Estd:1980

SAGI RAMA KRISHNAM RAJU ENGINEERING COLLEGE (AUTONOMOUS)

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

All UG Programmes are Accredited by NBA

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

MECHANICAL ENGINEERING

(Accredited by NBA)

SCHEME OF INSTRUCTION & EXAMINATION

(Regulation R19)

IV/IV B.TECH

I-SEMESTER

(With effect from **2019-2020**Admitted Batch onwards**)**

Course Code	Name of the Course	Category	Cr.	L	T	P	Internal Marks	External Marks	Total Marks
B19ME4101	Heat Transfer	PC	3	3	--	--	25	75	100
B19ME4102	CAD/CAM	PC	3	3	--	--	25	75	100
# PE-III	Program Elective-III	PE	3	3	--	--	25	75	100
#PE-IV	Program Elective-IV	PE	3	3	--	--	25	75	100
#OE-II	Open Elective-II	OE	3	3	--	--	25	75	100
B19ME4111	Heat Transfer Lab	PC	1.5	--	--	3	20	30	50
B19ME4112	CAD/CAM Lab	PC	1.5	--	--	3	20	30	50
B19ME4113	Project Work-I	PR	2	--	--	4	20	30	50
		TOTAL	**20**	**15**	**--**	**10**	**185**	**465**	**650**

	Course Code	Course
#PE-III	B19ME4103	Project Management
	B19ME4104	Mechatronics
	B19ME4105	Renewable Energy Sources
	B19ME4106	MOOCs –III
#PE-IV	B19ME4107	Power Plant Engineering
	B19ME4108	Robotics
	B19ME4109	Mechanical Vibrations
	B19ME4110	MOOCs –IV
#OE-II	Student has to study one Open Elective offered by CE or CSE or ECE or EEE or IT or S&H from the list enclosed.	

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B19ME4101	PC	3	--	--	3	25	75	3 Hrs.

HEAT TRANSFER

(For ME)

Course Objectives:

1.	To make the student calculate the heat transfer phenomena through conduction.
2.	To make the student calculate the heat transfer rate in convection.
3.	To make the student determine the overall heat transfer coefficient in heat exchangers and boiling and condensation phenomena.
4.	To make the student to evaluate the heat transfer by radiation.

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

S.No	Outcome	Knowledge Level
1.	Apply the modes of heat transfer and study the problems involving steady and unsteady state heat conduction in various Cross sections.	K3
2.	Formulate and solve the heat transfer coefficients for natural and forced convection for various cross section areas.	K3
3.	Design Simple heat exchanger units, acquiring basic knowledge on boiling and condensation heat transfer.	K4
4.	Analyse radiation heat transfer between black body and gray body surfaces.	K4

SYLLABUS

UNIT-I (10Hrs)	**Introduction:** Modes and Mechanisms of Heat Transfer – Basic Laws of Heat Transfer – General Applications of Heat Transfer. **Conduction Heat Transfer:** Fourier Rate Equation – General Heat Conduction Equation In Cartesian, Cylindrical and Spherical Coordinates, Simplification and Forms of the Field Equation – Steady, Unsteady and Periodic Heat Transfer – Boundary and Initial Conditions. **One Dimensional Steady State Heat Conduction:** In Homogeneous Slabs, Hollow Cylinders and Spheres – Overall Heat Transfer Coefficient – Electrical Analogy – Critical Radius/Thickness of Insulation.
UNIT-II (10 Hrs)	**Heat Transfer in Extended Surface (Fins)**: efficiency, effectiveness and temperature distribution on Long Fin, Fin with Insulated Tip and Short Fin, Application to Errors in Temperature Measurement. **One Dimensional Transient Heat Conduction:** In Systems with Negligible Internal Resistance Significance of Biot and Fourier Numbers – Chart Solutions of Transient Conduction Systems – Problems on Semi-infinite Body.
UNIT-III (12 Hrs)	**Convective Heat Transfer:** Dimensional Analysis – Buckingham Π Theorem and Its Application for Developing Semi – Empirical Non-Dimensional Correlations for Convective Heat Transfer – Significance of Non-Dimensional Numbers.

