SAGI RAMA KRISHNAM RAJU ENGINEERING COLLEGE (AUTONOMOUS)

(Affiliated to JNTUK, Kakinada), (Recognized by AICTE, New Delhi)

UG Programmes CE,CSE,ECE,EEE,IT & ME are Accredited by NBA, Accredited by NAAC with A+

CHINNA AMIRAM (P.O):: BHIMAVARAM :: W.G.Dt., A.P., INDIA :: PIN: 534 204

Estd:1980

Regulation: R20	**IV / IV - B.Tech. I - Semester**

MECHANICAL ENGINEERING

SCHEME OF INSTRUCTION & EXAMINATION
(With effect from 2020-21 admitted Batch onwards)

Course Code	Course Name	Category	Cr	L	T	P	Int. Marks	Ext. Marks	Total Marks
B20HS4101	Universal Human Values-2: Understanding Harmony	HS	3	3	0	0	30	70	100
#PE-III	Professional Elective -III	PE	3	3	0	0	30	70	100
#PE-IV	Professional Elective -IV	PE	3	3	0	0	30	70	100
#PE-V	Professional Elective -V	PE	3	3	0	0	30	70	100
#OE-III	Open Elective-III	OE	3	3	0	0	30	70	100
#OE-IV	Open Elective-IV	OE	3	3	0	0	30	70	100
B20ME4113	MATLAB **(Skill Oriented Course)**	SOC	2	1	0	2	--	50	50
B20ME4114	Industrial/Research Internship 2 Months	PR	3	--	--	--	--	50	50
	TOTAL		**23**	**19**	**0**	**2**	**180**	**520**	**700**

	Course Code	Course
#PE-III	B20ME4101	Finite Element Analysis
	B20ME4102	Production Planning and Control
	B20ME4103	Industrial Robotics
	B20ME4104	MOOCs –III
#PE-IV	B20ME4105	Quality Control and Assurance
	B20ME4106	Control Systems
	B20ME4107	Unconventional Machining Processes
	B20ME4108	MOOCs –IV
#PE-V	B20ME4109	Automobile Engineering
	B20ME4110	Additive Manufacturing
	B20ME4111	Power Plant Engineering
	B20ME4112	MOOCs –V
#OE-III & #OE-IV	Student has to study one Open Elective each from OE-III & IV offered by CE or CSE or ECE or EEE or IT or S&H from the list enclosed.	

Code	Category	L	T	P	C	I.M	E.M	Exam
B20HS4101	**HS**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

UNIVERSAL HUMAN VALUES-2: UNDERSTANDING HARMONY

(Common to AIDS, CSBS, CSE, IT & ME)

Course Objectives:

1.	To enable students appreciate the essential complementarity between 'Values' and 'Skills' to ensure sustained happiness and prosperity which are the core aspirations of all human beings.
2.	To understand the harmony in the human being, family, society and nature/existence
3.	To facilitate the development of a Holistic perspective among students towards life, profession and happiness, based on a correct understanding of the Human reality and the rest of existence. Such a holistic perspective forms the basis of Value based living in a natural way.

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

S.No	Outcome	Knowledge Level
1.	Identify the importance of human values and skills for sustained happiness	K2
2.	Understand how to balance profession and personal happiness/ goals.	K2
3.	Express their commitment towards what they have understood (human values, human relationship and human society)	K2
4.	Explain the significance of trust, mutually satisfying human behavior and enriching interaction with nature.	K2
5.	Develop/ propose appropriate technologies and management patterns to create harmony in professional and personal life.	K3

SYLLABUS

UNIT-I (10 Hrs)	**Course Introduction** - Need, Basic Guidelines, Content and Process for Value Education Purpose and motivation for the course, recapitulation from Universal Human Values-I Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration Continuous Happiness and Prosperity- A look at basic Human Aspirations Right understanding, Relationship and Physical Facility- the basic requirements for fulfillment of aspirations of every human being with their correct priority Understanding Happiness and Prosperity correctly- A critical appraisal of the current scenario Method to fulfil the above human aspirations: understanding and living in harmony at various levels.
UNIT-II (08 Hrs)	**Understanding Harmony in the Human Being** - Harmony in Myself! Understanding human being as a co-existence of the sentient 'I' and the material 'Body' Understanding the needs of Self ('I') and 'Body' - happiness and physical facility Page 29 of 43 Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer) Understanding the characteristics and activities of 'I' and harmony in 'I' Understanding the

	harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail; Programs to ensure Sanyam and Health.
UNIT-III (08 Hrs)	**Understanding Harmony in the Family and Society- Harmony in Human- Human Relationship** Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship Understanding the meaning of Trust; Difference between intention and competence Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.
UNIT-IV (08 Hrs)	**Understanding Harmony in the Nature and Existence** - Whole existence as Coexistence Understanding the harmony in the Nature Interconnectedness and mutual fulfillment among the four orders of nature recyclability and self regulation in nature Understanding Existence as Co-existence of mutually interacting units in all pervasive space Holistic perception of harmony at all levels of existence.
UNIT-V (08 Hrs)	**Implications of the above Holistic Understanding of Harmony on Professional Ethics** Natural acceptance of human values Definitiveness of Ethical Human Conduct Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems. Case studies of typical holistic technologies, management models and production systems Strategy for transition from the present state to Universal Human Order: a. At the level of individual: as socially and ecologically responsible engineers, technologists and managers b. At the level of society: as mutually enriching institutions and organizations
Textbooks:	
1.	Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010
Reference Books:	
1.	Jeevan Vidya: Ek Parichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
2.	Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
3.	The Story of Stuff (Book).
4.	The Story of My Experiments with Truth
5.	Small is Beautiful E. F Schumacher by Mohandas Karamchand Gandhi
6.	Slow is Beautiful Cecile Andrews
7.	Economy of Permanence J C Kumarappa

8.	Bharat Mein Angreji Raj Pandit Sunderlal
9.	Rediscovering India by Dharampal Hind Swaraj or Indian Home
10.	Rule by Mohandas K. Gandhi
11.	India Wins Freedom Vivekananda Maulana Abdul Kalam Azad 12Romain Rolland (English)

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B20ME4101	PE	3	--	--	3	30	70	3 Hrs.

FINITE ELEMENT ANALYSIS

(Professional Elective -III)

(For ME)

Course Objectives:

1.	To provide students with a conceptual understanding of the principles of finite element analysis systems, the implementation of these principles, and its connections to CAD.
2.	To teach students how to perform structural analysis using finite element methods.

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

S.No	Outcome	Knowledge Level
1.	Understand the fundamental concepts of Finite Element Analysis and Solve the physical problem using functional approximation method.	K3
2.	Analyze the 1Dstructural problems by applying the concepts of finite element analysis.	K4
3.	Analyze Trusses and Beams by applying the concepts of finite element analysis.	K4
4.	Analyze 2D structural problems by applying concepts of finite element analysis and apply the principles of Numerical Integration and its application to Finite Element Analysis.	K4
5.	Analyze Axisymmetric solids by applying the concepts of Finite Element Analysis.	K4

SYLLABUS

UNIT-I (10 Hrs)	Introduction: stress and equilibrium, strain – displacement relations, stress – strain relations, plane stress and plane strain conditions, The potential energy approach; Rayleigh-Ritz method Finite Element Method: Discretization, Types of elements, band width, node numbering, interpolation functions, local and global coordinates, convergence requirements, Types of boundary conditions, Steps in Finite Element Method, Applications of Finite Element Method.
UNIT-II (10 Hrs)	One Dimensional Bar Problems: 1-D bar element - shape functions – Stiffness matrix and load vector– assembly of Matrices – Treatment of boundary conditions One dimensional quadratic element – Temperature Effects.
UNIT-III (10 Hrs)	Trusses: Introduction; Plane trusses; shape functions – Stiffness matrix and load vector– assembly of Matrices – Treatment of boundary conditions; simple problems on trusses. Analysis of Beams: Beam Element - Shape functions and Element stiffness matrix, load vector for concentrated and Uniformly Distributed Load, simple problems on beams.

UNIT-IV (10 Hrs)	Two Dimensional Problems: Finite element modeling of two-dimensional Problems - constant strain triangle Element - treatment of boundary conditions 2D four noded iso parametric element, numerical integration, Gaussian Quadrature Approach.
UNIT-V (8 Hrs)	Axisymmetric Solids Subjected to Axisymmetric Loading: Introduction; Axisymmetric formulation; Finite element modeling - triangular element; Problem modeling and boundary conditions.
Textbooks:	
1.	Introduction to Finite Elements in Engineering, Chandrupatla, Ashok and Belegundu, Prentice – Hall.
Reference Books:	
1.	The Finite Element Method by O.C. Zienkiewicz, Tata McGraw Hill Company Ltd.
2.	The Finite Element Methods in Engineering by Rao, S.S.
3.	Concepts and Applications of Finite Element Analysis by Cook, R.D.
4.	Applied Finite Element Analysis by Segerland, L.J.
e-Resources:	
1.	https://nptel.ac.in/courses/112104193
2.	https://nptel.ac.in/courses/112104116
3.	https://nptel.ac.in/courses/112104205

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B20ME4102	**PE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

PRODUCTION PLANNING & CONTROL

(Professional Elective -III)

(For ME)

Course Objectives:

1.	To develop an ability to apply PPC concepts in a various area like marketing, accounting, finance, engineering, personnel management, logistics, etc.
2.	To examine several classic Operations Management planning topics including production planning and inventory control.
3.	To aquire knowledge to make MRP, MRP-II by using Modern Production planning software for production of product with available resources.

