SCHEME & SYLLABI OF

M.TECH. MANUFACTURING & AUTOMATION

w.e.f.

2018 -2019

(as per AICTE Model Curriculum)

CH. BANSI LAL UNIVERSITY, BHIWANI

First Semester:

Subject Code	Subject Name	L-T-P	Credits	Mark Weightage		Course Type
				Internal	External	
18MMA-501	Mechanical Design	3-0-0	3	25	75	Core-I
18MMA-503	CAD/CAM	3-0-0	3	25	75	Core-II
	Discipline Specific Elective-I	3-0-0	3	25	75	Programme Elective I
	Discipline Specific Elective-II	3-0-0	3	25	75	Programme Elective II
18MMA-505	Manufacturing & Automation Lab-I	0-0-4	2	25	25	Core
18MMA-507	Manufacturing & Automation Lab-II	0-0-4	2	25	25	Core
18MMA-509	Research Methodology and IPR	3-0-0	2	25	75	Core
	Audit Course- 1	2-0-0	0	25	75	Audit
	Total	**17-0-8**	**18**	**200**	**500**	

Discipline Specific Elective-I

18**MMA-511 Welding & Allied Process**
18**MMA-513 Mechatronics and Product Design**
18**MMA-515 Production Management**

Discipline Specific Elective-II

18**MMA-517 Metal Forming Analysis**
18**MMA-519 Numerical Methods & Computing**
18**MMA-521 Total Quality Management**

Audit course 1 & 2

18 AUD- 101 Research Paper Writing
18 AUD -102 Disaster Management
18 AUD -103 Sanskrit and Technology
18 AUD -104 Value Education
18 AUD -105 Constitution of India
18 AUD -106 Pedagogy Studies
18 AUD -107 Stress Management
18 AUD -108 Personality Development through Life Enlightenment Skills

Second Semester:

Subject Code	Subject Name	L-T-P	Credits	Mark Weightage		Course Type
				Internal	External	
18MMA-502	Advanced Metrology and Calibration	3-0-0	3	25	75	Core-III
18MMA-504	Diagnostic and Maintenance Monitoring	3-0-0	3	25	75	Core-IV
	Discipline SpecificElective-III	3-0-0	3	25	75	Programme Elective III
	Discipline SpecificElective-IV	3-0-0	3	25	75	Programme Elective IV
18MMA-506	Manufacturing & Automation Lab-III	0-0-4	2	25	25	Core
18MMA-508	Manufacturing & Automation Lab-IV	0-0-4	2	25	25	Core
	Audit Course- 2	2-0-0	0	25	75	Audit
18MMA-510	Mini-Project	0-0-4	2	25	75	Core
	Total	**14-0-12**	**18**	**200**	**500**	

Discipline Specific Elective-III

18MMA-512 Robotics and Automation
18MMA-514 Metal Cutting and Tool Design
18MMA-516 Finite Element Analysis

Discipline Specific Elective-IV

18MMA-518 Material Management
18MMA-520 Advanced Optimization Techniques
18MMA-522 Industrial Inspection

Third Semester:

Subject Code	Subject Name	L-T-P	Credits	Mark Weightage		Course Type
				Internal	External	
	Discipline SpecificElective-V	3-0-0	3	25	75	Programme Elective V
	Open Elective	3-0-0	3	25	75	Open Elective
18MMA-523	Dissertation Phase-I	0-0-20	10	50	150	Dissertation
	Total	**6-0-20**	**16**	**100**	**300**	

Discipline Specific Elective-V

18MMA-525 Computer Integrated Manufacturing
18MMA-527 Design & Metallurgy of Welded Joints
18MMA-529 Artificial Intelligence in Manufacturing

Open Elective

18 OEC- 531 Business Analytics
18 OEC -533 Industrial Safety
18 OEC -535 Operations Research
18 OEC -537 Cost Management of Engineering Projects
18 OEC -539 Composite Materials
18 OEC -541 Waste to Energy

Fourth Semester:

Subject Code	Subject Name	L-T-P	Credits	Mark Weightage		Course Type
				Internal	External	
18MMA-524	Dissertation Phase-II	0-0-32	16	150	350	Dissertation
	Total	**0-0-32**	**16**	**150**	**350**	

Total Credits for the programme = 18 + 18 +16 +16 = 68 Credit

Course code	**18MMA-501**
Course title	**MECHANICAL DESIGN**
Scheme (L-T-P)	**3-0-0**
Credits	**3**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

Course Objectives

1. To develop an ability to identify, formulate and solve engineering problem.
2. To develop an ability to use the technique and skill of modern engineering tools necessary for engineering practice.

Unit 1:

Concept Design: Brain storming method sand sketching, Quality Function Development, example. Design of experiments- Definition of experimental design, guidelines of designing experiment.

Unit 2:

Material Characteristics: Mechanical, thermal and electrical properties of engineering materials. Design consideration in forging, extrusion, casting & plastic dies.

Unit 3:

Production technologies: Metal forming, casting, machining, surface treatment, Welding, bonding, fastening, clinching, Defects and there remedies.

Unit 4:

Machine tool structure: Functions and requirements, Design criteria, Material used and their properties. Advanced techniques used in design. Design: Design for assembly, Design for manufacturing.

Course Outcomes:-At the end this course, the students will be able to:

1. Know the use of software for analysis and design.
2. Apply knowledge of mathematics, science and engineering in design of machine elements.
3. Analyze the design and conduct experiments as well as to define and interpret data.
4. Understand of professional and ethical responsibility.

References:

1. Quality Function Development, L. Cohen.
2. Manufacturing Engineering: Principles for Organization, D.T. Koenig.
3. Materials Science and Engineering: An Introduction, W.D. Callister Jr.
4. Handbook of Aluminium: Alloy Production and Materials Manufacturing Vol.2, G.E.Totten.
5. CAD Software Catia, Dassault system.

