Production Technology I	
Course Code: BMA-201 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 3

Introduction: This course focuses on the introduction to mechanical manufacturing methods by which materials are economically processed into different shapes. We study different types of material removing and shaping process to convert a material to desired shape.

Course Objectives: The Objective of this course is to

- Familiarize the student with all conventional Machine Tools.
- Make them able to decide proper process of machining for real time economic manufacturing operations.
- The overall goal is to develop an understanding of how the functionality, shape, materials and cost of a product influence manufacturing process design.
- The students are to be provided hands on practical exposure on topics covered in the course.

Pre-Requisites: NIL

Course Outcomes: Having successfully completed this course, the student will

- Have sound knowledge of conventional Machine Tools.
- Be able to perform solve analytical problems on the subject.
- Be able to define the real-world manufacturing process steps.
- Analyze and design steps of machining and dos and don'ts while machining.
- The practical sessions will improve visualization of the concepts taught in theory.

Pedagogy: Classroom teaching is supported by White board, black board, chalks, markers, projector and screen. The hand written notes, PowerPoint slides and assignments will be provided to the students and also mailed to them. The students can also raise their issues related to the course in the class and mail.

Contents:

UNIT I	10 Hours
General Introduction- Manufacturing; definition and broad classification **Casting** – Sand mould casting, Pattern types, Design of pattern, Testing of moulding sand, Cores, Gating systems, Principle, process and applications of Die casting, Centrifugal casting, Investment casting, and Continuous casting, Melting of metal for casting, Casting defects their causes and remedies, Cleaning and Inspection of castings, Foundry mechanization.	
UNIT II	10 Hours
Welding- Fusion welding, Principle, equipment, and applications of Arc Welding, Gas Welding, Submerged arc welding, TIG and MIG, Induction welding; Plasma arc welding, Resistance welding, Solid state welding, Ultrasonic Welding, Electron Beam Welding (EBW) and Laser Beam Welding (LBW).Edge preparation, Types of joints, welding techniques and position. Welding defects, their causes and remedies.	
UNIT III	11 Hours
Forming Processes – Hot Forming and Cold Forming, Analysis of important metal forming processes like Forging, Rolling, Extrusion, Wire Drawing, Sheet metal forming processes. **Powder Metallurgy** Introduction, Production of metal powders, Compaction and sintering processes, Secondary and finishing operations, advantages, limitations and applications of powder metallurgy.	

Additive Manufacturing Introduction to 3-D Printing, Stereo lithography, Selective Laser Sintering, Fused Deposition Modeling.	
UNIT IV	11 Hours
Measurement: **Length Standards:** Line standards, end standards, transfer from line standards to end standards, Numerical based on-line standards, Slip gauges – its use and care, methods of building different heights using different sets of slip gauges. **Linear and angular measurements devices and systems Comparators:** Types of Gauges, Limit Gauge, Snap Gauge, Receiving Gauge, Taylor's Principle of Gauge Design.	
Text Books	
1.	Rao.P.N. "Manufacturing technology: foundry, forming and welding": McGraw-Hill, 2018.
2.	Ghosh, A., & Mallik, A. K. "Manufacturing science", Ellis Horwood, 1986.
3.	Raghuwanshi B. S, "Workshop Technology", Vol. 1, Dhanpat Rai and Sons, 2006.
4.	Hazra Chaudhuri S. K., "Elements of workshop Technology", Vol. 2, Media Promoters, 2003.
5.	Kai, Chua Chee, Fai Leong, Rapid Prototyping: Principle & Application in Manufacturing, John Willey, London, 2003.
6.	A Textbook of Metrology, M.Mahajan,Dhanpat Rai & Co.
Reference Books	
1.	Kalpakjian, S., & Schmid, S. R. "Manufacturing processes for engineering materials": Pearson Education, 2008.
2.	Campbell, J. S. "Principles of manufacturing materials and processes", Tata McGraw-Hill, 2005.
3.	Date. P.P." Introduction to manufacturing processes", Jaico Publishing House, 2002.

Strength of Materials	
Course Code: BMA-203 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 3

Introduction: Strength of materials subject is basically the branch of mechanics which deals the study of forces on deformable solids. The study of strength of materials often refers to various methods of calculating the stresses and strains in structural members, such as beams, columns, and shafts. The methods employed to predict the response of a structure under loading and its sensitivity to various failure modes takes into account the properties of the materials.

Course Objectives:

- To get detailed analysis of the stress and strain behaviours in deformable solids
- To find deflections in different elements when these elements are under bi axial state of stress.
- Evaluate the allowable loads and associated allowable stresses before mechanical failure.
- Understand the adequacy of mechanical and structural elements under different loads is essential for the design and safe evaluation of any kind of structure.
- The students are to be provided hands on practical exposure on topics covered in the course.

Pre-Requisites: BMA-110 (Engineering Mechanics)

Course Outcomes: Having successfully completed this course, the student will be able to

- Establish an understanding of the fundamental concepts of mechanics of deformable solids.
- Calculate and represent the stress diagrams in bars and simple structures
- Solve problems relating to pure and non-uniform bending of beams
- Solve problems relating to torsional deformation of bars
- Understand the concept of buckling and be able to solve the problems related to isolated bars
- To build the necessary theoretical background for further design courses.
- The practical sessions will improve visualization of the concepts taught in theory.

