



**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA**  
**UNIVERSITY COLLEGE OF ENGINEERING KAKINADA**  
**B.TECH MECHANICAL ENGINEERING**  
**(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)**

**B.Tech. – IV Year I Semester**

S.No.	Category	Title	L	T	P	Credits
1	Professional Core	CAD/CAM	2	0	0	2
2	Management Course- II	Operations Research	2	0	0	2
3	Professional Core	CAD/CAM & CAE Lab	0	0	2	1
4	Professional Elective	Professional Elective-IV	3	0	0	3
5	Professional Elective	Professional Elective-V	3	0	0	3
6	Open Elective - III	1. Finite Element Methods 2. Introduction to Mechatronics 3. Product design and development 4. Advanced Materials 5. Smart Manufacturing 6.NPTEL	3	0	0	3
7	Open Elective-IV	1. Optimization Techniques 2. Quantum Technology 3. Total Quality Management 4. Operations Management 5. Energy Auditing 6.NPTEL	3	0	0	3
8	Skill Enhancement Course	Mechatronics Lab	0	0	4	2
9	Audit Course	Constitution of India	2	0	0	-
	Internship	Evaluation of Industry Internship	-	-	-	2
<b>Total</b>			<b>18</b>	<b>0</b>	<b>06</b>	<b>21</b>

**Professional Elective-IV**

1. Mechatronics
2. Computational Fluid Dynamics
3. Functional Materials
4. Embedded Systems and Programming
5. NPTEL

**Professional Elective-V**

1. Hydrogen and Fuel Cell Technology
2. Smart manufacturing
3. Cryogenics
4. Electrical drives and actuators
5. Quantum Science and Technology
6. NPTEL

Dr. D.Ravi Kumar

Dr. A.Venu Gopal

Dr. N.Ramanaiah

Dr. S.V.Ramana Murthy

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**B.Tech. – IV Year II Semester**

S.No.	Category	Title	L	T	P	Credits
1	PR	Internship and Project	-	-	24	12

Dr. D.Ravi Kumar

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KAKINADA-533003, Andhra Pradesh, India

B.TECH MECHANICAL ENGINEERING

(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)

IV Year-I Semester	CAD/CAM	L	T	P	C
		2	0	0	2

**COURSE OBJECTIVES:** To enable the students to

1. Understand the basic fundamentals of computer aided design and manufacturing.
2. Learn 2D & 3D transformations of the basic entities like line, circle, ellipse etc
3. Understand the different geometric modeling techniques like solid modeling,
4. Explain surface modeling, feature based modeling etc. and to visualize how the components look like before its manufacturing or fabrication
5. Learn the part programming, importance of group technology, computer aided process planning, computer aided quality control
6. To learn the overall configuration and elements of computer integrated manufacturing systems.

## UNIT I:

### INTRODUCTION:

Fundamentals of CAD, CAM, Automation, design process, Application of computers for design, Benefits of CAD, Product Design and CAD- Comparison, benefits of using CAD in product design and product development cycle.

**COMPUTER GRAPHICS:** Raster scan graphics coordinate system, database structure for graphics modeling, transformation of geometry, 3D transformations, mathematics of projections.

## UNIT II:

**WIRE FRAME MODELLING:** Definition, advantages, dis-advantages, wire frame entities- analytic entities and synthetic entities.

**SURFACE MODELLING:** Definition, advantages, disadvantages, surface entities- analytic entities and synthetic entities.

**SOLID MODELLING:** Definition, constructive solid geometry, advantages, modelling entities. Curve representation: Implicit and explicit forms of straight line, circle, ellipse, cubic spline and Bezier curve, differences between Bezier curve and, cubic spline curve and Introduction to Data exchange formats.

## UNIT III:

### PART PROGRAMMING:

NC, NC modes, NC elements, CNC machine tools and their applications, Parts and power transmission in CNC machine tools, features of Machining center, turning center, CNC Part Programming: fundamentals, manual part programming methods, Computer Aided Part Programming- APT language, simple problems in manual part programming and Computer Aided Part Programming. Direct Numerical Control, Adaptive Control.

## UNIT IV:

### GROUP TECHNOLOGY:

Part family, coding and classification, Optiz and MICLASS classification system, benefits of group technology - production flow analysis, types and advantages.

FMS-Introduction, types of FMS, Equipment, Tool management systems, Layouts, FMS

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Control.

## UNIT V:

**COMPUTER INTEGRATED MANUFACTURING SYSTEMS:** Types of manufacturing systems, machine tools and related equipment, material handling systems, material requirement planning, MRP, Enterprise resource planning, computer control systems, human labor in manufacturing systems, CIMS benefits, computer aided quality control, Computer aided processes planning – variant process planning and generative process planning-Implementation considerations.

## TEXT BOOKS:

1. Automation, Production systems & Computer integrated Manufacturing/ M.P. Groover/Pearson Education
2. Mastering CAD / CAM / Ibrahim Zeid / McGraw-Hill

## REFERENCES:

1. CAD / CAM Principles and Applications/PN Rao / McGraw-Hill
2. Principles of Computer Aided Design and Manufacturing / Farid Amirouche / Pearson
3. Computer Numerical Control Concepts and programming / Warren S Seames / Thomson learning, Inc
4. Product manufacturing and cost estimation using CAD/CAE/ Kuang Hua Chang/Elsevier Publishers

## COURSE OUTCOMES: At the end of the course, student will be able to

- CO1** Understand the basic fundamentals of computer aided design and manufacturing.
- CO2** To learn 2D & 3D transformations of the basic entities like line, circle, ellipse etc
- CO3** To understand the different geometric modeling techniques like solid modeling, surface modeling, feature based modeling etc. and to visualize how the components look like before its manufacturing or fabrication
- CO4** To learn the part programming, importance of group technology, computer aided process planning, computer aided quality control
- CO5** To learn the overall configuration and elements of computer integrated manufacturing systems.

