimates – independent – dependent – hypothesis – types of hypothesis- steps – types 1 & 2 errors – Framing – strang law of large numbers.

### UNIT II:

Building of Simulation model – validation – verification – credibility – their timing – principles of valid simulation Modeling – Techniques for verification – statistical procedures for developing credible model. Modeling of stochastic input elements – importance – various procedures – theoretical distribution – continuous – discrete – their suitability in modeling.

### UNIT III:

Generation of random variates – factors for selection – methods – inverse transform – composition – convolution – acceptance – rejection – generation of random variables – exponential – uniform – weibull – normal Bernoullie – Binomial – uniform – poisson. Simulation languages – comparison of simulation languages with general purpose languages – Simulation languages vs Simulators – software features – statistical capabilities – G P S S – SIMAN- SIMSCRIPT –Simulation of M/M/1 queue – comparison of simulation languages.

### UNIT IV:

Output data analysis – Types of Simulation w.r.t output dat analysis – warmup period- Welch algorithm – Approaches for Steady – State Analysis – replication – Batch means methods – comparisons

### UNIT V :

Applications of Simulation – flow shop system – job shop system – M/M/1 queues with infinite and finite capacities – Simple fixed period inventory system – Newboy paper problem.

### TEXT BOOKS:

1. Simulation Modelling and Analysis / Law, A.M.& Kelton / McGraw Hill, 2nd Edition, New York, 1991.
2. Discrete Event System Simulation / Banks J. & Carson J.S., PH / Englewood Cliffs, NJ, 1984.
3. Simulation of Manufacturing Systems / Carrie A. / Wiley, NY, 1990.
4. A Course in Simulation / Ross. S.M., McMillan, NY, 1990.
5. Simulation Modelling and SIMNET / Taha H.A. / PH, Englewood,Cliffs, NJ, 1987.



## MTM-033 INTELIGENT MANUFACTURING SYSTEM

### UNIT I:

Computer Integrated Manufacturing Systems – Structure and functional areas of CIM system - CAD, CAPP, CAM, CAQC, ASRS. Advantages of CIM.

Manufacturing Communication Systems – MAP/TOP, OSI Model, Data Redundancy, Top-down and Bottomup Approach, Volume of Information. Intelligent Manufacturing – System Components, System Architecture and Data Flow, System Operation.

### UNIT II:

Components of Knowledge Based Systems – Basic Components of Knowledge Based Systems, Knowledge Representation, Comparison of Knowledge Representation Schemes, Interference Engine, Knowledge Acquisition.

### UNIT III:

Machine Learning – Concept of Artificial Intelligence, Conceptual Learning, Artificial Neural Networks - Biological Neuron, Artificial Neuron, Types of Neural Networks, Applications in Manufacturing

### UNIT IV:

Automated Process Planning – Variant Approach, Generative Approach, Expert Systems for Process Planning, Feature Recognition, Phases of Process planning  
Knowledge Based System for Equipment Selection (KBSES) – Manufacturing system design, Equipment Selection Problem, Modeling the Manufacturing Equipment Selection Problem, Problem Solving approach in KBSES, Structure of the KBSES.

### UNIT V:

Group Technology: Models and Algorithms – Visual Method, Coding Method, Cluster Analysis Method, Matrix Formation – Similarity Coefficient Method, Sorting-based Algorithms, Bond Energy Algorithm, Cost Based method, Cluster Identification Method, Extended CI Method. Knowledge Based Group Technology - Group Technology in Automated Manufacturing System, Structure of Knowledge based system for group technology (KBSGT) – Data Base, Knowledge Base, Clustering Algorithm.

### TEXT BOOKS:

1. Intelligent Manufacturing Systems / Andre Kusaic.
2. Artificial Neural Networks / Yagna Narayana.
3. Automation, Production Systems and CIM / Groover M.P. Neural Networks / Wassarman.



**ELECTIVE - IV**  
**MTM-041 OPTIMIZATION TECHNIQUES AND DESIGN OF**  
**EXPERIMENTS**

**UNIT I:**

**Single Variable Non-Linear Unconstrained Optimization:** One dimensional Optimization methods, Uni-modal function, elimination method, Fibonacci method, golden section method, interpolation methods- quadratic & cubic interpolation methods.