Pedagogy: Classroom teaching is supported by White board, black board, chalks, markers, projector and screen. The hand written notes, PowerPoint slides and assignments will be provided to the students and also mailed to them. The students can also raise their issues related to the course in the class and mail.

Contents:

UNIT I	11 Hours
Simple Stresses & strains: Tensile, Compressive, shear and volumetric stresses and Strains, stress strain diagram, complementary shear stress, lateral strain and Poisson's ratio. **Compound bars and Temperature stresses**: Stresses in compound bars carrying axial loads and subjected to temperature stresses. **Compound Stresses & Strains:** Two dimensional stress system, conjugate shear stress at a point on a plane, principal- planes, principal stresses, Mohr's circle for plane stresses, Plane strain.	
UNIT II	11 Hours
Simple bending: Shear force and bending moment diagrams of cantilevers, simply supported beams under concentrated, uniformly loaded and varying loads with and without overhangs. **Stresses in Beams:** Combined bending and direct stresses, bending stresses in beams, bending stresses in composite beams, shearing stress in beams. **Deflection of Beams:** Moment curvature relation, direct integration method, Macaulay's and moment-area method, theories of elastic failures, strain energy due to bending, Castigliano's theorem.	
UNIT III	10 Hours
Fixed Beams: Macaulay's method for built-in beams, moment area method for fixed beams. **Continuous beams**: Clapeyron's theorem, beams with overhang, continuous beams with fixed ends. **Torsion**: Torsion of circular shafts, strain energy due to torsion, shaft under action of varying torque, shaft in series and parallel, compound shafts, combined bending and torsion.	
UNIT IV	10 Hours
Springs: Closed and open coil helical spring subjected to axial load, spring in parallel & series. C**olumns and Struts**: Elastic stability of columns, buckling of columns, slenderness ratio and conditions, derivations of Euler's formula for elastic buckling load, Equivalent lengths and Rankine Gordon empirical Formulae. **Thin Pressure Vessel:** Thin Pressure Vessels, Circumferential and longitudinal stresses in thin cylindrical shells and thin spherical shell under internal pressure. **Thick Pressure Vessel:** Lame's theory.	
Text Books	
1.	R.K. Rajput, "Strength of Materials", S. Chand Publication, New Delhi, 1998.
2.	Ryder G.H., "Strength of Materials", Macmillan, Delhi, 2003.
3.	R.K. Bansal, "Strength of Materials", Laxmi Publication, New Delhi, 2001.
Reference Books	
1.	Timoshenko S.P., "Elements of Strength of Materials", E-W. P, N. Delhi, 2000.
2.	Hibbler R.C., "Mechanics of Materials", Prentice Hall, New Delhi, 1994.
3.	Popov Eger P., "Engg. Mechanics of solids", Prentice Hall, New Delhi, 1998.

THERMAL ENGINEERING I	
Course Code: BMA-205 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 3

Introduction: Thermal Engineering is a specialized sub-discipline of Mechanical Engineering that deals exclusively with heat energy and its transfer between not only different mediums, but also its transformation into other usable forms of energy. The basis of all thermal engineering topics is thermodynamics. Therefore, in this course, initially the emphasis has been given on advanced principles of thermodynamics. It is then followed by the studies on the components of steam power plant

Course Objectives:

- To get a better understanding of various laws and principles of thermodynamics and their applications in analyzing the processes taking place in heat engines.
- To provide a good platform to mechanical engineering students to understand, model and appreciate concept of dynamics involved in thermal energy transformation.
- The students are to be provided hands on practical exposure on topics covered in the course.

Pre-Requisites: NIL

Course Outcomes: Having successfully completed this course, the students will be able to

- Apply the laws of thermodynamics to analyze the processes taking place in a steam power plant and other thermal systems.
- The students will have the thermodynamics view point for real life processes.
- The students will have the broad understanding of the actual processes on the basis of thermodynamics.
- Based on the laws of thermodynamics the students will be able to analyze the scope of further improvement in the existing systems.
- The practical sessions will improve visualization of the concepts taught in theory.

Pedagogy: Classroom teaching is supported by White board, black board, chalks, markers, projector and screen. The hand written notes, PowerPoint slides and assignments will be provided to the students and also mailed to them. The students can also raise their issues related to the course in the class and mail.

Contents:

UNIT I	11 Hours
Fundamentals of Thermodynamics: Thermodynamic System, Microscopic and Macroscopic Point of View, Property and State, Equilibrium, Process, Concept of Reversibility, Work, Heat, Ideal Gas, Zeroth Law of Thermodynamics. First Law of Thermodynamics, Corollary of First Law of Thermodynamics, Internal Energy, First law applied to a closed system and open system, SFEE. **Second Law of Thermodynamics**: Clausius and Kelvin Planck statements, Equivalence of two statements, Carnot Theorems, Clausius Theorem.	
UNIT II	11 Hours
Entropy: Definition, Clausius inequality, Entropy a point function, Principle of increase of entropy, Entropy change during constant volume, isothermal, constant pressure and polytropic processes, Numerical problems. **Availability and Irreversibility:** High and low grade energy, Available and unavailable energy, Loss of available energy due to heat transfer through finite temperature difference,	

Availability, Availability of a non-flow or closed system, Availability of a steady flow system, Helmholtz and Gibbs functions, Irreversibility, Numerical problems.
Thermodynamic relations: Reciprocal and cyclic relations, Property relations, Maxwell relations, Tds equations, Heat capacity relations, Relations for internal energy and enthalpy.