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IV Year-I Semester	OPERATIONS RESEARCH	L	T	P	C
		2	0	0	2

**COURSE OBJECTIVES:** The student will acquire the knowledge

1. Understand Linear Programming models
2. Interpret Transportation and sequencing problems
3. Solve replacement problems and analyze queuing models
4. Understand game theory and inventory problems
5. Interpret dynamic programming and simulation.

## UNIT I:

**INTRODUCTION** - definition- characteristics and phases – types of operation research models – applications.

**LINEAR PROGRAMMING:** Linear programming problem formulation – graphical solution – simplex method – artificial variables techniques -two-phase method, big-M method – duality principle.

## UNIT II:

**TRANSPORTATION PROBLEM:** Formulation – optimal solution, unbalanced transportation problem – degeneracy, assignment problem – formulation – optimal solution - variants of assignment problem- travelling salesman problem.

**SEQUENCING** – Introduction – flow –shop sequencing – n jobs through two machines – n jobs through three machines – job shop sequencing – two jobs through ‘m’ machines.

**UNIT III:REPLACEMENT:** Introduction – replacement of items that deteriorate with time – when money value is not counted and counted – replacement of items that fail completely, group replacement.

**GAME THEORY :** Introduction – mini. max (max. mini) – criterion and optimal strategy – solution of games with saddle points – rectangular games without saddle points – 2 x 2 games – dominance principle – m x 2 & 2 x n games -graphical method.

## UNIT IV:

**QUEUEING THEORY:** Introduction – single channel – poisson arrivals – exponential service times – with infinite population and finite population models– multichannel – poisson arrivals – exponential service times with infinite population single channel.

**INVENTORY CONTROL :** Introduction – single item – deterministic models – purchase inventory models with one price break and multiple price breaks – shortages are not allowed – stochastic models – demand may be discrete variable or continuous variable, Instantaneous demand and continuous demand and no set up cost. ABC & VED Analysis.

## UNIT V:

**DYNAMIC PROGRAMMING:** Introduction – Bellman’s principle of optimality – shortest path problem.

**SIMULATION:** Definition – types of simulation models – phases of simulation– applications of simulation – inventory problems

## TEXT BOOKS:

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1. Operations Research-An Introduction/Hamdy A Taha/Pearson publishers
2. Operations Research –Theory & publications / S.D.Sharma-Kedarnath/McMillan publishers India Ltd

**REFERENCES:**

1. Introduction to O.R/Hiller &Libermann/TMH
2. Operations Research /A.M. Natarajan, P. Balasubramani, A. Tamilarasi /Pearson Education.
3. Operations Research: Methods & Problems / Maurice Saseini, ArhurYaspan& Lawrence Friedman/Wiley
4. Operations Research / R.Pannerselvam/ PHI Publications.
5. Operations Research / Wagner/ PHI Publications.
6. Operation Research /J.K.Sharma/MacMilan Publ.
7. Operations Research/ Pai/ Oxford Publications
8. Operations Research/S Kalavathy / Vikas Publishers
9. Operations Research / DS Cheema/University Science Press
10. Operations Research / Ravindran, Philips, Solberg / Wiley publishers

**COURSE OUTCOMES: At the end of the course, student will be able to**

- CO1** Understand Linear Programming models
- CO2** Interpret Transportation and sequencing problems
- CO3** Solve replacement problems and analyze queuing models
- CO4** Understand game theory and inventory problems
- CO5** Interpret dynamic programming and simulation.

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IV Year-I Semester	CAD/CAM&CAE LAB	L	T	P	C
		0	0	2	1

**COURSE OBJECTIVES:**

1. To give exposure to software tools needed to analyze engineering problems.
2. To expose the students to different applications of simulation and analysis tools.

**Note: Student shall perform at least three experiments from each section**

**CONTENTS**

1. Experiments to determine stresses, deflection, natural frequencies, harmonic analysis, HT analysis and buckling analysis.
  - a) Determination of deflection and stresses in 2D and 3D trusses and beams.
  - b) Determination of principal and Von-mises stresses in plane stress, plane strain and axisymmetric components.
  - c) Determination of stresses in 3D and shell structures (at least one example in each case)
  - d) Estimation of natural frequencies and mode shapes, harmonic response of 2D beam.
  - e) Steady state heat transfer analysis of plane and axisymmetric components.
  - f) Buckling analysis
2. Study of CNC part programming fundamentals and write part programmes for simple components on CNC lathe and Mill and Study of RP machine.
  - a) CNC part programming for turned components
    - (i) Plain turning and facing
    - (ii) Step Turning Operation
    - (iii) Taper turning
  - b) CNC programming for milled components
    - (i) circular interpolation
    - (ii) End milling
    - (iii) Pocket milling
3. Automated CNC Tool path and G-Code generation using CAM packages.
4. Study and demonstration of RP machine-creation of simple parts.
5. Virtual 3D Printing Simulation lab using Vlabs.

<https://3dp-dei.vlabs.ac.in/List%20of%20experiments.html>

**COURSE OUTCOMES: At the end of the course, student will be able to**

- CO1** Generate CNC Turning and Milling codes for different operations using standard CAM packages.
- CO2** Apply rapid prototyping concepts in engineering and real time applications

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IV Year-I Semester	MECHATRONICS (Professional Elective-IV)	L	T	P	C
		3	0	0	3

**COURSE OBJECTIVES:** The student will acquire the knowledge

1. To understand the use the various mechatronics systems, measurement systems, sensors and transducers.
2. To apply the concepts of solid state electronic devices.
3. To identify the components in the design of electro mechanical systems.
4. To apply the concepts of digital electronics and applications of PLCs for control.
5. To understand system interfacing, data acquisition and design of mechatronics systems.

## UNIT I:

Mechatronics systems – elements & levels of mechatronics system, Mechatronics design process, system, measurement systems, control systems, microprocessor-based controllers, advantages and disadvantages of mechatronics systems. Sensors and transducers, types, displacement, position, proximity, velocity, motion, force, acceleration, torque, fluid pressure, liquid flow, liquid level, temperature and light sensors.