	Forced Convection: **External Flows:** Concepts of Hydrodynamic and Thermal Boundary Layer and Use of Empirical Correlations for Convective Heat Transfer for Flow Over – Flat Plates, Cylinders and Spheres. **Internal Flows:** Division of Internal Flow through Concepts of Hydrodynamic and Thermal Entry Lengths – Use of Empirical Relations for Convective Heat Transfer in Horizontal Pipe Flow, Annular Flow. **Free Convection:** Development of Hydrodynamic and Thermal Boundary Layer along a Vertical Plate – Use of Empirical Relations for Convective Heat Transfer on Plates and Cylinders in Horizontal and Vertical Orientation.
UNIT-IV (8 Hrs)	**Heat Transfer with Phase Change:** Boiling: Pool Boiling – Regimes, Determination of Heat Transfer Coefficient in Nucleate Boiling, Critical Heat Flux and Film Boiling. Condensation: Film wise and Drop wise Condensation – Nusselt's Theory of Condensation on a Vertical Plate- Film Condensation on Vertical and Horizontal Cylinders Using Empirical Correlations. **Heat Exchangers:** Classification of Heat Exchangers – Overall Heat Transfer Coefficient and Fouling Factor –Concepts of LMTD and NTU Methods – Problems using LMTD and NTU Methods.
UNIT-V (10 Hrs)	**Radiative Heat Transfer:** Emission Characteristics and Laws of Black-Body Radiation – Irradiation –Total and Monochromatic Quantities– Laws of Planck, Wien, Kirchoff, Lambert, Stefan And Boltzmann – Heat Exchange Between Two Black Bodies – Concepts of Shape Factor – Emissivity – Heat Exchange Between Gray Bodies – Radiation Shields – Electrical Analogy for Radiation Networks.

Text Books:	
1.	Fundamentals of Engg. Heat and Mass Transfer, R.C.Sachdeva, New Age International Publications, Fifth edition.
2.	Heat Transfer, P.K.Nag, TMH Publications, Third edition.
Reference Books:	
1.	Heat Transfer, J. P. Holman, TMH Publications, Special Indian edition.
2.	Principles of Heat Transfer, Frank Kreith, R. M. Manglik& M. S. Bohn, Cengage learning publishers, Special edition.
3.	Heat and Mass Transfer, Domkundwar, Arora, Domkundwar, Dhanpath Rai & Co. Publications.
4.	Heat and Mass Transfer, Cengel, McGraw Hill Publications, Fifth edition.
5.	Heat and mass transfer, R.K. Rajput, S. Chand Publications, Revised edition.
Web links	
1.	https://nptel.ac.in/courses/112101097/
2.	http://web.mit.edu/lienhard/www/ahttv212.pdf
3.	https://www.grc.nasa.gov/www/k-12/airplane/heat.html

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B19ME4102	**PC**	**3**	**--**	**--**	**3**	**25**	**75**	**3 Hrs.**

CAD/CAM

(For ME)

Course Objectives: The objective of this course is to:

1.	To impart the student with the fundamentals of CAD and Applications of computers in CAD
2.	To acquaint the student with the concepts of Artificial intelligence in design and manufacturing fields.
3.	To acquaint the student in using advanced modelling approaches and tools for real - world mechanical design problems that will enable him to execute comprehensive and professional engineering projects and understand the role of computers in manufacturing.
4.	To educate the student about the role of computers in different phases of manufacturing.

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

S.No	Outcome	Knowledge Level
1.	Understand the fundamentals of CAD and Applications of computers in CAD	K3
2.	Apply the principles of transformations and geometric modeling in CAD.	K3
3.	Analyze advanced computational tools for complex part analysis and apply the principles of artificial intelligence and expert systems in CAD applications.	K4
4.	Illustrate concepts of CAM, CNC, group technology and computer aided process planning methods.	K3
5.	Demonstrate various computer aided material handling systems and computer aided inspection and quality control techniques.	K3