UNIT III	10 Hours

Gas Power cycles: Carnot cycle, Otto cycle, Diesel cycle, Dual cycle, Stirling and Ericsson cycles, Brayton cycle, Numerical problems.
Steam and its properties: Phase transformation of water on p-v, T-v, T-s and h-s diagrams, Properties of saturated water, wet steam, dry saturated steam and superheated steam, Steam Tables and Mollier chart for thermodynamics properties, Measurement of dryness fraction, Numerical problems.

UNIT IV	10 Hours

Vapor Power Cycles: Rankine cycle, Comparison of Rankine and Carnot vapor cycles, Methods of improving the performance of Rankine cycle, Superheating, Reheating, Regenerative cycle, Binary vapor cycle, Numerical problems.
Combustion of Fuels: Combustion reactions, First law applied to a combustion reaction, Mass balance, Energy balance, Stoichiometric air-fuel ratio, Actual air-fuel ratio from the analysis of products, Enthalpy of formation, Heat of combustion, Heating Values-Enthalpy of combustion, Adiabatic flame temperature.

Text Books

1.	Cengel and Boles, “Thermodynamics: Engineering Approach”, Tata McGraw-Hill Companies, 2011.
2.	P. K. Nag, “Engineering Thermodynamics”, Tata McGraw-Hill Publishing Company Limited, New Delhi, India, 2011.
3.	Van Wylen and Sonntag, “Fundamentals of Classical Thermodynamics”, John Wiley & Sons Inc., 2002.
4.	P. L. Ballaney, “Thermal Engineering”, Khanna Publishers, Delhi, India,2012.

Reference Books

1.	Michael J. Moran, Howard N. Shapiro, “Fundamentals of Engineering Thermodynamics”, John Wiley & Sons Inc.
2.	P. K. Nag, “Power Plant Engineering”, Tata McGraw-Hill , New Delhi, India.2012
3.	S. C. Arora and S. Domkundwar, “A course in Power Plant Engineering”, Dhanpat Rai & Sons, Delhi, India., 2012.
4.	M.M. El Wakil, “Power Plant Engineering”, Tata McGraw-Hill Companies, 2002.

NUMERICAL TECHNIQUES FOR ENGINEERS	
Course Code: BAS-205 Contact Hours: L-2 T-1 P-0 Course Category: AEC	Credits: 3 Semester: 3

Introduction: Numerical Methods give insight into problems we cannot otherwise solve. These methods provide us the way to solve problem when exact methods fails or unable to produce the desirable results.

Course Objectives:

- To motivate the students to understand and learn various numerical techniques to solve mathematical problems representing various engineering, physical and real life problems.
- To provide constructive methods for obtaining answers to such problem for which analytical methods fails to find solutions.

Pre-requisites: Calculus, Differential equations, some exposure to linear algebra (matrices) helps.

Course Outcomes: Upon completion of this course, the students will be able to:

- Understand the errors, source of error and its effect on any numerical computations and also analysis the efficiency of any numerical algorithms.
- Learn how to obtain numerical solution of nonlinear equations using bisection, secant, Newton, and fixed-point iteration methods.
- Solve system of linear equations numerically using direct and iterative methods.
- Understand how to approximate the functions using interpolating polynomials.
- Learn how to solve definite integrals and initial value problems numerically.

Pedagogy: Apart from class room teaching, main focus is to enhance problem solving ability supported by weekly assignments and discussing individual's doubts.

Content

UNIT-I	7 Hours
Floating-Point Numbers: Floating-point representation, rounding, chopping, error analysis, -conditioning and stability, Convergence of iterative methods. Non-Linear Equations: Bisection, secant, fixed-point iteration, Newton method for simple and multiple roots, their convergence analysis and error analysis.	
UNIT-II	7 Hours
Linear Systems and Eigen-Values: LU decomposition, Gauss Seidel iteration method, Successive-over-relaxation (SOR) iteration methods and their convergence, ill and well-conditioned systems, Rayleigh's power method for eigen-values and eigen-vectors.	
UNIT-III	6 Hours
Interpolation and Approximations: Finite differences, Newton's forward and backward	

interpolation, Lagrange and Newton's divided difference interpolation formulas with error analysis. Numerical Integration: Newton-Cotes quadrature formulae (Trapezoidal and Simpson's rules) and their error analysis, Gauss-Legendre quadrature formulae.	
UNIT-IV	8 Hours
Differential Equations: Solution of initial value problems using Picard, Taylor series, Euler's and Runge-Kutta methods (up to fourth-order), system of first-order and second-order differential equations.	
Text Books	
1	Jain M.K., Iyengar, S.R.K., and Jain, R.K. Numerical Methods for Scientific and Engineering Computation, 6th Edition, New Age International Publication,2012.
2	Sastry S., Introductory Methods of Numerical Analysis, 5th Edition, Prentice Hall India Learning Private Limited; 2012.
3	Conte, S.D and Carl D. Boor, Elementary Numerical Analysis: An Algorithmic approach, SIAM-Society for Industrial and Applied Mathematics, 2017.
4	Grewal, B. S. , "Higher Engineering Mathematics", 44thEdition, Khanna Publishers, 2012.
Reference Books	
1	Gerald C.F and Wheatley P.O., Applied Numerical Analysis, 8thEdition, Pearson Education, 2011.
2	Chappra S.C., Numerical Methods for Engineers, 7th Edition, McGraw-Hill Higher Education, 2014.