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

S.No	Outcome	Knowledge Level
1.	Understand different types of production systems and the internal organization of production planning and control.	K2
2.	Identify forecasts in the manufacturing and service sectors using selected quantitative and qualitative techniques	K3
3.	Understand the importance and function of inventory and to be able to apply for its control and management	K3
4.	Apply routing procedures and differentiate schedule and loading and interpret scheduling policies and aggregate planning	K3
5.	Interpret dispatching procedure and applications of computers in production planning and control.	K3

SYLLABUS

UNIT-I (10Hrs)	Introduction: Definition – objectives and functions of production planning and control – elements of production control – types of production – organization of production planning and control department.
UNIT-II (10 Hrs)	Forecasting – Importance of forecasting –types of forecasting, their uses – general principles of forecasting – forecasting techniques – qualitative methods and quantitative methods.
UNIT-III (10 Hrs)	Inventory management – functions of inventories – relevant inventory costs – ABC analysis – VED analysis – EOQ model – Inventory control systems – P–Systems and Q-Systems Introduction to MRP I,MRP II, ERP, LOB (Line of Balance).

UNIT-IV (10 Hrs)	Routing –definition – routing procedure –route sheets – bill of material – factors affecting routing procedure, schedule –definition – difference with loading. Scheduling policies – techniques, standard scheduling methods. Line Balancing, aggregate planning, chase planning, expediting, controlling aspects.
UNIT-V (10 Hrs)	Dispatching – activities of dispatcher – dispatching procedure – follow up – definition – reason for existence of functions – types of follow up, applications of computer in production planning and control.

Textbooks:	
1.	Elements of Production Planning and Control / Samuel Eilon/Universal Book Corp.
2.	Manufacturing, Planning and Control/Partik Jonsson Stig- Arne Mattsson/Tata McGraw Hill
Reference Books:	
1.	Inventory Control Theory and Practice / Martin K. Starr and David W.Miller/Prentice-Hall
2.	Production Planning and Control/Mukhopadyay/PHI.
3.	Production Control A Quantitative Approach / John E.Biegel/Prentice-Hall
4.	Production Control / Franklin G Moore & Ronald Jablonski/Mc-GrawHill
5.	Production and Operations Management/Shailendra Kale/McGraw-Hill
6.	Production and Operations Management/Ajay K Garg/McGraw-Hill
e-Resources:	
1.	https://nptel.ac.in/courses/112107143
2.	https://archive.nptel.ac.in/courses/110/105/110105095

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B20ME4103	**PE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

INDUSTRIAL ROBOTICS

(Professional Elective -III)

(For ME)

Course Objectives:

1.	This course is designed to equip the students with basic understanding of working of robot
2.	This course helps the students to understand robot frame assignment and transformations
3.	Students will learn kinematics of robot
4.	Students can formulate joint trajectory planning for robot
5.	Students can learn developing dynamic model and control for robot

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

S.No	Outcome	Knowledge Level
1.	Understand basic components of robot, terminology used in robot, work space of robot, configurations of robot and applications of robot.	K2
2.	Implement the matrix transformations for representing the rigid body, for relative motions of frame and understand the concept of Euler angles.	K3
3.	Develop the forward kinematics for robot manipulator using Denavit-Hartenberg notation, solve the problem of inverse kinematic of robot, and derive Jacobian matrix of robot manipulator	K3
4.	Implement proper joint trajectory for robot joint and analyze the dynamics robot manipulator using Lagrange method.	K3
5.	Analyze second order dynamic systems, develop linear control for the robot, develop model base control of robot and apply Lypunov method for stability of nonlinear systems	K4

SYLLABUS

UNIT-I (10 Hrs)	**Fundamentals of robotics:** Robot and robotics, classification of robotics, advantages and disadvantages, Robot-components, degrees of freedom, joints, coordinates, workspace, applications. **Sensors:** potentiometers, encoders. **Actuators:** Characteristics of actuation system and comparison of actuating systems
UNIT-II (10 Hrs)	**Robot position analysis:** Matrix transformations, Homogeneous transformations of matrix, Representations of transformations. **Forward and Inverse Kinematic Equations:** Orientation-RPY angles, Euler angles
UNIT-III (10 Hrs)	**Denavit-Hartenberg representation of forward kinematic equations of robots**: simple 2-DOF, Inverse kinematic of 2-DOF robot.

	Differential Motions and Velocities: Differential relationships, Jacobian, Differential motions of frame, Differential changes between frames.
UNIT-IV (10 Hrs)	**Trajectory planning:** Joint space versus Cartesian space, Joint space trajectory planning: Third-order polynomial trajectory planning, Linear segments with parabolic blends **Dynamic analysis of robot:** Introduction to Lagrangian method, dynamic equation of 2-DOF robot manipulator (RR and RP).
UNIT-V (10 Hrs)	**Control of manipulators:** Feedback and closed loop control, Second order linear systems, Control of second order systems, control-law partitioning **Nonlinear control of manipulators:** Nonlinear and time varying systems, Lypunov stability analysis.
Text Books:	
1.	Introduction to Robotics: Analysis, Control, Applications by Saeed B Niku
2.	Introduction to Robotics: Mechanics and Control by J J Craig
Reference Books:	
1.	Introduction to Robotics by SK Saha, The McGrah Hill Company
2.	Robotics / Fu K S/ McGraw Hill
3.	Industrial Robotics /Groover M P /Pearson Edu.
e-Resources:	
1.	https://nptel.ac.in/courses/112105249
2.	https://nptel.ac.in/courses/107106090

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B20ME4104	**PE**	**--**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**
MOOCs-III								
(For ME)								
MOOCs-III course should belong to the B.Tech. Programme and that course should not be studied earlier. Students should select a course from SWAYAM/ NPTEL with minimum 12 weeks of duration. The percentage obtained for the candidate in MOOCs will be mapped to the grade table given in the Academic Regulations.								