## UNIT II:

Solid state electronic devices - PN junction diode, BJT, FET, DIAC, TRIAC and LEDs. Analog signal conditioning, operational amplifiers, noise reduction, filtering

## UNIT III:

Hydraulic and pneumatic actuating systems - Fluid systems, Hydraulic systems, and pneumatic systems, components, control valves, electro-pneumatic, hydro-pneumatic, electro-hydraulic servo systems. Mechanical actuating systems and electrical actuating systems – basic principles and elements.

## UNIT IV:

Digital electronics and systems, digital logic control, microprocessors and micro controllers, programming, process controllers, programmable logic controllers, PLCs versus computers, application of PLCs for control.

**UNIT V:** System and interfacing and data acquisition – Data Acquisition Systems, Analog to Digital and Digital to Analog conversions; Digital Signal Processing – data flow in DSPs, block diagrams, typical layouts, Interfacing motor drives. Design of mechatronics systems & future trends.

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**TEXT BOOKS:**

1. MECHATRONICS Integrated Mechanical Electronics Systems/KP Ramachandran, GK Vijaya Raghavan & MS Balasundaram/WILEY India Edition

**REFERENCES:**

1. Mechatronics /Smaili A, Mrad F/ Oxford Higher Education, Oxford University Press
2. Mechatronics Source Book / Newton C Braga/Thomson Publications, Chennai.
3. Mechatronics – N. Shanmugam / Anuradha Agencies Publishers.
4. Mechatronics System Design / Devdasshetty/Richard/Thomson.
5. Mechatronics/M.D.Singh/J.G.Joshi/PHI.
6. Mechatronics – Electronic Control Systems in Mechanical and Electrical Engg. 4th Edition / W. Bolton/ Pearson, 2012
7. Mechatronics – Principles and Application / Godfrey C. Onwubolu/Elsevier, Indian print

**COURSE OUTCOMES: At the end of the course, student will be able to**

- CO1 Understand the use the various mechatronics systems, measurement systems, sensors and transducers.
- CO2 Apply the concepts of solid state electronic devices.
- CO3 Identify the components in the design of electro mechanical systems.
- CO4 Apply the concepts of digital electronics and applications of PLCs for control.
- CO5 Understand system interfacing, data acquisition and design of mechatronics systems.

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**(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)**

IV Year-I Semester	COMPUTATIONAL FLUID DYNAMICS (Professional Elective-IV)	L	T	P	C
		3	0	0	3

**COURSE OBJECTIVES:** The student will acquire the knowledge

1. To explain elementary details and numerical techniques for solving various engineering problems involving fluid flow.
2. To solve problems of fluid flow using applied numerical methods and understand equations governing fluid flow and heat transfer
3. To interpret fluid flow problems with steady flow and finite difference in heat conduction and convection
4. To understand the concepts of finite differences, discretization, consistency, stability and fundamentals of fluid flow modelling
5. To understand the concepts of finite element method applied to heat transfer problems.

**UNIT I:**

**Classification of PDE – REVIEW OF EQUATIONS GOVERNING FLUID FLOW AND HEAT TRANSFER:**

Introduction, conservation of mass, Newton's second law of motion, expanded forms of Navier-stokes equations (Derivation), conservation of energy principle, special forms of the Navier-stokes equations.

**APPLIED NUMERICAL METHODS:** Solution of a system of simultaneous linear algebraic equations, iterative schemes of matrix inversion, direct methods for matrix inversion, direct methods for banded matrices, TDMA – Algorithms.

**UNIT II:**

Steady flow, dimensionless form of momentum and energy equations, stokes equation, conservative body force fields, stream function - vorticity formulation.

Finite difference applications in heat conduction and convection –heat conduction, steady heat conduction in a rectangular geometry, transient heat conduction, finite difference application in convective heat transfer, closure.

**UNIT III:**

Finite differences, discretization, consistency, stability, and fundamentals of fluid flow modelling: introduction, elementary finite difference quotients, implementation aspects of finite-difference equations, consistency, explicit and implicit methods.

**UNIT IV:**

Introduction to first order wave equation, stability of hyperbolic and elliptic equations, fundamentals of fluid flow modelling, conservative property, the upwind scheme.

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**FINITE VOLUME METHOD:** Approximation of surface integrals, volume integrals, interpolation and differentiation practices, upwind interpolation, linear interpolation and quadratic interpolation.

Finite Element Method – Introduction – Weighted Residual and Variational Formulations – Rayleigh-Ritz Method – Interpolation – One dimensional and Two dimensional regions – Error Control – Applications of FEM to One dimensional Problems (Steady and Transient) – Two dimensional problems

## TEXT BOOKS:

1. Numerical heat transfer and fluid flow/Suhas V. Patankar/Butter-worth Publishers
2. Computational fluid dynamics-Basics with applications/John.D.Anderson/McGrawHill.

## REFERENCES:

1. Computational Fluid Flow and Heat Transfer/ Niyogi/Pearson Publications
2. Introduction to CFD: Finite Volume Method – H. Versteeg and W. Malalasekahara
3. Fundamentals of Computational Fluid Dynamics /TapanK.Sengupta/Universities Press.
4. Computational fluid dynamics: An introduction, 3<sup>rd</sup> edition/John.F Wendt/Springer publishers

## COURSE OUTCOMES: At the end of the course, student will be able to

- CO1 Find elementary details and numerical techniques for solving various engineering problems involving fluid flow.
- CO2 Solve problems of fluid flow using applied numerical methods and understand equations governing fluid flow and heat transfer.
- CO3 Interpret fluid flow problems with steady flow and finite difference in heat conduction and convection.
- CO4 Understand the concepts of finite differences, discretization, consistency, stability and fundamentals of fluid flow modeling.
- CO5 Understand the concepts of first order wave equation and finite volume method.