Machine Drawing Lab	
Course Code: BMA-207 Contact Hours: L-0 T-0 P-2 Course Category: DCC	Credits: 1 Semester: 3

Introduction: Technical Graphics is used to communicate the necessary technical information required for manufacture and assembly of machine components. These drawings follow rules laid down in national and International Organizations for Standards (ISO). Hence the knowledge of the different standards is very essential. Students have to be familiar with industrial drafting practices and thorough understanding of production drawings to make themselves fit in industries.

Course Objectives:

- Provide the fundamental concepts of machine drawing elaborating on how to concretize the idea of new structure such as a machine element.
- Study the conventions and rules to be followed by engineers for making accurate drawings.
- Understand the basic dimensioning practices that have to be followed in the preparation of drawings.
- Help the student in the visualization of assembly and sub assembly of various machine elements.
- Train the students in the preparation of assembly drawings

Pre-Requisites: BMA-130 Engineering Graphics

Course Outcomes:
Having successfully completed this course, the students will be able to:

- Develop ability to visualize and draw a Mechanical Engineering part and joints.
- Develop ability to draft a system, component or process to meet desired needs within realistic constraints.
- Develop ability to identify, formulate, and solve engineering drafting and drawing problems.

Pedagogy: Classroom teaching is supported by White board, black board, chalks, markers, projector and screen. The hand written notes, PowerPoint slides and assignments will be provided to the students and also mailed to them. The students can also raise their issues related to the course in the class and mail.

Contents:

List of Experiments:

To design and draw:

1) Forms of thread
2) Different types of bolts and rivets
3) Knuckle joint

4) Flange coupling
5) Universal coupling
6) Rivet joint
7) Threaded joint
8) Gib and cotter joint
9) Screw jack
10) Stuffing box
11) Connecting rod
12) Plumber Block
13) Multi plate clutch

Text Books	
1.	Gill P.S., A Textbook of Machine Drawing ,Katson Publishing, 2013.
2.	Bhatt, N.D., Machine Drawing, Charotar Publishing House Pvt. Limited, 2014.

Operations Management	
Course Code: BMA 210 Contact Hours: L-3 T-1 P-0 Course Category: OEC	Credits: 4 Semester: 3

Introduction: This course provides a general introduction to operations management. Operations management is the design and control of business processes, that is, the recurring activities of a firm. Along with finance and marketing, operations is one of the three primary functions of a firm. At the risk of being simplistic, one may say that marketing generates the demand, finance provides the capital, and operations produces the product or delivers the service. More generally, operations spans the entire organization: COOs are in charge of R&D, design/engineering, production operations, marketing, sales, support and service.

Course Objectives: This course considers the operations from a managerial perspective .

- To explain the performance measures of operations viz. productivity, quality and effectiveness.
- Deliver important concepts such as location decision, facility layout, forecasting, production scheduling, inventory management, replacement analysis are discussed.
- Provide a fair understanding of the role of a Production / Operations Manager in business processes.
- The students are to be provided hands on practical exposure on topics covered in the course.

Pre-Requisites: NIL

Course Outcomes: Having successfully completed this course, the student will be able to -

- Understand Productivity, efficiency and effectiveness, principles of management and organization structure;
- Understand business environment and importance of production function;
- Techniques to enhance value addition by method study;
- Be able to plan and control production;
- Manage inventory and be able to take replacement decisions;
- The practical sessions will improve visualization of the concepts taught in theory.

Pedagogy: Classroom teaching is supported by White board, black board, chalks, markers, projector and screen. The hand written notes, PowerPoint slides and assignments will be provided to the students and also mailed to them. The students can also raise their issues related to the course in the class and mail.

Contents:

UNIT I	11 Hours
Introduction –Introduction to productivity, Multi Factor productivity, Principles of management, Organization structure. **Capacity Planning, Plant Location and Plant Layout** – Introduction, need for selecting a suitable location, Location Factors, Quantitative Method, Principles of Plant layout, Types of Layout – Product, Process, Fixes Position, Cellular Layout.	
UNIT II	11 Hours
Demand Forecasting-Need for demand forecasting, Techniques of forecasting, Time series	

analysis, Least Square Method, Moving Average, Exponential Method and Qualitative Techniques. Method Study- Introduction, Objectives Steps, Micromotion Study, Cycle graph and chrono cycle graph, Therbligs and SIMO charts. Work Study – Objectives, Different Techniques, Standard Time, Allowances, Time study Numerical, Performance Rating, Work sampling. Process and Product Life Cycle, Material Requirement Planning – Introduction, MRP objectives, Functions served by MRP Production Planning and Control, Supply chain and Logistics Management, Production Scheduling.	
UNIT III	10 Hours
Inventory Management - Introduction, Reasons for Holding Inventories, Relevant Costs of Inventories, EOQ models, Quantity Discount Models, Safety Stock, Inventory control system, Selective Control of Inventory ABC analysis, VED analysis. Production Cost Concepts – Introduction, Cost of Production, Classification and analysis of Cost, break even analysis, Make and Buy.	
UNIT IV	10 Hours
Industrial Maintenance – Concepts of Maintenance, Organisation for Maintenance department, Types of Maintenance-Preventive, Breakdown and Corrective Maintenance, Failure Analysis, Maintenance Performance, Replacement policies of machines.	
Text Books	
1.	Martinich, J.S., Production and Operations Management: An Applied Modern Approach", John Wiley and Sons, New Delhi, 2008.
2.	Richard B. Chase, Nicholas J.A., Jacobs, F.R., "Production and Operation Management", Tata McGraw Hill, New Delhi, 1998.
3.	Ravi Shankar, "Industrial Engineering and Management", Galgotia Publications.
Reference Books	
1.	Paneerselvam, R., "Production and Operations Management", Prentice Hall India, 2012.
2.	Khanna, O.P., "Industrial Engineering and Management", Dhanpat Rai & Sons, 1985.