Course code	**18MMA-503**
Course title	**CAD/CAM**
Scheme (L-T-P)	**3-0-0**
Credits	**3**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

Course Objectives:
Explain principles of various theories of computer aided designing involved along with their industrial applications. Study the design process of any product or operation and how CAD improvises it by increasing the efficiency and accuracy of the process. Study the manual &Computer aided part programming and the various methods for CAPP.

Unit-1
Introduction of CAD/CAM, Co-ordinate system in CAD, 2D & 3D Transformation:-Scaling, Rotation, Shearing, Translations & Reflection, introduction of Part family and Group Technology.

Representation of parametric and non-parametric curves, Types of curves (analytic & synthetic curves), Geometric modeling, representation and types of surfaces.

Unit-2
Introduction to FEM and FEA, Basic Concepts of FEM, Meshing, Element Selection, Types of Analysis, Introduction of CAPP & its type (variant, generative and hybrid CAPP).

Unit-3
Classification of NC Machine, NC part programming, APT programming, advances in CAD/CAM (Agile & Lean manufacturing, concurrent Engineering and reverse engineering), Tool on CNC, Fixture on CNC, Material handling and Storage systems.

Unit-4
Fundamentals of Rapid Prototyping, Benefits and Application, STL file Generation, Introduction to Rapid Tooling (RT), Conventional Tooling vs. RT, Need for RT. Rapid Prototyping Machines, Classification and Description, Stereo lithography, Selective Laser Sintering, Fused deposition modeling, laminated object manufacturing, Laser powder forming.

Course Outcomes: At the end of the course, the student shall be able to:
1. Understand 2-D and 3-D transformations of different object based on coordinate system and design the 2D and 3D surfaces and solids.
2. Understand the various types of curves and develop a part program using CNC Part Programming.
3. Analyze a part program using APT language and Understand the applications of various CAPP techniques.

References:

1. CAD/CAM by Groover and Zimmer
2. CAD/CAM Theory and Practice, Ibrahim-Zeid, TATA McGraw Hill
3. CAD/CAM/CIM – P. Radhakrishnan, New age international.
4. Mathematical Elements of Computer graphics- Rogers and Adams
5. Computer Aided Design – Besant and Lui, PHI

Course code	**18MMA-511**
Course title	**WELDING & ALLIED PROCESS**
Scheme (L-T-P)	**3-0-0**
Credits	**3**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

Course Objectives:

1. To study essential concepts for welding parameters and welding processes.
2. To study various techniques for metal spraying and thermal cutting processes.
3. To study various techniques of welding automation.

Unit- 1

Introduction: Review of welding processes like gas, arc and resistance welding. Weld bead geometry and shape factors, Weld dilution. Welding Power Sources: Types of power sources, External V-I characteristics for constant current and constant voltage power sources, Rectifiers, Solid-state Rectifiers, Inverter systems, Duty cycle.

Arc Welding Consumables and Metal Transfer: Types of electrodes, AWS and Indian system of classification and coding of covered electrode for mild steel, Shielding gases and associated mixtures. Types of metal transfer, Short circuit/ dip transfer, Free flight, Globular type, Spray type, Forces affecting metal transfer.

Unit- 2

Arc welding processes: Electric arc welding principle, MIG: welding equipment and processes, shielding gas, types of metal transfer. Tungsten inert gas arc welding (GTAW): welding equipment, electrodes, inert gases and torches. Submerged arc welding (SAW): principle of processes, applications, fluxes and welding electrodes used. CO2 welding: Difference from MIG welding, Principle of operation, equipment, welding parameters and applications.

Unit-3

Weldability of specific Materials: Welding of plastics: Difficulties in welding of Plastics, Processes for welding of Plastics. Welding of Stainless Steel, Aluminum and Cast Iron, Types of defects in welding - process wise and severity wise, Destructive & Non-destructive testing techniques.

Welding Allied Processes: Surfacing and metal spraying: Surfacing methods such as SMAW, MIG, TIG, SAW. Thermal spraying: Introduction, Procedures, Applications, Advantages and Disadvantages. Thermal cutting of metals: Introduction, types, principle and operation of flame and plasma cutting.

Unit 4:

Advanced welding processes: Introduction, main features and applications of Ultrasonic welding, Friction welding, Explosive welding and Friction Stir welding, Underwater Welding.

Automation in Welding: Introduction, Semiautomatic welding, Automatic welding, Welding mechanization, Flexible Automated Welding, Robotic welding, Types of Welding Robots, Robot Selection Mechanics, Joint tracking system.

Course Outcomes: At the end of the course, students will demonstrate their ability to:

1. Understand principles of various traditional and newer welding processes
2. Develop concept of welding specific materials such as plastics, stainless steel.
3. Develop concept and techniques of welding automation.
4. Analyze methods of advanced welding processes like underwater welding.
5. Analyze arc welding parameter section and types of metal transfer.
6. Understand concept of thermal spraying and thermal cutting of metals.

References:

1. Modern Welding Technology: by Howard B. Cary and Scott C. Helzer, (Pearson Education)
2. Welding and Welding Technology: by R. Little (TMH)
3. Welding Processes and Technology: by R. S. Parmar (Khanna Publishers)
4. AWS- Welding Handbook.

Course code	**18MMA-513**
Course title	**MECHATRONICS AND PRODUCT DESIGN**
Scheme (L-T-P)	**3-0-0**
Credits	**3**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

Course Objectives:

The main objective of the course is to formulate mathematical models and to understand solution of various real life problems.

Unit- 1

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

Microprocessors and their applications – Microcomputer computer structure/microcontrollers, Integrated circuits – signal conditioning processes. Various types of amplifiers. Low pass and high pass filters, PID controllers and PLCs.

Unit-2

Sensors –sensors and transducers. Displacement, position proximity sensors, velocity, force sensors. Fluid presence Temperature, Liquid level and Llight sensors, flow sensors, Sensors in robotics, Selection of sensors, Actuators: Pneumatic and hydraulic systems, Mechanical actuation system, Electrical actuation system. Other Electrical/Electronic hardware in Mechatronics system.