SYLLABUS

UNIT-I (10 Hrs)	**Fundamentals of CAD** - Introduction - The design process - Application of computers for design - Operating systems - Hardware in CAD: The design work station - I/O Devices - CAD system configuration - Creating database for manufacturing - Benefits of CAD.
UNIT-II (10 Hrs)	**Interactive Computer Graphics** - Graphic display devices- Graphics system- Graphics standards - Graphical user interface- Transformation systems- windowing - clipping - 2D and 3D transformations - Linear transformation- Geometric Modeling - Modeling Techniques - Wire frame Modeling - Surface Modeling - 3 D Solid Modeling.
UNIT-III (10 Hrs)	**Introduction to Finite Element Analysis** – Steps of FEM for solving physical problem, CAD techniques to finite element data preparation- Automatic mesh generation- Presentation of results, CAD applications of FEM. **Introduction to Artificial Intelligence** - Applications of AI in design and CAD.
UNIT-IV (10 Hrs)	**Introduction to CNC and CAM:** Merits & demerits, Classification, manual part programming, Group technology and Coding systems (OPTIZ coding system only)

	Computer aided process planning: Introduction to process planning, Methods of process planning, Computer aided process planning
UNIT-V (10 Hrs)	**Computer aided material handling**: Robots: Structure and operation of Robots, robot sensors and applications. Automatic conveyor systems. Automated guided vehicles. **Computer aided inspection and quality control**: Quality assurance and quality control. Contact and Non-contact inspection -Coordinate measuring machine.

Textbooks:	
1.	CAD/CAM-ComputerAidedDesign&Manufacturing,byM.D.Groover&E.W.Zimmer.
2.	Computer Aided Design and Manufacturing, by Dr.Sadhu Singh, Khanna Publishers.
Reference Books:	
1.	Computer Integrated Design and Manufacturing, by David D. Bedworth, Mark R.Henderson& Philip M. Wolfe, McGraw-Hill Book Company, Singapore
2.	Computer Aided Manufacturing, by P.N.Rao, N.K.Tewari & T.K.Kundra, Tata McGraw- Hill publishing company Ltd, NewDelhi.
3.	CAD/CAM/CIM by Radhakrishna, New age international
Web links:	
1.	https://nptel.ac.in/courses/112102102
2.	https://archive.nptel.ac.in/courses/112/102/112102101/

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B19ME4103	**PE**	**3**	**--**	**--**	**3**	**25**	**75**	**3 Hrs.**

PROJECT MANAGEMENT

(Program Elective-III)

(For ME)

Course Objectives:

1.	To make the students understand the importance and necessity of Project Management.
2.	To teach students various project planning and scheduling tools and the concepts of cost estimation and budgeting.
3.	To make the students understand the concepts of risks, process of controlling the projects, evaluation of a project, communicate it to others, and terminate it.
4.	To make the students understand the roles and responsibilities within and outside the team, and how to manage the stress in projects.

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

S.No	Outcome	Knowledge Level
1.	Recognize the importance of project management especially in the context of present day complex business setting and thoroughly understand fundamentals of it.	K2
2.	Apply various tools and techniques for planning and scheduling the projects like Gantt chart, PERT, and CPM networks and have sound knowledge of cost estimating process.	K3
3.	Learn how to be proactive to the risks and manage them; understand the process of controlling the project in reaching its goal and the changes that occur.	K3
4.	Understand the importance and the ways of evaluating a project, communication management, and the process of terminating a project.	K3
5.	Understand different roles in project management, be an effective team member or project manager and knows how to manage the stress.	K3

SYLLABUS

UNIT-I (10 Hrs)	**Overview of Project Management:** Characteristics of projects, Need and evolution of project management, Definition and Objectives of project management, Project management: the person, the team, the system; The Project Life Cycle, Stages and different forms of Project Management.
UNIT-II (10 Hrs)	**Project Planning and Scheduling:** Work breakdown structure, Gantt charts, Network diagrams, CPM and PERT, Fundamentals of cost estimates and budgets, Cost estimating process.

UNIT-III (10 Hrs)	**Project Risk Management and Project Control:** Risk concepts, Risk identification: Sources of risks and identification techniques, Risk Assessment, Risk response planning, Risk analysis methods; Project control process, Project control emphasis, controlling changes.
UNIT-IV (10 Hrs)	**Evaluation, Communication, and Termination:** Project evaluation; Project communication management – meetings and reports; Terminating the project, Closure of contract, Project extensions.
UNIT-V (10 Hrs)	**Roles, Authority, and Teams in Project Management:** Project manager's role and responsibility, Authority in project management, Roles inside and outside the project team, Teams in project management and team building approach, Emotional stress and stress management.