ENGINEERING MEASUREMENT AND METROLOGY	
Course Code: BMA 209 Contact Hours: L-3 T-0 P-2 Course Category: OEC	Credits: 4 Semester: 3

Introduction: This is a basic introductory course on measurement and metrology to be used in industry. A course on how to adopt and apply various methods of measurement. It enlightens the students about the various errors, calibration, sensors, accuracy of measurements thus to help in standardising the methods

Course Objectives: The objectives of this course are

- To enlighten the students on measurement process and why it is so important.
- The course aims to explain the students that in what best way to do measurement and develop standardization of measuring methods.
- The students are to be provided hands on practical exposure on topics covered in the course.

Pre-Requisites: NIL

Course Outcomes: Having successfully completed this course, the student will be able to

- Understand Measurement Process and various techniques
- Understand sensors and Transducers
- Understand measurement instrument capabilities
- Understand Statically control techniques
- The practical sessions will improve visualization of the concepts taught in theory.

Pedagogy: Classroom teaching is supported by White board, black board, chalks, markers, projector and screen. The hand written notes, PowerPoint slides and assignments will be provided to the students and also mailed to them. The students can also raise their issues related to the course in the class and mail.

Contents:

UNIT I	11 Hours
Introduction: Introduction to measurement and measuring instruments generalized measuring system and functional elements, units of measurement, static and dynamic performance characteristics of measurement devices, calibration concept of error, Types and sources of error, statistical analysis of errors. **Sensors and Transducers:** Types of sensors, types of transducers and their characteristics, Difference b/w Open loop and Closed loop measurement system, Signal conditioning unit, indicating unit, static characteristics i.e. accuracy, precision, sensitivity, resolution, linearity. **Measurement of flow:** Methods of flow measurement, hot wire anemometer, ultrasonic flow meter.	
UNIT II	11 Hours
Measurement of pressure: Elastic and indirect type pressure transducers. Measurement of very low pressures. **Strain measurement:** Types of strain gauges and their working, temperature Compensation. **Measurement of force and torque:** Different types of load cells, elastic transducers, pneumatic and hydraulic systems. **Temperature measurement:** Thermocouples, pyrometers.	
UNIT III	10 Hours

Metrology and Inspection: Sources of error, Standards of linear measurement, line and end standards, Limit fits and tolerances, Interchangeability and standardization.

Length Standards: Line standards, end standards, transfer from line standards to end standards, Numerical based on-line standards, slip gauges – its use and care, methods of building different heights using different sets of slip gauges.

Linear and angular measurements devices and systems Comparators: Types of Gauges, Limit Gauge, Snap Gauge, Receiving Gauge, Taylor's Principle of Gauge Design.

UNIT IV	10 Hours

Measurement of geometric forms like straightness, flatness, roundness,
Tool maker's microscope, profile project autocollimator.

Interferometry: principle and use of interferometer, optical flat. Measurement of screw threads and gears.

Surface texture: quantitative evaluation of surface roughness and its measurement, Comparators, Feature inspection Form Tolerance Inspection. Tolerance Stack Analysis, CMM, working and features.

Text Books

1.	A.K. Tayal, "Instrumentation and Mechanical Measurement", Galgotia Publications Pvt. Ltd., 2003..
2.	T.G. Beckwith, R.D. Maragoni and J.H Lienhard, "Mechanical Measurements", Addison- Wesley, 1999.

Reference Books

1.	R.K. Jain, "Engineering Metrology", Khanna Publishers, Delhi,2010
2.	I.C. Gupta, "Engineering Metrology", Dhanpat Rai Publications, Delhi,2011
3.	F.W. Galyer& C.R. Shotbolt, "Metrology for Engineers", ELBS edition, 2009

Production Technology II	
Course Code: BMA-202 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 4

Introduction: At the heart of any manufacturing system is a set of processes which change the size, shape and form of raw materials into the desirable thus giving an industrial nation the power of growing. This course is an introductory course for engineering professionals who would like to take up careers in manufacturing particularly at the process level..

Course Objectives: The objective of this course is

- To familiarize the student with all conventional Machine Tools and to make them able to decide proper process of machining for real time economic manufacturing operations.
- Learn the fundamentals of machining, optimization, non-conventional machining, fixturing and metrology
- Develop first order mathematical descriptions for selected processes
- Understand the advantages and limitations of various processes in terms of quality productivity
- Apply this knowledge to manufacturing process selection, design and part quality
- The students are to be provided hands on practical exposure on topics covered in the course.

Pre-Requisites: BMA-202: Production Technology I

Course Outcomes: Having successfully completed this course, the student will

- Have sound knowledge of conventional Machine Tools.
- Be able to perform solve analytical problems on the subject.
- Be able to define the real world manufacturing process steps.
- Analyze and design steps of machining and dos and don’ts while machining.
- The practical sessions will improve visualization of the concepts taught in theory.