Unit-3

Principles of Electronic system communication, Signal conditioning, Interfacing, A.D. and D.A. convertors, Software and hardware principles and tools to build mechatronic systems, Basic system models, Mathematical models, Mechanical and other system building blocks.

System models – Engg. Systems, Rotational-translation, Electro- mechanical, Hydraulic mechanical system, System Transfer functions, First-second order system in series.

Unit-4

Design and selection of Mechatronics components namely sensors line encoders and resolvers, stepper and servomotors, ball screws, solenoids, line actuators and controllers with application to CNC system. PLC and Ladder programming, Robots, Consumer electronics products, etc. Design of a Mechatronic Products using available software CAD packages MATLAB and SIMULINK.

Course Outcomes:

At the end of the course, the student shall be able to:

1. To explore various problems of solution objective
2. To study the design principles of different Mechatronics components and system
3. To define different flip flop
4. To study various models of Engg. Systems.

References:

1. Mechatronics by W. Bolton, published by Pearson Education, 4th Ed.
2. Automation Production System and CIMS by Mikel P Groover, Prentice Hall of India New Delhi.

Course code	**18MMA-515**
Course title	**Production Management**
Scheme (L-T-P)	**3-0-0**
Credits	**3**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

Course Objectives:

To study life cycle approach both for production system and new product development &compare production system with service system. Clarify various MRP models in production planning & sequencing and scheduling of the job on the machines. Understand the utility of forecasting in planning of production system.

Unit 1:

Introduction to production systems: Aim of production system, generalized model of Production systems, Types and characteristics of production and service systems, Life cycle approach to production management. Case studies of production and service systems.

Unit 2:

Product development and design: Product life cycle, New product development and processselection, stages in new product development, use of decision tree, Breakeven Analysis, Make/buy decision, Problems for Break-even Analysis Non-linearity in B.E. Analysis, selection of location among alternatives –A case study, systematic layout planning, objectives, types, comparison and application of different types of layouts. Assembly line balancing concept and problems for maximum line efficiency.

Unit 3:

Planning and control for production system: Importance, objectives and types of forecasting methods, Analysis and comparison standard error of estimate, Material Requirement Planning (MRP) objective, dependent demand, inputs to MRP, MRP-II, MRP model, ERP. Element of monitoring and follow up.

Unit 4:

Sequencing and scheduling: Criteria for sequencing, priority sequencing and rules, n job 2machine, n job 3 machine, n job m machine problems. Scheduling of flow shops and job shops.Gantt chart.

Course Outcomes: At the end of the course, students will demonstrate their ability to:

1. Develop life cycle approach to new product development and production system.
2. Develop the concept of break-even analysis, line balancing and relate it with practical industrial work.
3. Understand and generate MRP-I, MRP-II and ERP models for a production system.
4. Estimating production requirement using various forecasting techniques.
5. Analyze the criteria for sequencing & accordingly schedule the job on machines.

References:

1. Modern Production / operations management 8th ed. - Buffa, Elwood and Sarin, Rakesh (Wiley)
2. Elements of Production, planning and control - Eilon Samuel (Macmillan)
3. Production control: A quantitative approach - Biegel. J (Prentice Hall)

4. Industrial Engineering and production management – MartandTelsang (S. Chand)
5. Operations Management – Theory and Problems – Joseph Monks (Mcgraw Hill))
6. Production and Operations Management – KanishkaBedi. (Oxford University Press)
7. Operations Management 2nd ed. – B. Mahadevan. (Pearson)

Course code	**18MMA-517**
Course title	**METAL FORMING ANALYSIS**
Scheme (L-T-P)	**3-0-0**
Credits	**3**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

Course Objectives:

To study effects of temperature and strain rate in metal working and application of finite element methods to metal forming processes. To study plastic deformation problems for metal forming analysis and analysis of important metal forming processes.

Unit -1

Stress- Strain relations in Elastic and plastic Deformations, Yield Criteria for Ductile Metals, Work hardening and Anisotropy in Yielding, Flow Curves.

Formulations of plastic deformation problems, application of theory of plasticity for solving metal forming problems using Slab method, Upper and lower Bound methods, Slip line field theory.

Unit -2

Effects of temperature and strain rate in metal working, friction and lubrication in Hot and Cold working. Technology and analysis of important metal forming processes- Forging, Rolling, Extrusion. Wire drawing, Sheet Metal forming processes like Deep drawing, Stretch forming, Bending.

Unit -3

Application of Finite Element Methods to Metal Forming Processes- special Discretization, Shape function, Stiffness matrices and their assembly, Implicit and explicit formulations, Elastoplastic approximations, Lagrangian Vs Eularian schemes, Material integration schemes, auxiliary equations for contact, friction and incompressibility, Thermo-mechanical problem formulation, steady state solutions for Drawing, Forging, rolling and extrusion problems.

Case Studies- analysis and validation of metal forming processes problems by standard softwares.

Unit-4

Forming defects in products and their critical effects, remedies, An introduction to use of International standards in Metal Forming Problem solutions and system Design

Course Outcomes: At the end of the course students will be able to:

1. Understand application of finite element methods to metal forming processes.
2. Understand the formulations of plastic deformation problems for metal forming analysis.
3. Understand technology and analysis of important metal forming processes- forging, rolling, extrusion, wire drawing, sheet metal forming processes.
4. Understand the thermos-mechanical problem formulation.
5. Analyse the effect of friction and lubrication in hot and cold working of materials.

References:

1. Metal Forming Analysis- R. H. Wagoner, Cambridge University Press.
2. Theory of Elasticity- Dally and Riley
3. Physical Metallurgy- Dieter, McGraw Hill Inc.
4. Metal Forming Handbook by H Frontzek, M Kasparbauer , Springer Verleg

Course code	**18MMA-519**
Course title	**NUMERICAL METHODS & COMPUTING**
Scheme (L-T-P)	**3-0-0**
Credits	**3**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

Course Objectives:

Demonstrate understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems. Apply numerical methods to obtain approximate solutions to mathematical problems. Analyze and evaluate the accuracy of common numerical methods.