**Multi Variable Non-Linear Unconstrained Optimization:** Direct search method – Univariant Method – pattern search methods – Powell's – Hook – Jeeves, Rosenbrock search methods – gradient methods, gradient of function, steepest decent method, Fletcher reeves method. Variable metric method.

**UNIT II:**

**Geometric Programming:** Polynomials – arithmetic – geometric inequality – unconstrained G.P - constrained G.P

**Dynamic Programming:** Multistage decision process, principles of optimality, examples, conversion of final problem to an initial value problem, application of dynamic programming, production inventory. Allocation, scheduling replacement.

**UNIT IV:**

**Linear Programming:** Formulation – Sensitivity analysis. Change in the constraints, cost coefficients, coefficients of the constraints, addition and deletion of variable, constraints.

**Simulation:** Introduction – Types – Steps – application – inventory – queuing – thermal system.

**UNIT V:**

**Integer Programming:** Introduction – formulation – Gomory cutting plane algorithm – Zero or one algorithm, branch and bound method.

**Stochastic Programming:** Basic concepts of probability theory, random variables – distributions – mean, variance, Correlation, covariance, joint probability distribution – stochastic linear, dynamic programming.

**REFERENCES:**

1. Optimization theory & Applications/ S.S Rao/ New Age International
2. Introductory to operation research/Kasan & Kumar/Springer
3. Optimization Techniques theory and practice / M.C Joshi, K.M Moudgalya/ Narosa Publications.
4. Operation Research/H.A. Taha/TMH
5. Optimization in operations research/R.L Rardin
6. Optimization Techniques/Benugundu & Chandraputla/Person Asia





7. Optimization Techniques /Benugundu & Chandraputla / Pearson Asia.

## MTM-042 AUTOTRONICS AND VEHICLE INTELLIGENCE

### UNIT-I

**Automotive fundamentals :** The engine-components-Drive train- starting & charging systems operation – Ignition system- Suspension systems- brakes- ABS- Steering systems.

### UNIT-II

**Automotive Sensors :** Temperature sensor- Gas sensor- Knock sensor- Pressure sensor- Flow sensor- Torque sensor- Crash sensor-Speed sensor and Acceleration sensor-Micro sensor- Smart sensor- Operation, types, Characteristics, advantage and their applications.

### UNIT-III

**Fuel Injection and Ignition System :** Introduction- fuel system components- Electronic fuel system-Fuel injection-types-throttle body versus port injection-Electronic control fuel injection-operation –different types- Fuel injectors- idle speed control- Continuous injection system- High pressure diesel fuel injection-MPFI system- Electronic ignition system- operation – types- Electronic spark timing control.

### UNIT-IV

**Electrical Vehicles and Hybrid Vehicles:** Introduction-Electric Vehicle development- system layout basic system components- Electric battery- solar cells- Rapid charging system-Motor drive system-fuel cell Electric vehicle- Hybrid vehicle- Series Hybrid Vehicle- Parallel Hybrid Vehicle-CNG Electric hybrid vehicle.

### UNIT-V

**Vehicle Intelligence :** Introduction – Base structure- Vision based autonomous road vehicles-Architecture for dynamics vision system-Features- applications –A visual control system using image processing and fuzzy theory- An application of mobile robot vision to a vehicle information system- Objective detection, collision warning and avoidance system-Low tyre pressure warning systems.

### TEXT BOOK:

1. Understanding Automotive Electronics, William B. Ribben, 6th edition Elsevier Science-2003.

### REFERENCES:

1. Sensor and Transducers, Ronald K. Jurgen, SAE-2003
2. Automotive Technology”, Jack Erjavec, Robert Scharff, -Delmar Publications Inc 1992.
3. Electric and Hybrid-electric vehicles, Ronald K. Jurgen, SAE 2002.
4. Vision-based Vehicle Guidance, Ichiro Masaki, -Springer verlag, New York 1992.
5. Class Room Manual for Automotive Service and System, Jay Webster, -Delmer Publications Inc 1995.
6. Light Weight electric/Hybrid Vehicle Design, Ron Hodgkinson, John Fenton.

## MTM-043 COMPUTER AIDED METROLOGY AND MACHINE VISION

### UNIT-I

**Coordinate Measuring Machine:** Evaluation of Measurement-Coordinate Measuring Machines- non- Cartesian CMMs- Accessory elements- Application software- Performance evaluations- Temperature fundamentals- Environmental control- Accuracy enhancement- Applications –Measuring integration of CMM and computers.