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IV Year-I Semester	FUNCTIONAL MATERIALS (Professional Elective-IV)	L	T	P	C
		3	0	0	3

**COURSE OBJECTIVES:** The student will acquire the knowledge:

1. To make the students to understand the basics of crystallography and its importance in studying materials properties.
2. To understand the electrical properties of materials including free electron theory, applications of quantum mechanics and magnetic materials.
3. To instil knowledge on physics of semiconductors, determination of charge carriers and device applications
4. To establish a sound grasp of knowledge on different optical properties of materials, optical displays and applications
5. To inculcate an idea of significance of nano structures, quantum confinement and ensuing nano device applications.

## UNIT I:

**CRYSTALLOGRAPHY:** Crystal structures: BCC, FCC and HCP – directions and planes - linear and planar densities – crystal imperfections- edge and screw dislocations – grain and twin boundaries - Burgers vector and elastic strain energy- Slip systems, plastic deformation of materials - Polymorphism – phase changes .

## UNIT II:

**ELECTRICAL AND MAGNETIC PROPERTIES OF MATERIALS:** Classical free electron theory - Expression for electrical conductivity – Thermal conductivity, expression - Quantum free electron theory :Tunneling – degenerate states – Fermi- Dirac statistics – Density of energy states – Electron in periodic potential – Energy bands in solids – tight binding approximation - Electron effective mass – concept of hole. Magnetic materials: Dia, para and ferromagnetic effects – paramagnetism in the conduction electrons in metals – exchange interaction and ferromagnetism – quantum interference devices – GMR devices.

## UNIT III:

**SEMICONDUCTORS AND TRANSPORT PHYSICS:** Intrinsic Semiconductors – Energy band diagram – direct and indirect band gap semiconductors – Carrier concentration in intrinsic semiconductors – extrinsic semiconductors - Carrier concentration in N-type & P-type semiconductors – Variation of carrier concentration with temperature – Carrier transport in Semiconductors: Drift, mobility and diffusion – Hall effect and devices – Ohmic contacts – Schottky diode

## UNIT IV:

**OPTICAL PROPERTIES OF MATERIALS:** Classification of optical materials – Optical processes in semiconductors: optical absorption and emission, charge injection and recombination, optical absorption, loss and gain. Optical processes in quantum wells – Optoelectronic devices: light detectors and solar cells – light emitting diode – laser diode - optical processes in organic semiconductor devices –excitonic state – Electro-optics and nonlinear optics: Modulators and switching devices – plasmonics.

## UNIT V:

**NANOELECTRONIC MATERIALS:** Quantum confinement – Quantum structures – quantum wells, wires and dots – Zener-Bloch oscillations – Resonant tunneling – quantum

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Dr. K.Meera saheb

Sri M.Kumara Swamy

Dr. T. Lakshmana kishore

Dr. V.Jaya prasad

Dr. K.Prasad



# JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

KAKINADA-533003, Andhra Pradesh, India

## B.TECH MECHANICAL ENGINEERING

### (R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)

interference effects - mesoscopic structures - Single electron phenomena – Single electron Transistor. Semiconductor photonic structures – 1D, 2D and 3D photonic crystal. Active and passive optoelectronic devices – photo processes – spintronics – carbon nanotubes: Properties and applications.

#### TEXT BOOKS:

1. V.Raghavan. Materials Science and Engineering: A First Course, Prentice Hall India Learning Private Limited, 2015.
2. S.O. Kasap, Principles of Electronic Materials and Devices, Mc-Graw Hill, 2018.
3. Jasprit Singh, Semiconductor Devices: Basic Principles, Wiley (India), 2007.
4. Jasprit Singh, Semiconductor Optoelectronics: Physics and Technology, Mc-Graw Hill India (2019)
5. G.W.Hanson. Fundamentals of Nanoelectronics. Pearson Education (Indian Edition), 2009.

#### REFERENCES:

1. R.Bala subramaniam, Callister's Materials Science and Engineering. Wiley (Indian Edition), 2014.
2. Wendelin Wright and Donald Askeland, Essentials of Materials Science and Engineering, CL Engineering, 2013.
3. Robert F.Pierret, Semiconductor Device Fundamentals, Pearson, 2006
4. Pallab Bhattacharya, Semiconductor Optoelectronic Devices, Pearson, 2017
5. Ben Rogers, Jesse Adams and Sumita Pennathur, Nanotechnology: Understanding Small Systems, CRC Press, 2017.

#### COURSE OUTCOMES: At the end of the course, student will be able to

- CO1 know basics of crystallography and its importance for varied materials properties
- CO2 gain knowledge on the electrical and magnetic properties of materials and their applications
- CO3 understand clearly of semiconductor physics and functioning of semiconductor devices
- CO4 understand the optical properties of materials and working principles of various optical devices
- CO5 appreciate the importance of functional nano electronic devices.

Dr. D.Ravi Kumar

Dr. A.Venu Gopal

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**KAKINADA-533003, Andhra Pradesh, India**

**B.TECH MECHANICAL ENGINEERING**

**(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)**

IV Year-I Semester	EMBEDDED SYSTEMS AND PROGRAMMING (Professional Elective-IV)	L	T	P	C
		3	0	0	3

**COURSE OBJECTIVES:** The student will acquire the knowledge:

1. To familiarize the architecture and fundamental units of microcontroller.
2. To know the microcontroller programming methodology and to acquire the interfacing skills and data exchange methods using various communication protocols.
3. To design the interface circuit and programming of I/O devices, sensors and actuators.
4. To understand ARM processor architecture and its functions to meet out the computational and interface needs of growing mechatronic systems.
5. To acquaint the knowledge of real time embedded operating system for advanced system developments

**UNIT I:**

**INTRODUCTION TO MICROCONTROLLER:** Fundamentals Functions of ALU - Microprocessor - Microcontrollers – CISC and RISC – Types Microcontroller - 8051 Family - Architecture - Features and Specifications - Memory Organization - Instruction Sets – Addressing Modes.