Unit 1:

Errors in numerical calculations

Introduction, Numbers and their accuracy, Absolute, Relative and percentage errors and their analysis, General error formula.

Interpolation and curve fitting

Taylor series and calculation of functions, Introduction to interpolation, Lagrange approximation, Newton polynomials, Chebyshev polynomials least squares fine ,Curve fitting, Interpolation by spline function.

Unit 2:

Numerical differentiation and integration

Approximating the derivative, Numerical differentiation formulas, Introduction to numerical quadrature, Newton-cores formula, Gausion quadrature.

Solution of nonlinear equations

Bracketing methods for locating error, Initial approximations and convergence criteria, Newton Raphsenand secant methods, Solution of problems through a structural programming language such as Corpascal.

Unit 3:

Solution of linear systems Direct Methods, Gaussian elimination and pivoting Matrix in version. UV factorization Iterative methods for linear problems through a structured programming language such as Cor Pascal.

Eigen value problems

Jacobi. Given‟s and Householder‟s methods for symmetric matrices, Rutishauser method for general matrices, power and inverse power methods solution of problems through a structured programming language such as CorPascal.

Unit 4:

Solution of differential equations

Introduction to differential equations, Initial value problems,Euler‟s methods, Heun‟s method, RungeKutta methods, Taylor series method, Predictor-corrector methods, Systems of differential equations, Boundary Valve problems, Finite-difference method, Solution of problems through a Structured programming language such as Cor Pascal.

Partial differential equations

Solution of hyperbolic .Parabolic and elliptic equations, The Eigen value problem the power method and the Jacobi‟s method for eigen value problems, Solution of problems through a structured programming language such as Corpuscles.

Course Outcomes: At the end of the course, the student shall be able to:

1. Understanding of common numerical methods and how they are used to obtain approximate solutions to otherwise intractable mathematical problems.
2. Understand the numerical methods to obtain approximate solutions to mathematical problems.
3. Understanding of how to analyze and evaluate the accuracy of common numerical methods.

References:

1. Applied Numerical Analysis by Curtis E. Gerald and Patrick Q. Wheatley- published by Addition Wesley.
2. Applied Numerical Methods- Carnahan. B.H., Luthar. H.A. and Wilkes.J.O. Pub- j. Wiley, New York.
3. Numerical Solution of Differential Equations by M.K. Jain. Published by Wiley Eastern, New York.
4. Introductory Methods of Numerical Analysis by S.D. Sastry. Published by Prentice Hall of India.
5. Numerical Methods- Hornbeek. R.W. Pub- prentice Hall.Englewood Cliffs. N.J.
6. Numerical Methods for Mathematics. Science and Engineering by John H.Mathews. PHI New Delhi.

Course code	**18MMA-521**
Course title	**TOTAL QUALITY MANAGEMENT**
Scheme (L-T-P)	**3-0-0**
Credits	**3**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

Course Objectives:
Quality issues are of increasing importance in an increasing number of business sectors. The development of TQM started in the products industry; it then spread to the private service sectors and is today an issue also in the public sector. Improved quality in products and services is necessary to compete for the customers in a globalized market and it is also a venue to better profitability for most industries and service companies.

Unit -1
Quality, Chain Reaction, Dimensions of Quality, Evolution of Quality, Quality Control, Quality Assurance, Quality Planning, Quality Improvement, Quality Management, Cost of Quality, Juran‟s Model of Optimum Quality Costs, Seven Quality Control Tools, Seven Management Tools

Unit -2
Total Quality Management Elements of TQM, Leadership for TQM, Demings 14 Points For Top Management, TQM Tools And Techniques, PDSA, Quality Cost Barriers For TQM Implementation.
Service Quality, Features of Services, Kano Model, Employee Motivation, Motivation Theory of Individual Employees, Effective Communications, Training and Mentoring, Recognition and Reward.

Unit-3
Statistical Process Control, Statistical Quality Control: Control Charts for Variables and Attributes, Acceptance Sampling, Single and Double Sampling Plans.

Unit -4
ISO 9000 standard, EMS 14001, Quality Awards, Benchmarking, QFD, TPM, FMEA, Quality Audit, Product Audit, Vendor Rating System, PDCA for Measurements, Performance Measure Design, BSC.

Course Outcomes: At the end of the course, the student shall be able to:
1. With this course the students should be able to not only participate in all kind of TQM activates in their own company or institution,
2. To understand the TQM development in selected areas.
3. The course draws heavily on practical cases and the professors own industrial
4. To analyze the theories taught.

References:
1. Total Quality Management by Oakland (Butter worth- HeinamannLtd.)
2. Managing for total quality from Deming to Taguchi and SPC by Logothetis N. (PHI)
3. Total Quality Control by Feigenbaum A.V (MGH)
4. Total Quality Management by Besterfield Dale H (Pearson Education)
5. A slice by slice guide to TQM by John Gilbert (Affiliated East West Press).

Course code	**18MMA-505**
Course title	**MANUFACTURING & AUTOMATION LAB-I**
Scheme (L-T-P)	**0-0-4**
Credits	**2**
Internal Assessment	**25**
External Assessment	**25**
Total	**50**

Course Objectives:
To develop domain knowledge in the field of welding and study of bead geometry, hardness microstructure of welding bead for various types of welding processes.

List of Experiments:

1. To study Heat flow in welding (Equipment for use -Gas Welding equipment).
2. To analyze the variation in process parameters such as welding current, voltage, wire feed rate etc. on different output parameters for Tungsten Inert Gas welding System.
3. To study and analyse the process parameters such as welding current, voltage, wire feed rate etc. on different output parameters for Metal Inert Gas welding System.
4. To study and analyse the process parameters such as welding current, voltage, wire feed rate etc. on different output parameters for Submerged Arc Welding System.
5. To study tensile property, Bead Geometry, Hardness of Bead, Micro structure of welding Bead in case of Arc welding.
6. To study mechanical behavior (tensile strength, hardness of bead, microstructure of welding bead) in case of Friction stir welding.