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B20ME4105	PE	3	--	--	3	30	70	3 Hrs.

QUALITY CONTROL AND ASSURANCE

(Professional Elective -IV)

(For ME)

Course Objectives:

1.	The overall objective of the course is to teach the basic principles of Quality management which includes Taguchi' loss function, Deming's philosophy.
2.	To understand the purpose and function of statistical quality control
3.	To understand the difference between attributes and variables
4.	To become familiar with basic methods of statistical process control

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

S.No	Outcome	Knowledge Level
1.	Apply the fundamentals in interpreting the concepts like Quality Costs, Deming's Philosophy	K3
2.	Construct and analyze control charts for Variables for the purpose of improving the process	K3
3.	Construct and analyze control charts for Attributes for the purpose of improvingthe process	K3
4.	Apply Taguchi loss function and different processes for their Process Capability	K3
5.	Apply different sampling plans for the purpose of inspection.	K3

SYLLABUS

UNIT-I (10Hrs)	**Quality control in Perspective:** Introduction to quality, quality assurance, quality control, examples of off-line and on-line quality control techniques; quality of design, quality of conformance and quality of performance; quality characteristics variables and attributes, growth of quality control, Deming's Philosophy, Introduction to six sigma concept.
UNIT-II (10 Hrs)	**Control charts for Variables:** Shewart's norm bowl, X and R charts, X and σ charts, Statistical control of processes, group control chart, X chart with linear trend, warning limits.
UNIT-III (10 Hrs)	**Control charts for Attributes:** Defect and defective, fraction defective and percent defective, p- chart, 100p -chart, np-chart, c-chart, u-chart, ku-chart, demerit control charts.

UNIT-IV (10 Hrs)	**Process capability analysis:** Determination of process capability, PCR, Taguchi's loss function, smaller the better type and larger the better type of product specifications, Design specifications and tolerances for sub-assemblies, setting tolerances for intermediate steps in Production.
UNIT-V (10 Hrs)	**Acceptance sampling plans:** Single, double, multiple and sequential sampling plans, OC curve, rectifying inspection, AOQ, AOQL, ASN and ATI, Use of Dodge Romig Tables, Design of single and sequential sampling plans.

Textbooks:	
1.	Statistical Quality Control by E.L.Grant and Leavenworth, McGraw Hill
2.	Quality control and application by Bertrand.L.Hansen and P.M.Ghare, PHI
Reference Books:	
1.	Introduction to Statistical Quality Control by D.C.Montgomery, Wiley
2.	Principles of Quality control by Jerry Banks, John Wiley
3.	Quality control hand book by Juran, McGrawHill
e-Resources:	
1.	https://nptel.ac.in/courses/110105088
2.	https://onlinecourses.nptel.ac.in/noc20_mg18/preview

Code	Category	L	T	P	C	I.M	E.M	Exam
B20ME4106	**PE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

CONTROL SYSTEMS

(Professional Elective -IV)

(For ME)

Course Objectives:

1.	To introduce basic principles of control systems and to develop mathematical models for physical systems.
2.	To familiarize students on basic concepts of feedback characteristics of control systems for standard test signals.
3.	To familiarize students on analyzing and finding stability of control systems using time and frequency domain techniques.

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

S.No	Outcome	Knowledge Level
1.	**Understand** basic linear feedback principles and **develop** the transfer function using various methods.	K3
2.	**Prepare** mathematical models for physical systems using fundamental principles of mathematics and control systems.	K3
3.	**Develop** and **Analyze** state space models	K3
4.	Compute and **discover** the output response and steady state error of first, second and higher order control systems for standard input signals.	K3
5.	**Calculate** the stability of a system using Routh-Hurwitz and Nyquist criterion	K3

SYLLABUS

UNIT-I (08 Hrs)	**Introduction:** Control systems, Classification of Control systems, Feedback and its effects. Transfer Function, Block Diagram and Signal Flow Graphs.
UNIT-II (10 Hrs)	**Mathematical Modelling of Physical Systems:** Modelling of mechanical and electrical system elements, Equations of mechanical and electrical systems, Electrical analogous of mechanical systems.
UNIT-III (10 Hrs)	**State-variable analysis:** State variables, State-Transition Matrix, State-Transition Equation, Relationship between state equations and high order differential equations, Relationship between state equations and transfer functions, Characteristic equation, Eigen values and Eigen vectors.
UNIT-IV (08 Hrs)	**Time Response Analysis:** Time response, Typical test signals for the time response of control systems, Order of a system, response of first and second order systems for various inputs, Time domain specifications, Steady state error, Static error constants.