**UNIT II:**

**PROGRAMMING AND COMMUNICATION:** Fundamentals of Assembly Language Programming – Instruction to Assembler – Compiler and IDE - C Programming for 8051 Microcontroller – Basic Arithmetic and Logical Programming - Timer and Counter - Interrupts – Interfacing and Programming of Serial Communication, I2C, SPI and CAN of 8051 Microcontroller – Bluetooth and WI-FI interfacing of 8051 Microcontroller.

**UNIT III:**

**PERIPHERAL INTERFACING:** I/O Programming – Interfacing of Memory, Key Board and Displays – Alphanumeric and Graphic, RTC, interfacing of ADC and DAC, Sensors - Relays - Solenoid Valve and Heater - Stepper Motors, DC Motors - PWM Programming – Closed Loop Control Programming of Servomotor – Traffic Light

**UNIT IV:**

**ARM PROCESSOR:** Introduction ARM 7 Processor - Internal Architecture – Modes of Operations – Register Set – Instruction Sets – ARM Thumb - Thumb State Registers – Pipelining – basic programming of ARM 7 - Applications.

**UNIT V:**

**SINGLE BOARD COMPUTERS AND PROGRAMMING:** System on Chip - Broadcom BCM2711 SoC – SBC architecture - Models and Languages – Embedded Design – Real Time Embedded Operating Systems - Real Time Programming Languages – Python for Embedded Systems- GPIO Programming – Interfacing

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**B.TECH MECHANICAL ENGINEERING**

**(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)**

**TEXT BOOKS:**

1. Frank Vahid and Tony Givagis, "Embedded System Design", 2011, Wiley.
2. Kenneth J. Aylala, "The 8051 Microcontroller, the Architecture and Programming Applications", 2003.

**REFERENCES:**

1. Muhammad Ali Mazidi and Janice GillispieMazdi, "The 8051 Microcontroller and Embedded Systems", Pearson Education, 2006.
2. Simon Monk, Programming the Raspberry Pi, Second Edition: Getting Started with Python McGraw Hill TAB; 2nd edition, 2015
3. James W. Stewart, "The 8051 Microcontroller Hardware, Software and Interfacing", Regents Prentice Hall, 2003.
4. John B. Peatman, "Design with Microcontrollers", McGraw Hill International, USA, 2005.

**COURSE OUTCOMES: At the end of the course, student will be able to**

- CO1** Know the various functional units of microcontroller, processors and system-on-chip based on the features and specifications.
- CO2** Recognize the role of each functional units in microcontroller, processors and system- on-chip based on the features and specifications
- CO3** Interface the sensors, actuators and other I/O's with microcontroller, processors and system on chip based interfacing
- CO4** Design the circuit and write the programming microcontroller, processors and system on ch
- CO5** Develop the applications using Embedded system.

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# JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

KAKINADA-533003, Andhra Pradesh, India

B.TECH MECHANICAL ENGINEERING

(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)

IV Year-I Semester	HYDROGEN AND FUEL CELL TECHNOLOGY (Professional Elective-V)	L	T	P	C
		3	0	0	3

**COURSE OBJECTIVES:** The student will acquire the knowledge:

1. To introduce the fundamentals of the hydrogen economy, including hydrogen production, storage, and transportation methods.
2. To explore various hydrogen production methods and in-depth knowledge of hydrogen storage technologies and materials.
3. To understand the principles, types, and working mechanisms of various fuel cells and their components.
4. To study hydrogen and lithium storage systems and their applications in energy systems.
5. To analyze green hydrogen technologies with emphasis on sustainable production, storage, and utilization methods.

## UNIT I:

Hydrogen Production: Hydrogen economy Introduction to hydrogen economy production, storage and transportation systems hydrogen from fossil fuels electrolysis of water thermochemical cycles - baseline and alternative thermochemical cycles.

## UNIT II:

Hydrogen storage Technology: Hydrogen production methods, purification, hydrogen storage methods and materials: metal hydrides and metal-organic framework materials, volumetric and gravimetric storage capacities, hydriding and dehydriding kinetics, high enthalpy formations and thermal management during hydriding reaction, multiple catalytic degradation of sorption properties, automotive applications.

## UNIT III:

Fuel cell Technology: Fuel cell Principles, types of fuel cells (Alkaline Electrolyte, Phosphoric acid, Molten Carbonate, solid oxide and direct methanol and Proton exchange fuel cells), Principle and operation of Proton Exchange Membrane (PEM) fuel cell, Materials and fabrication methods for fuel cell technology, micro fuel cell power sources - Biofuels.

## UNIT IV:

Energy applications: Lithium & Hydrogen adsorption & storages, Fuel cell applications and energy storage.

## UNIT V:

Green hydrogen technologies: Green Hydrogen Production, Storage, Utilization And Purification.

## TEXT BOOKS:

1. Mehrdad Ehsani, Yimi Gao, Sebastian E. Gay, Ali Emadi, Modern Electric, Hybrid Electric and Fuel Cell Vehicles: Fundamentals, Theory and Design, CRC Press, 2004.
2. Rakesh Kumar Maurya, Characteristics and Control of Low Temperature

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KAKINADA-533003, Andhra Pradesh, India

B.TECH MECHANICAL ENGINEERING

(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)

Combustion Engines. ISBN 978-3-319-68507-6 , SPRINGER

## REFERENCES:

1. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
2. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003
3. Rand D.A.J, Woods, R & Dell RM Batteries for Electric vehicles, John Wiley & Sons, 1998
4. Iqbal Hussein, Electric and Hybrid Vehicles: Design Fundamentals, CRC Press, 2003.
5. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiley, 2003

## COURSE OUTCOMES: At the end of the course, student will be able to :

- CO1** Explain various hydrogen production methods such as electrolysis, fossil-fuel based processes, and thermochemical cycles, and their role in the hydrogen economy.
- CO2** Evaluate hydrogen storage materials such as metal hydrides and MOFs based on their thermodynamic and kinetic properties for automotive and energy applications.
- CO3** Compare different types of fuel cells and demonstrate the working principles and fabrication techniques of Proton Exchange Membrane (PEM) fuel cells.
- CO4** Assess energy storage systems utilizing lithium and hydrogen adsorption technologies and their relevance in modern energy applications.
- CO5** Design a sustainable green hydrogen production and purification process and assess its feasibility for real-world energy systems.