### UNIT-II

**Laser in Measurements:** Laser source- Types, Characteristics and its application in measurement, - LASER Interferometer for measurement of flatness and displacement- LASER alignment- LASER micrometer- Tool wear online and in process measurement of diameter, Roundness measurement using LASER- Opto-Electric devices- Contact and non-contact types- Application of online and in process monitoring systems.

### UNIT-III

**Quality Control & Quality Assurance:** In-process inspection and online sensing, Automated inspection techniques total Quality Control (TQC)- Quality Assurance (QA)- POKA-YOKE statistical evaluation of data using computer, Total Quality Management(TQM)

### UNIT-IV

**Machine Vision and its Application:** Shape identification –edge detecting techniques- Normalization gray scale correction- template techniques- measurement of length and diameters, surface roughness using machine vision system- interfacing Robot and machine vision system- Industrial applications.

### TEXT BOOK:

1. Computers as Components, Principles of Embedded Computers Systems Design, Wayne Wolf Morgan.

### REFERENCE BOOKS:

1. J. Watson, Opto- electronics, Van Nostrand, Reinhold (UK) Co.Ltd, 1988.
2. Taguchi. G.L Syed et al. Quality Engineering in product Systems, McGraw Hill, 1980.
3. John bank, : Essence of TQM, Prentice Hall of India Pvt, 1990.



## MTM-044 MACHINE LEARNING

### **UNIT I:**

Basic Concepts, Introduction to Machine Learning, Applications of ML, Design Perspective and Issues in ML, Supervised, Unsupervised, Semi-supervised learning with applications and issues, A Formal Learning Model, The Runtime of Learning.

### **UNIT II:**

Model (or hypothesis) representation, decision boundary, cost function, gradient descent, regularization, Diagnostic: debugging a learning algorithm, evaluating a hypothesis (Model selection), training/validating/testing procedures, diagnosing bias versus variance and vice versa, regularization and bias/variance, learning curves, Accuracy and Error measures: classifier accuracy measures, predictor error measure, evaluating the accuracy of a classifier or predictor, Confusion metric, precision, recall, tradeoff between both, accuracy.

### **UNIT III:**

Decision Tree : representation, hypothesis, issues in Decision Tree Learning, Pruning, Rule extraction from Tree, Learning rules from Data, Probabilistic classifier: Bayes rule, Maximum Likelihood Estimation, case study, Support Vector Machine, Nearest Neighbor.

### **UNIT IV:**

Clustering: Unsupervised learning technique, Similarity and Distance Measures, k-means and k-medoids algorithm, optimization objective, random initialization, choosing value of k, EM algorithm Bayesian networks, bag of words classifiers, N-gram models; Markov and Hidden Markov models, Graphical Models, Combining Multiple Learners.

### **UNIT V:**

Reinforcement Learning: Elements of Reinforcement Learning, Model-Based Learning, Temporal Difference Learning, Generalization, Design and Analysis of Machine Learning Experiments.

### **REFERENCES:**

1. Ethem Alpaydin, Introduction to Machine Learning, PHI, 2015.
2. H. Witten and E. Frank, Data Mining: Practical Machine Learning Tools and Techniques Morgan Kaufmann 2005.
3. Tom Mitchell, Machine Learning, McGraw-Hill, 1997.

## MTM-251 APPLIED MECHATRONICS LAB

### LIST OF EXPERIMENTS:

1. Study and operation of CNC lathe.
2. Study and CNC milling machine.
3. Preparation of testing of typical part programs on CNC Trainer.
4. Preparation of testing of typical part programs on CNC milling machine.
5. Exercises using CAM software.
6. Training on Desktop Tutors.
7. Part program generation through G and M codes for Turning, Boring, Drilling, Reaming and Milling.
8. Development of tool path simulation by setting tool offsets for multi-operations (Combinations of above operations).
9. Study of various cutting tools used in above CNC Machines such as twist drill, End Mill cutter, and other Standard tooling.
10. Machining of various Components by generation of CNC code by (CAM Packages).
11. Interfacing the CNC Codes to the CNC Lathe and mill through RS232.
12. ROBOT Programming.
13. Designing of ladder logic for various practical applications.
14. Execution of ladder logic using PLC's.