Course Outcomes (CO's): At the end of the course, the student shall be able to:

1. Understand heat flow in gas welding.
2. Analyse about bead geometry, hardness and microstructure of MIG, TIG, SAW and Arc welding.
3. Understand the friction stir welding procedure.

Course code	**18MMA-507**
Course title	**MANUFACTURING & AUTOMATION LAB-II**
Scheme (L-T-P)	**0-0-4**
Credits	**2**
Internal Assessment	**25**
External Assessment	**25**
Total	**50**

Course Objectives:
To develop domain knowledge in the field of CAD/CAM. Exposure to CAD tools for use in mechanical engineering design conceptualization, geometric modelling, communication, analysis and optimization, further use in CAD/CAM related courses and research work.

List of Experiments:

1. To create a 2-Dimensional sketch with the help of all geometrical Shapes.
2. To list the coordinate of given diagram
3. To prepare a part programme for facing & turning operation on a CNC Lathe.
4. To prepare part programme for facing & taper turning operation on CNC Lathe in single cut programming in word address format.
5. To create a solid with all of all solid entities of basic solid modeling commands.
6. Practice Boolean operation on solids.
7. Create surface with help of ruled & the tabulated surfaces.
8. Create a surface with the help of a surface of revolution & edge surface.
9. To develop a code for the rotation of object about an axis.

Course Outcomes (CO's): At the end of the laboratory course, the students will be able to:
1. Understanding of code of rotation by using computer software like Matlab, „C" Language.
2. Solid modeling exercises using any CAD/CAM package.
3. Knowledge of CNC Part Programming
4. Knowledge of a surface that created with the help of a surface of revolution & edge surface.

Course code	**18MMA-509**
Course title	**RESEARCH METHODOLOGY AND IPR**
Scheme (L-T-P)	**3-0-0**
Credits	**2**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

Course Objectives:
The course has been developed with orientation towards research related activities and recognizing the ensuing knowledge as property. It will create consciousness for Intellectual Property Rights and its constituents. Learners will be able to perform documentation and administrative procedures relating to IPR in India as well as abroad.

Unit -1
Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations.

Unit -2
Effective literature studies approaches, analysis Plagiarism, Research ethics, Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee.

Unit -3
Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

Unit-4

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases, Geographical Indications.

New Developments in IPR: Administration of Patent System. New developments in IPR;IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

Course Outcomes: At the end of the course, students will demonstrate their ability to:

1. Understanding and formulation of research problem.
2. Analyze research related information.
3. Understand plagiarism and follow research ethics
4. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
5. Understanding that when IPR would take such important place in growth of individuals &nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among

students in general & engineering in particular.

6. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

References:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science &engineering students""
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
5. Mayall , "Industrial Design", McGraw Hill, 1992.
6. Niebel , "Product Design", McGraw Hill, 1974.
7. Asimov , "Introduction to Design", Prentice Hall, 1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley," Intellectual Property in New Technological Age", 2016.
9. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008.

Course code	**18MMA-502**
Course title	**ADVANCED METROLOGY AND CALIBRATION**
Scheme (L-T-P)	**3-0-0**
Credits	**3**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

Course Objective:-
The objective of this subject is to familiarize students with methods and procedures to evaluate and improve data acquisition and the quality of the data acquired.

UNIT -1
Fundamental deviation and its calculations, effect of tolerance on the fits, effects of Electroplating on the fit sand its solution, shaft basis and hole basis system and its applications, Go, No-Go gauges design, Design of limit gauges, tolerances grades, tolerance position and tolerance for bolt and nut, Geometrical Tolerances.

UNIT -2
Surface errors i.e. form, macro and micro errors, reasons for these errors. Surface texture parameters, amplitude, spacing and hybrid, bearing ratio/ ABBOTT-Fire stone curve, Average Slope.
Introduction to calibration, calibration of mechanical measuring instruments, micrometers depth micrometer, Vernier caliper, tool maker microscope.

UNIT-3
Measuring instrument for flatness & surface finishes, Roughness characterization, Roughness Grades, instrument for geometrical tolerances, profile projector, co-ordinate measuring machine, laser micrometer, various grades of slip gauges and pin gauges, auto collimeters and various types of micrometer. Comparators: Mechanical, Pneumatic, optical, electrical and electronics comparators

UNIT-4

Pin gauge, surface plate, dial gauges, optical flats, slip gauges, Calculation of uncertainty, both A type & B type, for micrometers, Vernier Calipers and co-ordinate measuring Machine.

Course Outcomes:-At the end of this course, the students will be able to:

1. Describe and apply inspection, measurement and test equipment standards in measuring the following length, temperature, pressure, force, mass, voltage/current/ resistance/ time/frequency / displacement & strain.
2. Determine advanced ratio measurement techniques and calculations.
3. Know precision measurement principle.
4. Analyse calibration configuration involving shields and guards.

References:

1. Engineering Metrology And Instrumentation by R.K. Rajput.
2. ISI–Standard 919 and ISI-Standard 4218.
3. Geometrical Tolerances Is: 800 (Part-I) – 1985 ISO 1101 – 1983.
4. Engineering Tolerances by H.G .Conwat.

Course code	**18MMA-504**
Course title	**DIAGNOSTIC MAINTENANCE & MONITORING**
Scheme (L-T-P)	**3-0-0**
Credits	**3**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

Course Objective:-
The objective of the subject is the comprehensive solution to integrated diagnosis of systems with many components (Modules, Boards, Replacement units etc.) that is subject to failure.

Unit 1
Maintenance Management: Relevance of Maintenance: maintenance services,problems of the plant manager, automation and maintenance.
Maintenance Importance: Maintenance objectives and costs, quality and quality circle inmaintenance, engineering reliability, maintainability.