Pedagogy: Classroom teaching is supported by White board, black board, chalks, markers, projector and screen. The hand written notes, PowerPoint slides and assignments will be provided to the students and also mailed to them. The students can also raise their issues related to the course in the class and mail.

Contents:

UNIT I	11 Hours
Introduction: Classification of machine tools based on application and production rate: General purpose, Single purpose and Special purpose machines, Classification based on Types of machine tools and the processes, Generating and forming **Single Point cutting tool nomenclature** Elements of tool geometry, cutting tool & its Materials and applications. **Lathe -** Centre lathe, facing lathe, gap-bed lathe, capstan and turret lathe, CNC lathe, major difference between CNC lathe and conventional lathe. Major sub-assemblies- Bed, headstock, tail stock, and carriage consisting of saddle, cross-slide, compound Slide tool post and apron, Work holding devices: self-centering three jaw chuck, Independent, four jaw chuck, collets,	

face plates, dog carriers, centers and mandrels. Driving mechanisms, apron mechanism, thread cutting mechanism and Calculations, features of half-nut engagement – disengagement, indexing dial mechanism.

UNIT II	11 Hours

Lathe contd...Operations on lathe: taper turning, related calculations, thread cutting, facing, under-Cutting, Drilling, boring, parting-off, knurling, is chamfering. Reciprocating Type Machine Tools- Shaper, Planer and Slotter, Constructional features, Basic Machines and kinematics and related calculations

Drilling Machines: Classification and uses, Constructional features of bench drilling machine, radial drilling machine, multi-spindle drilling machine, feed mechanism, work Holding devices, Tool – holding devices. Different drilling operations: Drilling, reaming, Counter boring and countersinking etc., estimation of drilling time.

UNIT III	10 Hours

Milling Machines: Types of general-purpose milling machines- horizontal, vertical and Universal. Types of milling cutters and their applications, different milling operations, work holding devices- vice, clamps, chucks, dividing head and its use, simple, compound and differential indexing. Indexing calculations and machining time calculations. Introduction to machining centres

Grinding Machines: Different types of grinding machines: cylindrical, surface and center-less grinding machines, basic constructional features and mechanisms, specifications, Wheel Dressing and Wheel Truing Specifications of grinding wheel, Mechanics of grinding, effect of grinding conditions and type of grinding on wheel behavior, equivalent diameter of grinding wheel. Introduction to honing, lapping and super-finishing processes.

Non-Conventional Manufacturing Process

Introduction to Electric Discharge Machining, Electro Chemical Machining, Abrasive Jet Machining and Ultrasonic Machining.

UNIT IV	10 Hours

Measurements: Measurement of geometric forms like straightness, flatness, roundness, surface roughness , Tool makers micro--scope, Comparators, profile projector, autocollimator, Introduction to CMM.

Interferometry: principle and use of interferometer, optical flat. Measurement of screw threads and gears.

Text Books

1.	P.N. Rao, “Manufacturing Technology: Metal Cutting & Machine Tools”, McGraw Hill Higher Education, 2013.
2.	Serope Kalpakjian and Steven Schmid, “Manufacturing Engineering & Technology”, (7th Edition), Pearson Education 2013.
3.	B.S. Raghuwanshi, “Workshop Technology”, Vol.2, Dhanpat Rai & Sons, 2013.
4.	Hajra Chandhari S.K & Nirjhar Roy S.K., “Elements of Workshop Technology”, Vol.2, Media Promoters, 2018.
5.	A Textbook of Metrology, M.Mahajan, Dhanpat Rai & Co.

Reference Books

1.	P.C. Sharma, “A Text Book of Production. Engineering”, S. Chand, New Delhi, 2004.
2.	Bawa H.S., “Workshop Technology”, Vol.2, Tata McGraw Hill, 2004.
3.	Juneja & Shekhon, “Fundamental of Metal Cutting”, New Age Publications
4.	S.F. Krar, Stevan F. and Check A.F., “Technology of M/C Tools”, McGraw Hill Book Co.,1986

Theory of Machines	
Course Code: BMA-204 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 4

Introduction: This is an important core mechanical design subject. This is a prerequisite for understanding machine design subject and students have to understand problems involved in designing mechanisms.

Course Objectives: The objectives of this course are

- To develop basic concepts of kinematics and dynamics in machines.
- To explain the concepts and formulas to be used for designing mechanism with linkages, using cams, gears, balancing and vibrations.
- To introduce the approaches and mathematical models used in kinematic and dynamic analysis of machinery.
- To give basic knowledge on kinematic and dynamic design of machinery.
- To give basic knowledge on mechanical vibrations.
- The students are to be provided hands on practical exposure on topics covered in the course.

Pre-Requisites: BMA-110: Engineering Mechanics

Course Outcomes: Having successfully completed this course, the student will be able to -

- Draw inversions and determine velocity and acceleration of different links in mechanisms.
- Construct different types of cam profile for a given data.
- Solve problems on power transmission by gears & do turning moment computations.
- Calculate balancing mass and its design its position.
- Understand vibration, and gyroscope effect.
- The practical sessions will improve visualization of the concepts taught in theory.