UNIT-V (10 Hrs)	**Stability of control systems:** Stability, Characteristic equation, Routh-Hurwitz criterion for determining stability of linear control systems. **Frequency-domain Analysis of Control Systems:** Nyquist stability criterion (simple problems).

Text Books:	
1.	Control Systems by A. Nagoor Kani, RBA Publications.
2.	Automatic Control Systems by Benjamin C Kuo
3.	Advanced Control Theory by A. Nagoor Kani, RBA Publications.
Reference Books:	
1.	Control Systems Engineering by Nagrath/Gopal , New Age International.
2.	Control systems principles and design by M Gopal, Tata Mcgraw-Hill.
3.	Control systems A K Jairath, CBS problems and solutions series.
e-Resources:	
1.	https://www.tutorialspoint.com/control_systems/control_systems_introduction.html
2.	https://onlinecourses.nptel.ac.in/noc19_de04/preview

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B20ME4107	PE	3	--	--	3	30	70	3 Hrs.

UNCONVENTIONAL MACHINING PROCESSES

(Professional Elective -IV)

(For ME)

Course Objectives:

1.	To impart the student the knowledge of unconventional machining methods and their applications.
2.	To acquaint the student with the knowledge of different Mechanical energy based unconventional machining methods.
3.	To acquaint the students with the concepts of Thermal and Thermo-electrical energy based unconventional machining process.
4.	To impart the student the concept of different Electro-Chemical and Chemical energy based unconventional machining process.

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

S.No	Outcome	Knowledge Level
1.	Distinguish the types of unconventional machining processes and their applications.	K3
2.	Describe the unconventional machining process using Mechanical energy and its applications.	K3
3.	Describe the process of unconventional machining using Thermal energy and its applications	K3
4	Describe the process of unconventional machining using Thermo electric energy and its applications	K3
5.	Describe the process of unconventional machining using electro-chemical and chemical energy and their applications.	K3

SYLLABUS

UNIT-I (06 Hrs)	**Introduction**–Need for non-traditional machining methods – Classification of modern machining processes– considerations in process selection-Materials – Applications.
UNIT-II (10 Hrs)	**Abrasive Jet Machining, Water Jet Machining and Abrasive Water Jet Machine**: Basic principles- equipment-process variables- and mechanics of metal removal- MRR- application and limitations. **Ultrasonic machining**– Elements of the process – mechanics of metal removal– processparameters – economic considerations – applications and limitations – recent developments.

UNIT-III (10 Hrs)	**Electric Discharge Machining**–Power Circuits – Mechanics of metal removal – Processparameters – selection of tool electrode and dielectric fluids – flushing – applications –Wire EDM – principle – applications.
UNIT-IV (10 Hrs)	**Electron Beam Machining (EBM) -Laser Beam Machining (LBM) –Plasma Arc Machining (PAM) -** Principles – Equipment – Process Parameters – Applications. Magnetic abrasive finishing – Electro stream drilling machining.
UNIT-V (10 Hrs)	**Electro–Chemical Machining Processes**: Principles of ECM –equipment – MRR –process parameter –electrochemical grinding – electro chemical honing process. **Chemical machining** –principle–etchants –maskants– maskant application methods –process parameter – MRR – applications.

Textbooks:	
1.	Advanced Machining Processes/VKJain/Allied Publishers
2.	Modern Machining Processes-P. C.Pandey, H. S.Shan
Reference Books:	
1.	Manufacturing Engineering and Technology By Serope Kalpak Jain, Pearson Publications, 2001
2.	Manufacturing Engineering & Technology, Kalpak Jain
3.	Unconventional Manufacturing Processes, Singh M. K
e-Resources:	
1.	NPTEL :: Mechanical Engineering - Manufacturing Processes II
2.	NPTEL :: Mechanical Engineering - NOC:Non Traditional Abrasive Machining Processes-Ultrasonic, Abrasive Jet and Abrasive Water Jet Machining

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B20ME4108	**PE**	**--**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**
MOOCs-IV								
(For ME)								
MOOCs-IV course should belong to the B.Tech. Programme and that course should not be studied earlier. Students should select a course from SWAYAM/ NPTEL with minimum 12 weeks of duration. The percentage obtained for the candidate in MOOCs will be mapped to the grade table given in the Academic Regulations.								

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B20ME4109	PE	3	--	--	3	30	70	3 Hrs.

AUTOMOBILE ENGINEERING

(Professional Elective-V)

(For ME)

Course Objectives:

1.	To make students familiar with the constructional details of chassis and body.
2.	To understand about various steering systems, steering linkages, Transmission system, steering gear boxes and power steering
3.	To introduce students to the rear axles and types of suspension systems.
4.	To introduce students to braking systems, wheels and tyres and provides the information on various aspects of vehicle maintenance.
5.	To understand upcoming technology of hybrid electric vehicles.