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**B.TECH MECHANICAL ENGINEERING**

**(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)**

IV Year-I Semester	SMART MANUFACTURING (Professional Elective-V)	L	T	P	C
		3	0	0	3

**COURSE OBJECTIVES:** The students will acquire the knowledge:

1. To define smart manufacturing and understand its key characteristics, corporate adaptation processes, and the role of Industry 4.0 technologies in minimizing the Six Big Losses in manufacturing.
2. To explore the role and applications of smart machines and sensors in IIoT, focusing on their function, ecosystem, and integration within industrial processes.
3. To understand the 5C architecture of Cyber-Physical Systems (CPS) and its role in enhancing manufacturing processes in Industry 4.0 environments.
4. To introduce Digital Twin technology, explore its applications in manufacturing, and understand the integration of Machine Learning (ML), AI, and predictive maintenance in enhancing industrial operations.
5. To study the IoT communication infrastructure and protocols required for Industry 4.0, focusing on connectivity standards and the selection of appropriate IoT protocols for industrial applications.

**UNIT I:**

**Concepts of Smart Manufacturing:** Definition and key characteristics of smart manufacturing, Corporate adaptation processes, manufacturing challenges, challenges vs technologies, Overview of circular manufacturing, Stages in smart manufacturing. Minimizing Six big losses in manufacturing with Industry 4.0, Industry 5.0, and their benefits

**UNIT II:**

**Smart Machines and Smart Sensors:** Concept and Functions of a Smart, Machine Salient features and Critical Subsystems of a Smart Machine, Smart sensors; smart sensors ecosystem, need, benefits and applications of sensors in industry, Sensing for Manufacturing Process in IIoT, Block Diagram of a IoT Sensing Device, Sensors in IIoT Applications, Smart Machine Interfaces

**UNIT III:**

**Architecture of Cyber-Physical system (CPS):** Functions of CPS, 5C Architecture; Smart Connection Level, Data-to- Information Level, Cyber Level, Cognition Level, Configuration Level. Design of PHM based CPS systems. Comparison of today's factory and Industry 4.0 factory by the implementation of 5C CPS architecture

**UNIT IV:**

**Digital Twin:** Introduction, applications of digital twins, impact zones of digital twins in manufacturing (factories/plants and OEMs), advantages of digital twins, basic steps of digital twin technology, Multiverse and AR and VR.

**Machine Learning (ML) and Artificial Intelligence (AI) in Manufacturing:** Introduction, benefits and applications of ML in industries, common approaches of ML; supervised and unsupervised, semi-supervised and reinforced ML, Application of AI and ML for predictive maintenance.

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# JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

KAKINADA-533003, Andhra Pradesh, India

B.TECH MECHANICAL ENGINEERING

(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)

## UNIT V:

**IoT connectivity for Industry 4.0:** Industrial communication requirement and its infrastructure, an overview of different types of networks, mesh network in industrial IoT, IoT protocols and the internet, TCP/IP (transmission control protocol/internet protocol) model, IoT connectivity standards: common protocols, application layer protocols, internet/network layer protocols, physical layer IoT protocols.

## TEXT BOOKS:

1. Industry 4.0 The Industrial Internet of Things by Alasdair Gilchrist, Apress
2. Industrial Internet of Things, Cyber Manufacturing System by Sabina Jeschke, Christian Brecher, Houbing Song Danda B. Rawat, Springer

## COURSE OUTCOMES: At the end of the course, student will be able to

- CO1 Demonstrate a comprehensive understanding of smart manufacturing and explain how Industry 4.0 minimizes the Six Big Losses in manufacturing processes.
- CO2 Analyze and explain the function of smart machines and sensors, including their integration into IIoT and their impact on manufacturing processes.
- CO3 Explain the 5C architecture of CPS and how its implementation transforms manufacturing systems in the context of Industry 4.0.
- CO4 Describe the key benefits and applications of Digital Twin technology, ML, AI, and predictive maintenance in optimizing manufacturing processes.
- CO5 Identify and assess various IoT connectivity protocols, selecting the most suitable for specific industrial IoT applications in the context of Industry 4.0.

Dr. D.Ravi Kumar

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**B.TECH MECHANICAL ENGINEERING**  
**(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)**

IV Year-I Semester	CRYOGENICS (Professional Elective-V)	L	T	P	C
		3	0	0	3

**COURSE OBJECTIVES:** The students will acquire the knowledge:

1. To Understand the different fluid and material properties at low temperatures
2. To impart knowledge of the working principles of various Cryo refrigerators, thermodynamic cycles for attaining low temperature, and gas separation and purification principles
3. To Understand the fundamental principles of thermal design of storage vessels and insulation, transfer systems.
4. Understand the cool-down process and heat transfer in cryogenic fluids and the occurrence of two-phase flow and stratification in cryogenic systems.
5. Understand the importance of vacuum requirements in cryogenics, superconductivity, and special phenomena at very low-temperature engineering applications.

**UNIT I:**

**FLUID AND MATERIAL PROPERTIES AT LOW TEMPERATURE & APPLICATIONS OF CRYOGENICS:**

Introduction to cryogenics: Cryogenic temperature scale, Properties of cryogenic fluids, super fluidity of He<sup>3</sup> & He<sup>4</sup>, properties of engineering materials at cryogenic temperatures, mechanical properties, thermal properties, electric & magnetic properties, super conducting materials.