Pedagogy: Classroom teaching is supported by White board, black board, chalks, markers, projector and screen. The hand written notes, PowerPoint slides and assignments will be provided to the students and also mailed to them. The students can also raise their issues related to the course in the class and mail.

Contents:

UNIT I	11 Hours
General concepts, Velocity and Acceleration Analysis: Introduction of Simple mechanism, Different types of Kinematics pair, Grublers rule for degree of freedom, Grashof's Criterion for mobility determination Inversions of 3R-P, 2R-2P chains, Kinematic analysis of planar mechanism.	
UNIT II	11 Hours
Cams: Classification, Cams with uniform acceleration and retardation, SHM, Cylcloidal motion, oscillating followers. **Vibrations:** Vibration analysis of SDOF systems, natural, damped forced vibrations, based excited vibrations, transmissibility ratio.	

UNIT III	10 Hours
Gears: Geometry of tooth profiles, Law of gearing, involute profile, interference, helical, spiral and worm gears, simple, compound gear trains, Epicyclic gear trains–Analysis by tabular and relative velocity method, fixing torque. **Dynamic Analysis:** Slider-crank mechanism, turning moment computations.	
UNIT IV	10 Hours
Balancing: Static and Dynamic balancing, balancing of revolving and reciprocating masses, single and multi-cylinder engines. **Gyroscopes:** Gyroscopic law, effect of gyroscopic couple on automobiles, ships, aircrafts.	
Text Books	
1.	S.S. Rattan, “Theory of Machines”, Tata McGraw Hill, 2000
2.	Dr. V.P. Singh, “Theory of Machines”, Dhanpat Rai & Co. (P) Ltd., 2001
3.	Ghosh & A.K. Mallik, 'Theory of Mechanisms and Machines”, East West, Press, 2012.
Reference Books	
1.	Jagdish Lal, “Theory of Mechanism & Machines”, Metropolitan Education, 2000
2.	Thomas Beven, “The Theory of Machines”, CBS Publishers, 2000.
3.	P.L. Ballaney, “Theory of Machines & Mechanism”, Khanna Publishers, 23rd Edition, 2003.
4.	Norton, 'Kinematics and Dynamics of Machinery', Tata McGraw Hill, 2011.
5.	Khurmi R.S., Gupta J.K., ”Theory of Machines”, S. Chand & Co. Ltd.

Engineering Materials	
Course Code: BMA-206 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 4

Introduction: This course provides an overview of Engineering Materials as a basis for understanding how structure/property/processing relationships are developed and used for different types of materials

Course Objectives:

- To understand how and why the properties of materials are controlled by structure and bonding at the atomic-scale, and by features at the micro-structural and macroscopic levels.
- To understand the design, selection and processing of materials for a wide range of applications in engineering and elsewhere.
- To understand how and why the structure and composition of a material may be controlled by processing.

- The students are to be provided hands on practical exposure on topics covered in the course.

Pre-Requisites: NIL

Course Outcomes: After taking this course students will be able to

- Summarize significance of material science and its role in manufacturing.
- Classify different engineering material (metals, plastics, composites).
- Describe phase diagram and heat treatment processes.
- Identify properties of engineering materials by various testing methods.
- Develop concept of diffusion, mechanical properties and high temperature material problems.
- Select a material for a specific use based on consideration of cost, performance and application.
- The practical sessions will improve visualization of the concepts taught in theory.

Pedagogy: Classroom teaching is supported by White board, black board, chalks, markers, projector and screen. The hand written notes, PowerPoint slides and assignments will be provided to the students and also mailed to them. The students can also raise their issues related to the course in the class and mail.

Contents:

UNIT I	11 Hours
Structure of metals: Crystal structure, crystal systems, crystallographic points, directions and planes, linear and planar density computations, Single crystal, polycrystalline materials, Anisotropy, Polymorphism and anisotropy X-Ray diffraction technique. **Imperfection in solids:** Point defects, vacancies, linear defects, interfacial defects, volume defects, effect of crystal defects on mechanical properties of the materials, grain size determination.	
UNIT II	11 Hours

Materials: Classifications of Cast Iron, steels and their alloys, effect of alloying elements, properties, IS standards codes for Cast iron and steels, composite materials and non-metals.

Phase and Equilibrium Diagrams: Unary and binary phase diagrams, phase equilibria, phase rule, types of equilibrium diagrams, solid solution types, Iron- Carbon diagrams. Microstructural Exam: Grain size determination, Comparative study of microstructure of various metals such as mild steel, CI, brass.

UNIT III	10 Hours

Heat Treatment: Principles and purpose of heat treatment of plain carbon steels, annealing, Normalizing, hardening, tempering, isothermal treatment, case hardening – carburizing, nitriding etc, precipitating hardening of aluminum alloys, cooling curves.

Corrosion: Types of corrosion, Galvanic cell, rusting of Iron, Methods of protection from corrosion.

UNIT IV	10 Hours

Failure of the materials: Ductile fracture and brittle fracture; Fatigue failure, Design considerations for fatigue failure, Creep failure of the materials and creep resistant materials.

Dislocations and strengthening mechanisms in solids: Slip systems, slip in single crystal, twinning, Hall-Petch equation, solid-solution strengthening, strain hardening, recovery, recrystallization and grain growth.

Text Books

1.	V. Raghavan, "Material Science & Engineering", Prentice Hall India Ltd., 2001.
2.	William D. Callister, "Material Science & Engineering" Wiley India Ltd., 2010.
3.	Sidney H. Avner, "Introduction to Physical Metallurgy", Tata McGraw-Hill, 2007.