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

S.No	Outcome	Knowledge Level
1.	Illustrate the Automobile layout, types of IC engines and their subsystems.	K3
2.	Illustrate various types and working principles of clutch, gearbox, drive shaft and final drive systems.	K3
3.	Illustrate key elements of Steering geometry in automobile and can compare various types of steering mechanism, suspension systems, wheels, tires based on their construction.	K3
4.	Illustrate the concepts of brakes, electrical and electronic systems, pollution control methods and norms.	K3
5.	Identify technological updates in Hybrid Vehicles and the need of trouble shoot and maintenance in Automotive Vehicles.	K3

SYLLABUS

UNIT-I (10Hrs)	**Introduction to Automobile**, Automobile Layout, Chassis and body, Power unit- types of automobile engines, engine parts, Classification: 'In-line' and 'V' type, Multi-Valve Engines, Super Charging/Turbo charging, Air filters. **Fuel Systems:** Petrol Engines: Carbureted and MPFI, Diesel Engines: Conventional, CRDI and Dual fuel Engines, Engine Cooling and Lubrication.
UNIT-II (10 Hrs)	**Clutches:** principle, Types: cone clutch, single plate clutch, diaphragm clutch, multi plate clutch, centrifugal clutches and fluid coupling. **Gearbox:** Construction and Working Principle, Selector Mechanism, Types: Sliding mesh, Constant mesh, Synchromesh, and Epicyclical, Overdrive, Automatic Gearbox-CVT, Torque converter. **Drive shaft and Final Drive:** Drive Shaft, Types of Propeller shafts, Final drive and Differential, Power transmission: Front, Rear and Four wheel drive.

UNIT-III (10 Hrs)	**Suspension System:** Leaf springs coil springs, torsion bar, shock absorber, Independent suspension system. **Steering System:** Steering geometry: camber, caster, Kingpin angle, Toe-in, and Toe-out. Steering Mechanism and its Elements: Steering gear box and its types, Steering gear ratio, Power-Steering **Wheels:** Disc and Drum type, Tires: Tire Construction, Tube and Tubeless Tires, Radial Tires, Tire specification, Tire rotation and Tire Maintenance.
UNIT-IV (10 Hrs)	**Braking System:** Necessity, Parking and Power Brakes, Parts and Working Principle of Mechanical, Air and. Hydraulic Brakes: Master and Wheel cylinder, Properties of Brake Fluids, Brake Diagnostics and Service: Brake Bleeding, Anti-lock Braking System. **Air pollution and their control:** EGR and Catalytic Converters, EURO/Bharat Stage Norms, Mufflers. **Electrical and Electronic system:** Starting System, Ignition system, battery, ECU/ ECM.
UNIT-V (10 Hrs)	**Hybrid Vehicles:** History and Introduction of Hybrid Vehicles, Components in hybrid vehicles, Classification of hybrid topologies- Drivetrain structure, Degree of hybridization, Nature of the power source, Advantages and Disadvantages, Applications, Basic components of electric vehicles, Types of motors, types of batteries. **Trouble shooting and Maintenance:** Engine and Vehicle Troubles: Diagnostic Information, Symptom descriptions and their Causes and Remedies, Maintenance - Periodic, Preventive and Break down
Textbooks:	
1.	Automotive Mechanics (10/e) - William H. Crouse and Donald L. Anglin, Tata McGraw-Hill Publishing Company Limited, ISBN: 0-07-059054-0.
2.	Automobile Engineering – KK Jain/ RB Asthana, Tata McGraw-Hill Publishing Company Limited, ISBN: 0-07-044529-X.
3.	Internal Combustion Engines and Air Pollution- E.F. Obert, Harper & Row International Publishers Inc., ISBN: 0-06-350561-4.
4.	Electric and Hybrid Vehicles, Tom Denton, Taylor & Francis,2018.
Reference Books:	
1.	Automotive Mechanics – S. Srinivasan, Tata McGraw-Hill Publishing company Limited, ISBN: 0-07-044941-6
2.	Internal Combustion Engines – Heywood, John, B. McGraw-Hill Publications Limited.
3.	Automotive Engines- S Srinivasan, Tata McGraw-Hill Publishing Company Limited, ISBN: 0-07-040265-5.
4.	Hybrid Vehicles and the future of personal transportation, Allen Fuhs, CRC Press,2011.
e-Resources:	
1.	https://nptel.ac.in/courses/107/106/107106088/
2.	https://nptel.ac.in/courses/108/103/108103009/
3.	https://www.theengineerspost.com/category/automobile-engg

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B20ME4110	**PE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

ADDITIVE MANUFACTURING

(Professional Elective-V)

(For ME)

Course Objectives:

1.	The course is designed to develop fundamental knowledge on Additive Manufacturing
2.	Study the Liquid based, solid based, and powder based rapid prototyping techniques
3.	Learn tools used for Additive Manufacturing

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

S.No	Outcome	Knowledge Level
1.	Understand the working principles and process parameters of additive manufacturing processes	K2
2.	Illustrate various liquid and solid based additive manufacturing processes	K3
3.	Ilustrate various powder based additive manufacturing process and post processing Treatment	K3
4.	Develop the CAD models for rapid prototyping	K3
5.	Use the tools of AM Production	K3