Unit 2
Failure analysis: Defect generation types of failures, FTA, FMEA, FMECA MaintenanceTypes/systems, Planned and unplanned maintenance, breakdown, corrective, opportunistic, routine, preventive, predictive, CBM, Design out maintenance

Unit 3

Condition monitoring: NDT concepts, visual and temperature monitoring, leakage monitoring, vibration monitoring, lubricant monitoring methods.
Equipment‟s used for condition monitoring: Equipment‟s, ferrography, spectroscopy, cracks monitoring, thickness monitoring, corrosion monitoring, noise monitoring, sound monitoring, smell monitoring.

Unit 4

Total productive maintenance: Development and scope of concept, terotechnology, basic systems of TPM procedure and steps of TPM, productivity circle.

Course Outcomes:-At the end this course, the students will be able to:

1. Understand significant advantages in relation to quality, safety, availability and costreduction in industrial plants.
2. Apply decision making processes involved such as the selection of the most suitable diagnostic techniques.
3. Analyze the failure of equipment and various condition monitoring techniques
4. Understand the various vibration monitoring techniques and total productive maintenance

References:
1. Maintenance planning and control-Kelly,A., Buttersworth & Co., 1984
2. Maintenance and spare parts Management–Krishanan, G, Prentice Hall–1991

Course code	**18MMA-512**
Course title	**ROBOTICS & AUTOMATION**
Scheme (L-T-P)	**3-0-0**
Credits	**3**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

Course Objective:-
The objective of this subject to identify significant relationship between models of competitive manufacturing and business performance.

UNIT-1
Automation in Production System, Principles and Strategies of Automation, Basic Elements of an Automated System, Advanced Automation Functions, Levels of Automations, introduction to automation productivity.

UNIT-2
Overview of Material Handling Systems - Rotary feeders, oscillating force feeder, vibratoryfeeder, elevator type and Centrifugal type feeders, Principles and Design Consideration, Material Transport Systems, Storage Systems.

UNIT-3
Industrial Control Systems, Process Industries Verses Discrete - Manufacturing, IndustriesContinuous Verses Discrete Control, Computer Process and its Forms. Sensors Actuators and other Control System Components.

UNIT-4
Introduction/need for system Modeling, Building Mathematical Model of a manufacturing Plant, Fuzzy decision and control, robots and application of robots for automation.

Course Outcomes: At the end of this course, the students will be able to:

1. Understand modern manufacturing operations, including their capabilities, limitation and how to design for lowest cost.
2. Analyse, design, implement and maintaining practical, mechanical and manufacturing systems.
3. Understand communicate effectively and work well on team-based engineering projects.
4. Succeed in manufacturing and mechanical engineering technology positions.

References:

1. Hand book of design, manufacturing and Automation: R.C. Dorf, John Wiley and Sons.
2. Automation, Production Systems and Computer integrated Manufacturing, M.P. Groover, Pearson Education.
3. Industrial Automation: W.P. David, John Wiley and Sons.
4. Computer Based Industrial Control, Krishna Kant, EEE- PHI

Course code	**18MMA-514**
Course title	**Metal Cutting and Tool Design**
Scheme (L-T-P)	**3-0-0**
Credits	**3**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

Course Objectives:

1. To study the basic concepts regarding design and manufacture of a component by various casting methods.
2. To provide knowledge to the students, on the principles that guides production of sound engineering castings.

Unit- 1

Introduction to casting process, Domestic and Engineering items made by casting process, Advantage and limitations of casting process over the other manufacturing processes.

Ferrous and Non-ferrous casting metals & their alloys and items made of them. Melting furnaces for cast iron, cast steels, aluminium and copper. Pattern: Pattern material, Types of patterns,Pattern allowances, Colour coding system for patterns, Numerical on pattern allowances.

Unit -2

Moulding: Mould material, properties of moulding sand, Main constituents of moulding sand, Classification of moulding sand, Preparation of moulding sand, Testing of moulding sand. Core: Introduction, Characteristics of core, Types of core, Core making, Core chaplets, Core print.

Unit -3

Gating system: Requirements of gating system, elements of gating system, Types of gates, Types of risers, Calculation of pouring time and solidification time, Casting design considerations, Chills.

Unit -4

Special casting methods: Gravity die casting, Cold chamber die casting, Hot chamber die casting, Investment casting, Centrifugal casting, Shell mould casting, Continuous casting

Fettling of castings, Casting inspection, Heat treatment of castings, Quality control of castings, Pollution control in foundry, Modernization of foundry.

Course Outcomes: At the end of the course the students should be able to:

1. Distinguish the different metals, their melting furnaces and applications in foundry technology.
2. Design the pattern and gating system for preparing the mould.
3. Describe the basic concepts of core and mould.
4. Explain the different types of special casting methods.
5. Discuss the various processes for improving or controlling the quality of casted product and environment of foundry shop.

References:

1. Principles of Metal Casting - Richard W. Heine , Carl R. Hoper, Philip C. Rosenthal, Tata McGraw Hill Education.

2. Principles of Foundry Technology - P. L. Jain, Tata McGraw-Hill Education.
3. Foundry practice - W.H. Salmon and E.N. Simons, Pitman.
4. Principles of manufacturing materials and processes - J. S. Campbell, McGraw Hill.
5. Materials and processes in manufacturing - E. Paul DeGarmo, J. T. Black, Ronald A. Kohser, John Wiley & Sons.
6. A Textbook of Production Technology: Manufacturing Processes - P. C. Sharma, S. Chand Publications.

Course code	**18MMA-516**
Course title	**FINITE ELEMENT ANALYSIS**
Scheme (L-T-P)	**3-0-0**
Credits	**3**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

Course Objective:-
The objective of the Finite Element Method is finding approximate solution of partial differential equation of physics and engineering by discretization of the domain of analysis into elements.

Unit 1
Overview of engineering systems: Continuous and discrete systems (discussion on differential equations, matrix algebra**).**

Unit 2
Energy methods: Variational principles and weighted residual techniques (least square method, collocation, sub-domain collocation, Galerkin method) for one-dimensional equation, RayleighRitz Formulation, development of bar and beam element, application to truss and frames.