Text Books:	
1.	John M Nicholas, Project Management for Business and Technology: Principles and Practice, Prentice Hall of India, 2002.
2.	Shtub, Bard and Globerson, Project Management: Engineering, Technology, and Implementation, PH Inc.
Reference Books:	
1.	S. Choudhury, Project Scheduling and Monitoring in Practice.
2.	P. K. Joy, Total Project Management: The Indian Context, Macmillan India Ltd.
3.	Larson, E.W. and Gray, C.F. (2018), Project management the managerial process, Seventh Edition, McGraw-Hill
4.	Jerome D. Wiest and Ferdiannd K. Levy, A management guide to PERT/CPM, PHI.
Web links:	
1.	https://nptel.ac.in/courses/110104073

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B19ME4104	PE	3	--	--	3	25	75	3 Hrs.

MECHATRONICS

(Program Elective-III)

(For ME)

Course Objectives:

1.	To equip the students with fundamental knowledge on mechatronic systems.
2.	To familiarize the student with interdisciplinary knowledge of electronics required for application in mechanical engineering.

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

S.No	Outcome	Knowledge Level
1.	**Understand** about various types of sensors, transducers and amplifiers applied in a mechatronic system.	K2
2.	**Identify** the use of signal converters, logic gates and actuation systems required for the design of mechatronic systems.	K2
3.	**Illustrate** mathematical models for physical systems using the fundamental knowledge of control systems.	K3
4.	**Produce** transfer function of first and second order systems with feedback loops.	K3
5.	**Develop** the knowledge on microcontrollers, programmable logic controllers and their applications in mechatronic systems.	K3

SYLLABUS

UNIT-I (10 Hrs)	**Introduction to Mechatronics:** **Sensors & Transducers:** Introduction, performance terminology, Classification of sensors, potentiometer sensor, strain gauged element, Capacity element, LVDT, Optical Encoders, Tacho generator and stain gauge load cell, Selection of sensors. **Signal Conditioning**: Introduction signal Conditioning-Operational amplifiers: Inverting amplifier, summing amplifier, Integrating amplifier, Difference amplifier, filtering process.
UNIT-II (10 Hrs)	**Digital signals:** Digital and analog signals - DA and AD converter – Data Acquisition **Digital logic**: Digital logic - Logic gates – Application of logic gates **Pneumatic and hydraulic Actuation Systems**: Direction control valves –process control valve-cylinders**,** Mechanical actuation systems
UNIT-III (10 Hrs)	**Electric Actuation System**: Switching devices: Mechanical switches, solid state switches – solenoids - DC motors, AC motors, stepper motors **Basic System Models**: Modeling of one and two degrees of freedom Mechanical, Electrical, Fluid and thermal systems. Block diagram representations for these systems. Mechanical translational systems, Mechanical rotational systems, Electromechanical coupling

UNIT-IV (10 Hrs)	**System Transfer functions**: The Transfer function, Laplace transforms, First order systems, Second order systems, systems in series, systems with feedback loops. **Closed loop controllers**: Continuous and discrete processes, control modes, Two step, Proportional, Derivative, Integral, PID controllers
UNIT-V (10 Hrs)	**Microprocessors:** Microprocessor systems, Micro controllers, Applications **PLC**: Introduction, basic structure, I/P, O/P, processing, programming, ladder diagrams, timers, internal relays and counters, data handling, analogue input and output, selection of PLC. **Case studies of Mechatronic Systems**: Pick and place robot, Digital camera, Automotive control
Text Books:	
1.	Mechatronics Electronic control systems in Mechanical and Electrical Engineering by W. Bolton, Pearson Education, 4th Edition,2011
2.	Introduction to Mechatronics – David and Alcaitore Michael B.Histand TMH, 4th Edition, 2006.
Reference Books:	
1.	Mechatronics System Design by Devdas Shetty and Richard A. Kolk, P.W.S. Publishing Company, 2001
Web links:	
1.	https://nptel.ac.in/courses/112107298
2.	https://nptel.ac.in/courses/112103174

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B19ME4105	PE	3	--	--	3	25	75	3 Hrs.

RENEWABLE ENERGY SOURCES

(Program Elective-III)

(For ME)

Course Objectives:

1.	Significance of alternative sources of energy
2.	Significance of green energy systems and processes and provides the theory and working principles of probable sources of renewable and green energy systems that are Environmental friendly.