SYLLABUS

UNIT-I (10Hrs)	**Introduction to AM:** Principle of AM, AM evolution, Generic AM process, classification, Benefits of AM, Distinction Between AM and CNC Machining, Generalized Additive Manufacturing Process Chain (Eight Steps) **Design for AM:** Preparation of CAD Models – STL File, STL File Format, STL Files from a CAD System, Software for Slicing**,** Part Orientation, Support Structure
UNIT-II (10 Hrs)	**Additive Manufacturing Processes:** **Liquid Based AM:** Stereolithography (SL) – Apparatus, Working Principle, Process Modeling, Process Parameter, advantages, limitations & Applications. **Solid Based AM:** Fused Deposition Modelling (FDM), Laminated object Manufacturing (LOM), Ultrasonic AM- Working Principle, materials, Processes modeling, products, advantages, limitations, and applications
UNIT-III (10 Hrs)	**Powder-Based AM:** Selective Laser Sintering, Direct Metal Laser Sintering, Electron Beam Melting - Working Principle, Processes Modeling, materials, products, advantages, applications, and limitations. **Post Processing Treatment in AM**: Support Material Removal, Improve - surface quality, Dimensional Deviations, Property Enhancements using Non-thermal and Thermal Techniques

UNIT-IV (10 Hrs)	**Reverse Engineering:** Basic concept- Digitization techniques – Model Reconstruction – Data Processing for Rapid Prototyping: CAD model preparation, Data Requirements. **Materials for AM:** Polymers, Thermoplastics and Thermosetting Polymers, Metals, Ceramics and Composites
UNIT-V (10 Hrs)	**Rapid Tooling:** Introduction, Conventional v/s RT, Classification – Direct and Indirect, Differentiate, Direct Methods -Laminated Tooling, DMLS, Indirect Methods- RTV Tools, 3D Keltool, Applications **Application Areas for AM**: Automotive, Aerospace, Medical Modeling, Reverse Engineering Data, Architectural Modeling,
Textbooks:	
1.	Additive Manufacturing Technologies, Gibson, Ian, David W. Rosen, Brent Stucker, and Mahyar Khorasani, Springer, 2021
2.	Rapid prototyping: Principles and applications, second edition, Chua C.K., Leong K.F., and Lim C.S., World Scientific Publishers, 2003.
Reference Books:	
1.	Rapid prototyping, Andreas Gebhardt, Hanser Gardener Publications, 2003.
2.	Rapid Prototyping and Engineering applications: A tool box for prototype development, LiouW.Liou, Frank W.Liou, CRC Press, 2007.
3.	Rapid Prototyping: Theory and practice, Ali K. Kamrani, Emad Abouel Nasr, Springer, 2006.
4.	Paul F.Jacobs – "Stereo lithography and other RP & M Technologies", SME, NY 2011
5.	Additive Manufacturing Technologies: 3D Printing, Rapid Prototyping, and Direct Digital Manufacturing, Ian Gibson, David W Rosen, Brent Stucker, Springer, 2015, 2nd Edition.
6.	Rapid Tooling: Technologies and Industrial Applications, Peter D.Hilton, Hilton/Jacobs, Paul F.Jacobs, CRC press, 2000.
e-Resources:	
1.	https://courses.gen3d.com/courses/enrolled/988400
2.	https://all3dp.com/1/design-for-additive-manufacturing-dfam-simply-explained/#where-to-learn-dfam
3	https://markforged.com/resources/blog/design-for-additive-manufacturing-dfam

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B20ME4111	**PE**	**3**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**

POWER PLANT ENGINEERING

(Professional Elective- V)

(For ME)

Course Objectives:

1.	The course is aimed at providing knowledge of power generation through different prime movers viz steam, ICGT, Hydro, nuclear and hybrid systems.
2.	To impart knowledge on power plant economics and environmental considerations.

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

S.No	Outcome	Knowledge Level
1.	Illustrate the layouts and working of steam power plant with fuel handling and ash handling systems	K3
2.	Discuss the working of Diesel engine and gas turbine power plants.	K3
3.	Examine various hydroelectric power plant along with its economics.	K3
4.	Describe various types of nuclear power plants, reactors and their impact on Environment.	K2
5.	Calculate load factor, capacity and utilization factor and cost of power generated by power plants.	K3

SYLLABUS

UNIT-I (10 Hrs)	**Steam Power Plant:** Plant layout, working of different circuits, fuel and handling equipment, types of coals, coal handling, coal storage, and ash-handling systems. Combustion: overfeed and underfeed fuel beds, traveling grate stokers, spreader stokers, Retort stokers, pulverized fuel burning system and types of dust collectors.
UNIT-II (08 Hrs)	**Internal Combustion and Gas Turbine Power Plants:** **Diesel Power Plant:** Plant layout with auxiliaries – fuel supply system, air starting equipment, super charging. **Gas Turbine Plant:** Introduction – classification - construction – layout with auxiliaries, Combined cycle power plants and comparison.
UNIT-III (08 Hrs)	**Hydro Electric Power Plant:** Waterpower – hydrological cycle / flow measurement -hydrographs – storage and pondage –classification of dams and spill ways. Classification of hydroelectric power plants.
UNIT-IV (08 Hrs)	**Nuclear Power Station:** Nuclear fuel – breeding and fertile materials – nuclear reactor– reactor operation. TYPES OF REACTORS: Pressurized water reactor, boiling water reactor, sodium-graphite reactor, fast breeder reactor, homogeneous

	reactor, gas cooled reactor, radiation hazards and shielding – radioactive waste disposal.
UNIT-V (08 Hrs)	**Power Plant Economics and Environmental Considerations:** Capital cost, investment of fixed charges, operating costs, general arrangement of power distribution, load curves, load duration curve, definitions of connected load, maximum demand, demand factor, average load, load factor, diversity factor. Effluents from power plants and Impact on environment.