Unit 3
Finite elements for two-dimensions: Equivalence between energy formulation and Galerkin approach, discretization concepts, choice of elements, derivation of element shape functions(Lagrangian and Hermite) in physical coordinates, Iso-parameteric mapping, numerical integration, Assembly procedure, solution techniques.

Unit 4

Introduction to finite element programming, Applications to problems in engineering: plane elasticity, heat conduction, potential flow and Transient problems, Computer implementation.

Course Outcomes:-At the end of this course the students will be able to:

1. Differentiate between continuous and discrete systems.
2. Demonstrate the ability to create models of trusses, frames, plate structure machine components using ANSYS general purpose software.
3. Analyze the finite element for two-dimension problems.
4. Analyze model multi-dimensional heat transfer problem.

References:

1. K J Bathe, Finite element procedures, Prentice Hall, Indian edition, 2006.
2. J Fish and T Belytschko, A first course in finite elements, Wiley, USA, 2007.
3. R D Cook, D A Malkus, M E Plesha, RJ Witt, Concepts and Applications of finite element analysis, John Wiley & Sons, 4th edition, 2002.
4. B Szabo and I Babuska, Introduction to finite element analysis, John Wiley & Sons, UK,2011.
5. OC Zienkiewicz and RL Taylor, The finite element method, Volume 1 & 2, 5th edition,Butterworth Heinemann, New Delhi, 2000.

Course code	**18MMA-518**
Course title	**MATERIAL MANAGEMENT**
Scheme (L-T-P)	**3-0-0**
Credits	**3**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

Course Objectives:
Study the basic concepts of materials management like productivity, techniques of materials management, purchasing in production process and cost reduction techniques. Illustrate the material requirement planning process like JIT, production planning, economic analysis and break even analysis.

Unit 1
Introduction: introduction to material management and productivity, functions of materialmanagement, organization structures in material management.
Price analysis, material cost reduction techniques, variety reduction, cost reduction and value improvement.

Unit 2
Material planning: objectives, material requirement planning, manufacturing resource planning, JIT production planning, strategic material planning, material control: acceptance, sampling, inspection, make or buy decision, simple cost analysis, economic analysis, break even analysis, break-even point theory, whether to add or drop a product line store management and warehousing, product explosion.

Unit 3
Purchasing: importance of good purchasing system, organization of purchasing functions,purchase policy and procedures, responsibility and limitations, purchasing decisions, purchasing role in new product development,

role of purchasing in cost reduction, negotiations and purchase, purchasing research: identification of right sources of supply, vendor rating, standardization, vendor certification plans, vendor and supply reliability, developing new source of supply.

Unit 4
Inventory management: inventory v/s stores, types of inventory, inventory control, inventorybuild –up, EOQ, various inventory models, inventory models with quantity discount, exchange curve concept, coverage analysis, optimal stocking and issuing policies, inventory management of perishable commodities, ABC – VED analysis, design of inventory distribution systems, surplus management, information system for inventory management, case studies.

Course Outcomes: At the end of the course, students will demonstrate their ability to:
1. Understand materials management techniques for productivity improvement.
2. Analyse the concept of materials planning with the theoretical concepts like break even analysis, JIT etc.
3. Apply different concepts of Purchasing while purchasing a material for the company.
4. Understand mathematical model the cost reduction techniques for reducing the cost & enhancing the profits of an organization.
5. Analyse inventory management techniques like EOQ for the efficient Inventory management of production plant.

References:

1. Material management :- W. R. Stelzer Jr. (PHI)
2. Material management :- D. S. Ammer& Richard Erwin Inc.
3. Material management :- A. K. Dutta (PHI)
4. Material management- An integrated approach :- P. Gopal;akrishnan,& M. Sundersen (PHI)

Course code	**18MMA-520**
Course title	**Advanced Optimization Techniques**
Scheme (L-T-P)	**3-0-0**
Credits	**3**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

Course Objectives:

1. To study about statistical concepts in quality control, quality control techniques, various control charts. Study about variables inspection and attributes inspection, relative merits and demerits.
2. To study about special control charts for variables, group control chart total quality control.

Unit 1

Statistical concepts in Quality Control, Graphical Representation of Grouped Data, Continuous and Discrete Probability Distributions, control limit Theorem.

Unit 2

Introduction to Quality Control, Process Control and Product Control, Chance and Assignable causes of Quality variation, Advantages of shewhart control charts, Process Control charts for variables, X, R and σ charts, fixation of control limits, Type I and Type II Errors, Theory of runs, Interpretation of Out of Control points, Probability limits, Initiation of control charts, Trial control limits, Determination of aimed at value of Process Setting, Rational method of subgrouping, control chart parameters, control limits and specification limits, Natural tolerance limits, Relationship of a process in Control to upper and lower specification limits, process capability studies.

Unit 3

Special control charts for variables, group control chart, arithmetic moving X and R charts, Geometric moving chart, control chart with reject limits, steady trend in Process average with constant dispersion, trend chart with sloping limits, variable subgroup size.

Variables inspection and Attributes inspection, Relative merits and demerits, Control charts for Attributes, p chart and np chart, varying control limits, high defectives and low defectives, special severe test limits, C chart, U chart, Dodge demerit chart, Quality rating, CUSUM or Cumulative sum control chart, Average Run Length (ARL) Relative efficiency or sensitivity of control chart.

Unit 4

Probability theory, binomial and Poisson distribution, Acceptance Inspection, 100% Inspection, No Inspection and sampling Inspection, operating characteristic curve (O.C. curve). Effect of sample size and Acceptance number, type A and type B O.C. curves, Single, Double and Multiple sampling Plans, SS Plan. Acceptance/Rejection and Acceptance/Rectification Plans, Producers Risk and Consumer‟s Risk, Indifference Quality level, Average Outgoing quality (AOQ) curve, AOQL, quality protection offered by a sampling Plan, Average sample Number (ASN) curve, Average Total Inspection (ATI) curve.