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

S.No	Outcome	Knowledge Level
1.	Explain the importance of solar energy	K2
2.	Apply the principles of solar energy storage and applications of solar energy ,solar collectors	K3
3.	Apply the principles of wind energy and biomass.	K3
4.	Understand the principles and working of geo thermal and ocean energies	K2
5.	Discuss the concepts of Tidal and wave energy ,mechanical systems	K2

SYLLABUS

UNIT-I (10 Hrs)	**Introduction:** Role and potential of new and renewable sources, the solar energy option, Environmental impact of solar power. **Solar Radiation**: the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data,. Photo voltaic energy conversion – types of PV cells.
UNIT-II (10 Hrs)	**Solar Energy Collection**: Flat plate and concentrating collectors, classification of concentrating collectors **Solar Energy Storage And Applications**: sensible, latent heat and stratified storage, solar ponds, solar applications- solar heating-space heating, water heating systems ,continuous solar cooling system, solar distillation and drying, central power tower concept.
UNIT-III (10 Hrs)	**Wind Energy**: Introduction, types of winds, Basic principles of Wind Energy Conversion Systems, Sources and potentials, horizontal and vertical axis windmills, Economics of wind energy utilization, Site selection criteria. **Bio-Mass:** Principles of bio-conversion, anaerobic/aerobic digestion, types of bio-gas digesters -fixed dome, floating drum ,KVIC digester and chinese biogas plant, Environmental impacts and benefits, Future role of biomass
UNIT-IV	**Geothermal Energy:** Introduction, vapor dominated systems , liquid dominated systems-

(10 Hrs)	binary cycle and total flow system, hot dry rock resources, magma resources, advantages and disadvantages, applications, Geothermal sites in India **Ocean Energy**: OTEC, Principles of utilization, setting of OTEC plants, advantages and disadvantages of OTEC plants,
UNIT-V (10 Hrs)	**Tidal and wave energy**: Potential and conversion techniques, mini-hydel power plants and their economics **Mechanical Systems:** Fuel cells- principle, selection of fuels & working of various types of fuel cells-hydrogen fuel cell, hydrogen-oxygen fuel cell, Molten carbonate fuel cell, advantages and disadvantages of fuel cell , Environmental friendly and Energy efficient compressors and pumps.

Text Books:	
1.	Non-Conventional Energy Sources - G. D. Rai, fifth edition, Khanna Publishers, 2015.
2.	Non-Conventional Energy Resources - Khan B.H., Tata McGraw Hill, New Delhi, 2006
3.	Solar Energy – Principles of Thermal Collection and Storage/Sukhatme S.P. and J.K.Nayak/TMH
4.	Green Manufacturing Processes and Systems - J. Paulo Davim/Springer 2013.
Reference Books:	
1.	Alternative Building Materials and Technologies - K.S Jagadeesh, B.V Venkata Rama Reddy and K.S Nanjunda Rao/New Age International
2.	Non-Conventional Energy - Ashok V Desai /New Age International (P) Ltd
3.	Renewable Energy Technologies -Ramesh & Kumar /Narosa
4.	Principles of Solar Engineering - D.Yogi Goswami, Frank Krieth & John F Kreider/Taylor & Francis.
5.	Fuel Cell Technology -Hand Book / Gregor Hoogers / BSP Books Pvt. Ltd
Web links:	
1.	https://nptel.ac.in/courses/103103206
2.	https://nptel.ac.in/courses/115103123

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B19ME4106	**PE**	**--**	**--**	**--**	**3**	**25**	**75**	**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
B19ME4107	PE	3	--	--	3	25	75	3 Hrs.