**UNIT II:**

**CRYOGENIC GAS LIQUIFICATION:**

Gas liquefaction systems: Introduction, thermodynamically ideal systems, Joule Thomson effect, liquefaction systems such as Linde Hampton, precooled Linde Hampson, Linde dual pressure, cascade system, Claude system, Kapitza system, Heyland systems using expanders, comparison of liquefaction systems and its performance evaluations.

**UNIT III:**

**CRYOGENIC REFRIGERATOR AND CRYOCOOLERS:**

Cryogenic Refrigeration System: Ideal isothermal and reversible isobaric source refrigeration cycles, Joule Thomson system, cascade or pre-cooled joule-Thomson refrigeration systems, expansion engine and cold gas refrigeration systems, Sterling refrigerators, Importance of regenerator effectiveness for the Sterling refrigerators, Gifford single volume refrigerator, Gifford double volume refrigerators analysis, Refrigerators using solids as working media: Magnetic cooling, magnetic refrigeration systems, thermal; valves, nuclear demagnetization, dilution refrigerator

**UNIT IV:**

**CRYOGENIC FLUID STORAGE, INSTRUMENTATION, AND INSULATION:**

Dewar vessel for cryogenic fluid storage, Construction, Inner vessel design, outer vessel design, Temperature measurements, pressure measurements, flow measurements, liquid level measurements, fluid quality measurements, Cryogenic insulation – expanded foams, gas filled & fibrous insulation, vacuum insulation, evacuated powder & fibrous insulation, Opacified powder insulation, multilayer insulation, comparison of performance of various insulations

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**B.TECH MECHANICAL ENGINEERING**

**(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)**

**UNIT V:**

Applications of cryogenic systems: Super conductive devices, space technology, space simulation, cryogenics in biology and medicine, food preservation and industrial applications, nuclear propulsions, chemical propulsions.

**TEXT BOOKS:**

1. Barron, R., 1985, Cryogenic Systems, SI version, Oxford university press.
2. Scott, R. B., 1962, Cryogenic Engineering, D. Van Nostrand Company.

**REFERENCES:**

1. Timmerhaus, K. D. and Flynn, T. M., 1989, Cryogenic Process Engineering, Plenum Press.
2. Vance, R. W., and Duke, W. M., 1962, Applied Cryogenic Engineering, John Wiley.
3. Sittig, M., 1963, Cryogenics Research and Applications, D. Van Nostrand Company.
4. Hands, B.A., 1986, Cryogenic engineering, Academic press.
5. Flynn, T. M., 2005, Cryogenic Engineering, Marcel Dekker Inc., New York.

**COURSE OUTCOMES: At the end of the course, the student able to**

- CO1** To Understand the different fluid and material properties at low temperatures
- CO2** To impart knowledge of the working principles of various Cryo refrigerators, thermodynamic cycles for attaining low temperature, and gas separation and purification principles
- CO3** To Understand the fundamental principles of thermal design of storage vessels and insulation, transfer systems.
- CO4** Understand the cool-down process and heat transfer in cryogenic fluids and the occurrence of two-phase flow and stratification in cryogenic systems.
- CO5** Understand the importance of vacuum requirements in cryogenics, superconductivity, and special phenomena at very low-temperature engineering applications.

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# JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

KAKINADA-533003, Andhra Pradesh, India

B.TECH MECHANICAL ENGINEERING

(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)

IV Year-I Semester	Electrical drives and Actuators (Professional Elective-V)	L	T	P	C
		3	0	0	3

**COURSE OBJECTIVES:** The students will acquire the knowledge:

1. To familiarize a relay and power semiconductor devices
2. To get a knowledge on drive characteristics
3. To obtain the knowledge on DC motors and drives.
4. To obtain the knowledge on AC motors and drives.
5. To obtain the knowledge on Stepper and Servo motor

## UNIT I:

**RELAY AND POWER SEMI-CONDUCTOR DEVICES:** Study of Switching Devices – Relay and Types, Switching characteristics -BJT, SCR, TRIAC, GTO, MOSFET, IGBT and IGCT-: SCR, MOSFET and IGBT - Triggering and commutation circuit - Introduction to Driver and snubber circuits

## UNIT II:

**CHARACTERISTICS:** Electric drive – Equations governing motor load dynamics – steady state stability – multi quadrant Dynamics: acceleration, deceleration, torque, and Direction starting & stopping – Selection of motor

## UNIT III:

**DC MOTORS AND DRIVES:** DC Servomotor - Types of PMDC & BLDC motors - principle of operation- emf and torque equations - characteristics and control – Drives- H bridge - Single and Three Phases – 4 quadrant operation – Applications

## UNIT IV:

**AC MOTORS AND DRIVES:** Introduction – Induction motor drives – Speed control of 3-phase induction motor – Stator voltage control – Stator frequency control – Stator voltage and frequency control – Stator current control – Static rotor resistance control – Slip power recovery control.

## UNIT V:

**STEPPER AND SERVO MOTOR:** Stepper Motor: Classifications- Construction and Principle of Operation – Modes of Excitation Drive System-Logic Sequencer - Applications. Servo Mechanism – DC Servo motor-AC Servo motor – Applications.

## TEXT BOOKS:

1. Bimbhra B.S., "Power Electronics", 5th Edition, Kanna Publishers, New Delhi, 2012.
2. Mehta V.K. & Rohit Mehta, "Principles of Electrical Machines", 2nd Edition, S.Chand & Co. Ltd., New Delhi, 2016.