Reference Books

1.	Porter and Easterling, "Phase transformation in metals and alloys", Van Nostrand Reinhold Company Ltd, 1999.
2.	Reed Hill, "Principles of Physical Metallurgy" Cengage Learning Ltd, 2009
3.	Budinski et al, "Engineering Materials & Properties", Prentice Hall India, New Delhi, 2004.
4.	Peter Haasen, "Physical Metallurgy", Cambridge Univ. Press, 1996.

THERMAL ENGINEERING II	
Course Code: BMA-208 Contact Hours: L-3 T-0 P-2 Course Category: DCC	Credits: 4 Semester: 4

Introduction: This course discusses about the processes in an open and close system, the basic laws on heat transfer processes and their application, as well as the combustion occurs inside the engine cylinder. Analysis of compressors and gas turbines come under this course.

Course Objectives:

- The Objective of this course is to familiarize the student with the basics of compressors and engine performance with combustion analysis.
- To appreciate concept of dynamics involved in thermal energy transformation in power plants.
- The students are to be provided hands on practical exposure on topics covered in the course.

Pre-Requisites: BMA-205: Thermal Engineering I

Course Outcomes: Having successfully completed this course, the student will be able to

- Build a solid foundation of work consuming and work producing devices.
- Relate the applications of thermodynamics laws in practical life such as Engines and Compressors.
- Analyze the performance of an engine during combustion and throughout the cycle.
- Understand the combustion phenomenon in SI and CI Engines.
- Analyze the Gas Turbine and Jet Propulsions.
- Build the concepts of compressible fluid flow fundamentals.
- The practical sessions will improve visualization of the concepts taught in theory.

Pedagogy: Classroom teaching is supported by White board, black board, chalks, markers, projector and screen. The hand written notes, PowerPoint slides and assignments will be provided to the students and also mailed to them. The students can also raise their issues related to the course in the class and mail.

Contents:

UNIT I	11 Hours
Reciprocating Air Compressor - Single stage compressor: Equation for work, Isothermal, adiabatic and polytropic compression, Isothermal and adiabatic efficiency, Volumetric efficiency, Effect of clearance, Multi-stage compression with inter cooling. **Centrifugal Air Compressor** – Constructional details, working principle, Static and total heads, Velocity diagrams and theory of operation, Work done by impeller, Losses and isentropic efficiency of compressor, Prewhirl, Surging and choking of compressors.	
UNIT II	11 Hours
Fundamentals of IC Engines - Classification, Engine components and basic terminology, two stroke and four stroke engines, SI and CI engines, Theoretical and actual indicator diagrams, Valve and Port timing diagram, Components of IC Engine and their functions, Battery ignition system for SI engines, Fuel Injection system for CI Engines, Basics of Cooling and lubrication systems for IC engines, Detonation in SI Engines, Knocking in CI Engines, Octane Number and Cetane Number.	
UNIT III	10 Hours

Gas Turbines- Open and closed cycles for gas turbine, Analysis of basic closed cycle for gas turbine, Thermal efficiency and specific work output, Optimum pressure ratio for maximum cycle output and for maximum cycle efficiency, Effects of regeneration, Re-heating and intercooling on thermal efficiency and work output, Isentropic efficiencies of turbine and compressor, Advantages and disadvantages of gas turbines, Application of gas turbines

UNIT IV	10 Hours

Jet Propulsion - Different types– screw propeller, turbo-jet, turbo-prop, ram jet and pulse jet engines; Operation of rocket engine.

Fundamentals of Compressible Flow: Continuity, momentum and energy equation, control volume, sonic velocity, Mach number and its significance, Mach waves, Mach cone and Mach angle, Static and stagnation states, Stagnation pressure ratio, stagnation temperature ratio, Numerical Problems.

Text Books

1.	Cengel and Boles, "Thermodynamics: Engineering Approach", Tata McGraw-Hill Companies, 2011.
2.	Van Wylen and Sonntag, "Fundamentals of Classical Thermodynamics", John Wiley & Sons Inc., 2002.
3.	P. K. Nag, "Engineering Thermodynamics", Tata McGraw-Hill Publishing Company Limited, New Delhi, India, 2011.
4.	Mathur and Sharma, "Internal Combustion Engines", Dhanpat Rai Publications, 2003.
5.	V. Ganesan, "Internal Combustion Engines", Tata McGraw-Hill Publishing Company Limited, New Delhi, India, 2004.
6.	P. L. Ballaney, "Thermal Engineering", Khanna Publishers, Delhi, India, 2012.

Reference Books

1.	Michael J. Moran, Howard N. Shapiro, "Fundamentals of Engineering Thermodynamics", John Wiley & Sons Inc.
2.	P. K. Nag, "Power Plant Engineering", Tata McGraw-Hill , New Delhi, India, 2012.
3.	S. C. Arora and S. Domkundwar, "A course in Power Plant Engineering", Dhanpat Rai & Sons, Delhi, India., 2012.
4.	Arthur H. Lefebvre and Dilip R. Ballal, "GAS Turbine Combustion Alternative Fuels and Emissions" CRC Press: Taylor & Francis Group.
5.	M.M. El Wakil, "Power Plant Engineering", Tata McGraw-Hill Companies, 2002.