POWER PLANT ENGINEERING

(Program Elective-IV)

(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.	K2
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)	**Introduction to the sources of energy**: – resources and development of power in India. **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 (10 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 (10 Hrs)	**Hydro Electric Power Plant:** Water power – hydrological cycle / flow measurement - hydrographs – storage and pondage –classification of dams and spill ways. Classification of hydro electric power plants and typical layouts.
UNIT-IV (10 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 (10 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.
Text Books:	
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.
Web links:	
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
B19ME4108	**PE**	**3**	**--**	**--**	**3**	**25**	**75**	**3 Hrs.**

ROBOTICS

(Program Elective-IV)

(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, terminology and applications of robot	K2
2.	Learn the Homogeneous transformation of robot	K3
3.	Formulate forward and inverse kinematics for robot manipulator	K3
4.	Develop proper joint trajectory for robot joint and analyze the dynamics robot manipulator using Lagrange method	K3
5.	Develop linear control for the robot	K3

SYLLABUS

UNIT-I (10 Hrs)	**Fundamentals of robotics:** Robot and robotics, classification of robotics, advantages and disadvantages, Robot-components, degrees of freedom, joints, coordinates, reference frames, programming modes, workspace, languages, 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, 3-DOF robot, 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, trajectory following control **Nonlinear control of manipulators:** Nonlinear and time varying systems, the nonlinear control problem for manipulators, Lyapunov 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
3.	Industrial Robotics /Groover M P /Pearson Edu.
Reference Books:	
1.	Introduction to Robotics by SK Saha, The McGrah Hill Company
2.	Robotics / Fu K S/ McGraw Hill
Web links:	
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
B19ME4109	PE	3	--	--	3	25	75	3 Hrs.

MECHANICAL VIBRATIONS

(Program Elective-IV)

(For ME)

Course Objectives:

1.	To gain the knowledge of mathematical modeling of a physical system and
2.	To gain knowledge by applying the principles of Newton's Second Law and conservation of energy to derive the equations of motion.

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

S.No	Outcome	Knowledge Level
1.	Determine natural frequency of undamped and damped single degree freedom systems	K3
2.	Analyze the forced vibrations of Single Degree Freedom Systems:	K3
3.	Calculate natural frequencies of two degree freedom system	K3
4.	Apply numerical methods to determine natural frequencies of multi degree freedom system	K3
5.	Calculate critical speed of shaft and describe vibration measuring instruments	K3

SYLLABUS

UNIT-I (10 Hrs)	**Single Degree of Freedom Systems:** Undamped free vibration: Classical method, Energy method, equivalent systems, Damped free vibration- Viscous damping-underdamping, critical damping, overdamping; Coulomb damping, equivalent damping coefficient.
UNIT-II (10 Hrs)	**Forced vibrations of Single Degree Freedom Systems:** Steady state forced vibration, sources of excitation, impressed harmonic force, resonance, impressed force due to rotating unbalance, base excitation, transmissibility and isolation, performance of different type of isolators, power absorbed by viscous damping.
UNIT-III (10 Hrs)	**Two degree Freedom Systems:** Principal modes of vibration, two masses fixed on tightly stretched string, double pendulum, torsional system with damping, forced vibration with harmonic excitation, undamped dynamic vibration absorber, untuned viscous damper.
UNIT-IV (10 Hrs)	**Multi Degree Freedom Systems:** Lagrangian method for formulation of equation of motion Rayleigh's method, Dunkerley's method, Stodola method, Rayleigh-Ritz method, Method of matrix iteration.
UNIT-V (10 Hrs)	**Whirling of shafts:** Critical speeds of shafts – Critical speed of a light shaft having a single disc – without damping and with damping. Critical speed of a shaft having multiple discs – secondary critical speed.

	Vibration measurement and Applications: Piezoelectric transducers and linear variable differential transformer transducer; Vibration pickups: Vibrometer, Accelerometer, Vibration exciters- Mechanical exciters, impact hammer and electrodynamic shaker.
Text Books:	
1.	G. K. Groover, Mechanical Vibrations, 8th Edition, Nem Chand & Bros, 2009
Reference Books:	
1.	L. Meirovich, Elements of Vibrations Analysis, 1st Edition, Tata McGraw Hill, 1986
2.	S. Graham Kelly, Mechanical Vibrations, 1st Edition, Tata McGraw Hill, 1996
3.	Singiresu S. Rao, Mechanical Vibrations, 6th Edition, Pearson Education, 2018
Web links:	
1.	https://nptel.ac.in/courses/112103111
2.	https://nptel.ac.in/courses/112107212

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B19ME4110	**PE**	**--**	**--**	**--**	**3**	**25**	**75**	**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
B19ME4111	PC	--	--	3	1.5	20	30	3 Hrs.