Course Outcomes: At the end of this course, the students will be able to:

1. Understand about the Concept of Quality control system and process capability study.
2. Analyze about process control charts and Errors.

3. Understand about the Inspection control methods.
4. Understanding about the probability theory, binomial and Poisson distribution.
5. Analyze product control, chance and assignable causes of Quality variation.

References:

1. Statistical Quality control by E.L. Grant
2. Quality control and Industrial Statistics, by A.J. Duncan
3. Quality control by Dale H. Bestefield
4. Total Quality Control by A.Y. Feigenboum
5. Elementary S.O.L. by I.W.Burr, M. Dekkar.

Course code	**18MMA-522**
Course title	**INDUSTRIAL INSPECTION**
Scheme (L-T-P)	**3-0-0**
Credits	**3**
Internal Assessment	**25**
External Assessment	**75**
Total	**100**
Duration of Exam	**3 HRS**

Note: Nine questions are to be set by the examiner. Question No. 1 will be compulsory and based on the entire syllabus. It will contain ten short answer type questions. Two questions are to be set from each unit. The student is required to attempt five questions in all by selecting one question from each unit and question no. 1, which is compulsory. All question carry equal marks.

Course Objectives:

1. To study industrial process of inspection, design consideration for gauges and measuringinstruments.
2. To study Indian and international standards for limits, fits, tolerances.
3. To identify geometrical and physical limitations in measuring devices. To study surface texture of components.

Unit 1:

Design consideration for Gauges and measuring instruments: material selection for gauges, NAS per Indian and international standards, design of plug gauge, snap gauge, center distance gauge.

Unit 2:

Inspection of threads and gears: thread gauge design; thread size measurement by two wire and three wire methods, vernier gear tooth gauge design.

Unit 3:

Surface textures: components of machined surface texture, specification of surface texture, surface roughness measuring device and techniques, design of pneumatic gauges in process gauging methods.

Unit 4:

Geometrical and positional tolerances, Geometrical and physical limitations in measuring devices.

Course Outcomes: At the end of the course, the student should be able to:

1. Understand about various types of gauges.
2. Design the gauges.
3. Analyze the surface texture.
4. Understand tolerances and their positioning with geometry.
5. Understand geometrical and physical limitations in measuring devices.

References:

1. Metrology:- I .C. Gupta (DhanpatRai Pub.)
2. Engg. Metrology :- R. K. Rajput (S. K. Kataria and sons)
3. Metrology :- R. K. Jain
4. PSG design data book for Gauge design

Course code	**18MMA-506**
Course title	**MANUFACTURING & AUTOMATION LAB-III**
Scheme (L-T-P)	**0-0-4**
Credits	**2**
Internal Assessment	**25**
External Assessment	**25**
Total	**50**

Course Objectives:
To develop the understanding of measuring instruments for industrialapplications by using optical projector and microscope. Measurement of cutting tool force using various types of dynamometers. Different techniques to measure the surface roughness and to study the hydraulic and neumatic softwares.

List of Experiments:

1. Measurements using Optical Projector/ Toolmaker Microscope.
2. Measurement of alignment using Auto collimator / Roller set
3. Measurement of cutting tool force using
    a) Lathe tool Dynamometer
    b) Drill toolDynamometer.
4. Measurements of Surface roughness, Using Tally Surf / Mechanical Comparator
5. Study and applications of Hydraulic software.
6. Study and applications of Pneumatic software.
7. Study and applications of Robotic software.
8. Study and applications of PLC software.
9. To design automated part feeder.

Course Outcomes (CO's): At the end of the Laboratory course, the students will be able :
1. To measure the alignment using Auto collimator/Roller set.
2. To use the optical projector and tool maker microscope.
3. To measure the cutting tool forces.
4. To study the various type of softwares viz. hydraulic software, pneumatic software, robotic software, PLC software etc.

Course code	**18MMA-508**
Course title	**MANUFACTURING & AUTOMATION LAB-IV**
Scheme (L-T-P)	**0-0-4**
Credits	**2**
Internal Assessment	**25**
External Assessment	**25**
Total	**50**

Course Objectives:
To introduce the concept of different maintenance techniques including preventive and predictive maintenance techniques. Developing the understanding of diagnostic maintenance to industrial machine tools for different type of industries like sugar industry, textile mills, thermal power plant, railways etc. Maintenance planning and control of large industries.

ListofExperiments:

1. To study the introduction to maintenance techniques. Preventive and predictiveMaintenance
2. To study and perform Non-Destructive Testing techniques, liquid dye penetrate andleak testing.
3. To study and perform Boroscope and Flexiscope.
4. To study and perform Eddy current testing &Ultrasonic testing.
5. To study and perform Magnetic particle detection and Particle counter.
6. To study wear Analysis through thermography and Ferrography.
7. To study the applications of Diagnostic Maintenance to Industrial Machines andplants such as Sugar Industry or Textile Mills or Thermal Power plantsand Railways.
8. To study the Maintenance planning and control of a large factory, work planning andwork control.

Course Outcomes (CO's): At the end of the laboratory course, the students will be able:

1. To study the various types of maintenance techniques.
2. To aware about the various type of non-destructive test techniques.
3. To understand the wear analysis, magnetic particle detection etc.
4. To understand the maintenance planning and control of a large factory.

Course code	**18MMA-510**
Course title	**MINI-PROJECT**
Scheme (L-T-P)	**0-0-4**
Credits	**2**
Internal Assessment	**25**
External Assessment	**25**
Total	**50**

Course Outcomes: At the end of the course:

1. Students will get an opportunity to work in actual industrial environment if they opt for internship.
2. In case of mini project, they will solve a live problem using software/analytical/computational tools.
3. Students will learn to write technical reports.
4. Students will develop skills to present and defend their work in front of technically qualified audience.

Syllabus Contents:

Students can take up small problems in the field of mechanical engineering as mini project. It can be related to solution to an engineering problem, verification and analysis of experimental data available, conducting experiments on various engineering subjects, material characterization, studying a software tool for the solution of an engineering problem etc.