Textbooks:	
1.	A course in Power Plant Engineering /Arora and Domkundwar/Dhanpatrai& Co.
2.	Power Plant Engineering /P.C.Sharma / S.K.Kataria Pub
Reference Books:	
1.	Power Plant Engineering: P.K.Nag/ II Edition /TMH.
2.	Power station Engineering – ElWakil / McGrawHill.
e-Resources:	
1.	https://archive.nptel.ac.in/courses/112/107/112107291/
2.	https://www.coursera.org/lecture/electricity/power-plants-gAZ4H

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B20ME4112	**PE**	**--**	**--**	**--**	**3**	**30**	**70**	**3 Hrs.**
MOOCs-V								
(For ME)								
MOOCs-V course should belong to the B.Tech. Programme and that course should not be studied earlier. Students should select a course from SWAYAM/ NPTEL with minimum 12 weeks of duration. The percentage obtained for the candidate in MOOCs will be mapped to the grade table given in the Academic Regulations.								

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B20ME4113	**SOC**	**1**	**--**	**2**	**2**	**--**	**50**	**3 Hrs.**

MATLAB
(Skill Oriented Course)

(For ME)

Course Objectives:

1	This course helps the students to get a basic understanding of MATLAB and Simulink
2	This is designed to learn applications of various domains of mechanical engineering using MATLAB.

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

S.No	Outcome	Knowledge Level
1	Apply the basic programming concepts in MATLAB	K3
2	Apply MATLAB program for solving the problems	K3
3	Apply various features and functions of MATLAB for solving problems of engineering	K3
4	Develop Simulink models of physical systems and perform simulation	K3

SYLLABUS

1	Write a MATLAB script for plotting the equation of motion of a particle.
2	Write a MATLAB script for plotting shear force and bending moment of a beam.
3	Write a MATLAB script for Finding roots of a nonlinear equation.
4	Write a MATLAB script for Gauss Elimination method.
5	Write a MATLAB script for solving a linear programming problem.
6	Write a MATLAB script for animation of a four bar mechanism
7	Develop a simulink model of spring-mass-damper system
8	Develop a Simulink model of a Pendulum
9	Write a MATLAB script for the non-dimensional response magnitude for a system with harmonically moving base and the response phase angle for system with harmonically moving base.
10	Write a MATLAB script for obtaining the dynamic equations of a 2-DOF robot.

Reference Books:

1	MATLAB: An Introduction with Applications by Rao V Dukkipati

Regulation: R20	IV / IV - B.Tech. II - Semester

MECHANICAL ENGINEERING

SCHEME OF INSTRUCTION & EXAMINATION
(With effect from 2020-21 admitted Batch onwards)

Course Code	Course Name	Category	Cr	L	T	P	Int. Marks	Ext. Marks	Total Marks
B20ME4201	Project Work (Project work, seminar and internship in industry)	PR	8	0	0	16	60	140	200
		TOTAL	**8**	**0**	**0**	**16**	**60**	**140**	**200**

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B20ME4201	PR	--	--	16	8	60	140	3 Hrs.

PROJECT WORK

(For ME)

Course Objectives:

1	To provide an opportunity to work in group on a topic / problem / experimentation
2	To encourage creative thinking process
3	To provide an opportunity to analyze and discuss the results to draw conclusions
4	To acquire and apply fundamental principles of planning and carrying out the work plan of the project through observations, discussions and decision-making process.

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

S.No.	Outcome	Knowledge Level
1	Identify a current problem through literature/field/case studies	K3
2	Identify the objectives and methodology for solving the problem	K3
3	Design and Develop technology/process for solving the problem	K4
4	Evaluate the technology/process	K5

*The object of Project Work is to enable the student to take up investigative study in the broad field of Mechanical Engineering, either fully theoretical/practical or involving both theoretical and practical work to be assigned by the Department on an individual basis or a group of students, under the guidance of a Supervisor. This is expected to provide a good initiation for the student(s) in R&D work.

The assignment to normally include:

a) Survey and study of published literature on the assigned topic.
b) Working out a preliminary approach to the problem relating to the assigned topic.
c) Conducting preliminary Analysis/Modeling/Simulation/Experiment/Design/ Feasibility.
d) Preparing a written report on the study conducted for presentation to the department.
e) Final Seminar, as oral Presentation before a departmental committee.