HEAT TRANSFER LAB

(For ME)

Course Objectives:

1.	This course is designed to introduce a basic study, the phenomena of heat and mass transfer, and to provide useful information concerning the performance and design of particular Systems and processes.
2.	A knowledge-based design problem requiring the formulations of solid conduction and fluid Convection and the technique of numerical computation.
3.	Examine the basic concepts of heat transfer models - thermal gradients, conduction, convection and radiation.
4.	To help the student develop skills that would apply to lifelong learning.

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

S.No.	Outcome	Knowledge Level
1.	Conduct experiments on conduction, convection and radiation of heat, collect data, perform analysis and interpret results to draw valid conclusions through standard test procedures.	K5
2.	Determine thermal properties and performance of heat exchanger.	K4

LIST OF EXPERIMENTS

1.	Determination of Thermal Conductivity for a Given Copper Metal Rod.
2.	Determination of Thermal Conductivity for a Composite Wall.
3.	Determination of Thermal Conductivity of Insulating Powder.
4.	Determination of Heat Transfer through Pin-Fin.
5.	Determination of Heat Transfer through Forced Convection.
6.	Determination of Heat Transfer through Natural Convection.
7.	Determination of overall heat transfer coefficient for Parallel and Counter Flow Heat Exchanger.
8.	Measure the Emissivity of given test surface.
9.	Measurement of Stefan Boltzmann constant.
10.	Determination of Heat Transfer through Drop Wise and Film Wise Condensation.
11.	Determination of Two phase heat Transfer.
12.	Study of Refrigeration and Air Conditioning Test Rig.

Reference Books:

1.	Yunus A. Cengel, “Heat Transfer a Practical Approach”, Tata McGraw-Hill Education.
2.	R. C. Sachdeva, “Fundamentals of Engineering, Heat and Mass Transfer”, New Age publication.
3.	Heat & Mass Transfer by P.K. Nag, McGraw Hill.

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B19ME4112	PC	--	--	3	1.5	20	30	3 Hrs.

CAD/CAM LAB

(For ME)

Course Objectives:

1.	Introduction to CAD package in design and drafting of the different parts by using computer aided modelling.
2.	Develop the design skills of the students to practice the different 2D/3D engineering drawings
3.	Application of CAD packages in solving the simple problems in modeling and analysis.
4.	Imparting the students with the necessary knowledge to write the part program of CNC machine.

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

S.No.	Outcome	Knowledge Level
1.	To impart the students with necessary computer aided modeling skills using standard CAD packages.	K4
2.	To expose the students to the techniques of CNC programming and cutting tool path generation through CNC simulation software by using G-Codes and M-codes and writing part program for simple machine parts.	K5

LIST OF EXERCISES

CAD Exercises:

1.	Drawing of primitives (line, arc, circle, ellipse, triangle etc.) and 2D sketching.
2.	Solid modeling Techniques Using any standard CAD Packages (3D Part Geometric Modeling Creation of simple mechanical components)
3.	Creation of 3D assembly model machine elements like Oldham's coupling, Muff coupling etc
4.	Finite Element Analysis of simple Structural elements like bar, truss, beam etc.

CAM Exercises:

5.	Preparation of manual part programming for CNC Lathe. (Operations like Facing, Step Turning, threading etc.)
6.	Preparation of manual part programming for CNC Milling.(Operations linear, circular interpolations, drilling cycle etc)

Reference Books:

1.	CAD/CAM Theory and Practice by Ibrahim Zeid.
2.	CAD/CAM Principles and Applications by P.N. Rao, Tata McGraw Hill PublishingCompany Ltd.
3.	Computer Integrated Design and Manufacturing by David D. Bedworth, Mark R. Henderson, Philip M. Wolfe.

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B19ME4113	PR	--	--	4	2	20	30	3 Hrs.

PROJECT WORK - I

(For ME)

Course Objectives:

1	To acquaint with the process of undertaking literature survey/industrial visit and identifying the problem
2	To familiarize the process of solving the problem in a group
3	To acquaint with the process of applying basic engineering fundamental in the domain of practical applications
4	To inculcate the process of research

Course Outcomes:

S.No.	Outcome	Knowledge Level
1	Identify a topic in advanced areas.	**K3**
2	Review literature to identify gaps and define objectives & scope of the work.	**K3**
3	Generate and implement innovative ideas for social benefit.	**K4**

*The object of Project Work I 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.

Estd:1980

SAGI RAMA KRISHNAM RAJU ENGINEERING COLLEGE (AUTONOMOUS)

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

(Accredited by NBA)

SCHEME OF INSTRUCTION & EXAMINATION

(Regulation R19)

IV/IV B.TECH

II-SEMESTER

(With effect from **2019-2020**Admitted Batch onwards**)**

Course Code	Name of the Course	Category	Cr.	L	T	P	Internal Marks	External Marks	Total Marks
B19ME4201	Quality Control and Assurance	PC	3	3	--	--	25	75	100
B19ME4202	Control Systems	PC	3	3	--	--	25	75	100
#OE-III	Open Elective-III	OE	3	3	--	--	25	75	100
B19ME4203	Project Work-II	PR	7	--	--	14	60	90	150
		TOTAL	**16**	**9**	**--**	**14**	**135**	**315**	**450**

#OE-III	Student has to study one Open Elective offered by CE or CSE or ECE or EEE or IT or S&H from the list enclosed.

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B19ME4201	PC	3	--	--	3	25	75	3 Hrs.

QUALITY CONTROL AND ASSURANCE

(For ME)

Course Objectives:

1.	The overall objective of the course is to teach the basic principles of Quality management which includes Taguchi's 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 improving the process	K3
4.	Apply Taguchi's loss function and different processes for their Process Capability	K3
5.	Apply different sampling plans for the purpose of inspection.	K3

SYLLABUS

UNIT-I (10 Hrs)	**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, Statistical quality control, quality costs, 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.
Text Books:	
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
Web links:	
1.	https://nptel.ac.in/courses/110105088
2.	https://onlinecourses.nptel.ac.in/noc20_mg18/preview

Course Code	Category	L	T	P	C	I.M	E.M	Exam
B19ME4202	PC	3	--	--	3	25	75	3 Hrs.

CONTROL SYSTEMS

(For ME)

Course Objectives:

1.	To introduce basic principles of control systems 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.	Classify control systems and explain the need and effects of feedback in a control system and **illustrate** transfer function of multiple subsystems modeled as block diagram / signal flow graph.	K3
2.	**Prepare** mathematical models for physical systems using fundamental principles of mathematics and control systems.	K3
3.	**Deduce** transfer function of subsystems modeled as state space representation.	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 (08Hrs)	**Introduction:** Control systems, Classification of Control systems, Feedback and its effects. Transfer Function, Block Diagram and Signal Flow Graphs.
UNIT-II (10Hrs)	**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.
UNIT-IV (08Hrs)	**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, Type number of control systems, Steady state error, Static error constants.

UNIT-V (10 Hrs)	**Frequency Response Analysis:** Frequency response, Frequency-domain Analysis of Control Systems: Gain margin, Phase margin. **Stability of control systems:** Stability, Characteristic equation, Methods of determining stability of linear control systems: Routh-Hurwitz criterion, Nyquist stability criterion, Application of the Nyquist criterion.
Text Books:	
1.	Control Systems by A. NagoorKani, RBA Publications.
2.	Automatic Control Systems by Benjamin C Kuo
3.	Advanced Control Theory by A. NagoorKani, 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.
Web links	
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
B19ME4203	PR	--	--	14	7	60	90	3 Hrs.

PROJECT WORK - II

(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:

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 II & Dissertation is to enable the student to extend further the investigative study taken up under Project Work I, either fully theoretical/practical or involving both theoretical and practical work, under the guidance of a Supervisor from the Department alone or jointly with a Supervisor drawn from R&D laboratory/Industry. This is expected to provide a good training for the student(s) in R&D work and technical leadership.

The assignment to normally include:

a) In depth study of the topic assigned in light of Report prepared under Project Work I.
b) Review and finalization of the approach to the problem relating to the assigned topic.
c) Preparing an Action Plan for conducting the investigation, including team work.
d) Detailed Analysis/ Modeling/Simulation/Design/Problem Solving/Experiment as needed.
e) Final development of product/process, testing, results, conclusions and future directions.
f) Preparing a paper for Conference presentation/publication in Journals, if possible.
g) Preparing a dissertation in the standard format for being evaluated by the department.