## REFERENCES

1. Gopal K. Dubey, "Fundamentals of Electrical Drives", 2nd Edition, Narosa Publishing House, New Delhi, 2001.
2. Theraja B.L. & Theraja A.K., "A Text Book of Electrical Technology", 2nd Edition, S.Chand & Co. Ltd., New Delhi, 2012.
3. Singh M.D. & Kanchandani K.B., "Power Electronics", McGraw Hill, New Delhi, 2007

**COURSE OUTCOMES:** At the end of the course, the student able to

Dr. D.Ravi Kumar	Dr. A.Venu Gopal	Dr. N.Ramanaiah	Dr. S.V.Ramana Murthy	Dr. G.R.K.Sastry
Dr. D.Lingaraju	Dr. V.V.Subba Rao	Dr. B.Balakrishna	Dr. A.Gopala Krishna	Dr. A.Swarna Kumari
Dr. N.Mohan Rao	Dr. K.Meera saheb	Sri M.Kumara Swamy	Dr. T. Lakshmana kishore	Dr. V.Jaya prasad
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**B.TECH MECHANICAL ENGINEERING**

**(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)**

- CO1** Recognize the principles and working of relays, drives and motors
- CO2** Explain the working and characteristics of various drives and motors.
- CO3** Apply the solid state switching circuits to operate various types of Motors and Drivers
- CO4** Interpret the performance of Motors and Drives.
- CO5** Suggest the Motors and Drivers for given applications

Dr. D.Ravi Kumar	Dr. A.Venu Gopal	Dr. N.Ramanaiah	Dr. S.V.Ramana Murthy	Dr. G.R.K.Sastry
Dr. D.Lingaraju	Dr. V.V.Subba Rao	Dr. B.Balakrishna	Dr. A.Gopala Krishna	Dr. A.Swarna Kumari
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**B.TECH MECHANICAL ENGINEERING**  
**(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)**

IV Year-I Semester	QUANTUM SCIENCE AND TECHNOLOGY (Professional Elective-V)	L	T	P	C
		3	0	0	3

**(Professional Elective-V)**

**Prerequisites:** Basic Physics, Linear Algebra, and Introduction to Modern Physics

**COURSE OBJECTIVES:** The students will acquire the knowledge:

1. To introduce fundamental concepts of quantum mechanics and its mathematical formalism.
2. To explore quantum computing and communication principles and technologies.
3. To understand the physical implementation and limitations of quantum systems.
4. To enable students to relate quantum theory to practical applications in computing, cryptography, and sensing.
5. To familiarize students with the emerging trends in quantum technologies.

**UNIT I:**

**Fundamentals of Quantum Mechanics:** Historical background: Blackbody radiation, photoelectric effect, and Compton scattering; Dual nature of light and matter; De Broglie hypothesis; Schrödinger equation; Free particle, infinite potential well, step potential; Operators and observables: position, momentum, Hamiltonian; Commutation relations and uncertainty principle; Quantum postulates and measurement theory; Eigenvalues, eigenfunctions.

**UNIT II:**

**Quantum Information Theory:** Classical vs. quantum information; Qubit representation using Bloch sphere; Quantum superposition and quantum entanglement; Dirac notation (bra-ket), tensor products, and composite systems; Bell states and EPR paradox; Quantum gates: Pauli-X, Y, Z; Hadamard; Phase; T; CNOT; Quantum circuit models and notation; Measurement in computational basis; Quantum teleportation and no-cloning theorem; Quantum state tomography (introductory)

**UNIT III:**

**Quantum Computing:** Classical computing review and limitations; Quantum parallelism and interference; Deutsch and Deutsch-Jozsa algorithms; Grover's search algorithm, Oracle and amplitude amplification; Shor's factoring algorithm (overview and significance); Quantum Fourier Transform (QFT); Quantum error correction: Bit-flip, phase-flip, and Shor's 9-qubit code; Introduction to quantum programming: Qiskit, Cirq, IBM Quantum Experience (overview)

**UNIT IV:**

**Quantum Communication:** Introduction to quantum cryptography; Quantum key distribution (QKD): BB84 protocol; Entanglement-based QKD: Ekert protocol (E91); Eavesdropping and security of QKD; Quantum teleportation (circuit and protocol); Quantum dense coding; Quantum networks and entanglement swapping; Role of quantum repeaters; Single-photon sources and detectors; Implementation challenges

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**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA**

**KAKINADA-533003, Andhra Pradesh, India**

**B.TECH MECHANICAL ENGINEERING**

**(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)**

(loss, decoherence, noise)

**UNIT V:**

**Quantum Technologies and Applications:** Quantum sensors: magnetometry, gravimetry; Quantum metrology: standard time, atomic clocks; Quantum imaging and lithography; Quantum materials: topological insulators, graphene, quantum dots; NV centers in diamonds for sensing; Hardware platforms: Superconducting qubits, Trapped ions, Photonic quantum processors; Quantum supremacy and NISQ era; Global initiatives: IBM, Google, D-Wave, IonQ, India's NQM; Ethical concerns and future prospects

**TEXT BOOKS:**

1. **"Quantum Computation and Quantum Information"** by Michael A. Nielsen and Isaac L. Chuang
2. **"Quantum Mechanics: Concepts and Applications"** by Nouredine Zettili

**COURSE OUTCOMES:** After completing this course, students will be able to.

- CO1 Explain core principles of quantum mechanics and their technological implications.
- CO2. Analyze quantum phenomena like superposition and entanglement.
- CO3. Apply mathematical tools to model and solve quantum systems.
- CO4. Demonstrate understanding of quantum algorithms and quantum circuits.
- CO5. Evaluate potential applications and challenges in quantum communication and sensing.

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KAKINADA-533003, Andhra Pradesh, India

B.TECH MECHANICAL ENGINEERING

(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)

IV Year-I Semester	FINITE ELEMENT METHODS (Open Elective – III)	L	T	P	C
		3	0	0	3

**COURSE OBJECTIVES:** The student will acquire the knowledge

1. To learn basic principles of finite element analysis procedure
2. To learn the theory and characteristics of finite elements that represent engineering structures of trusses and beams
3. To learn finite element modeling of two dimensional stress analysis
4. To learn the finite modelling for high order and isoparametric elements
5. To learn the usage of finite element method for the steady state heat transfer analysis

## UNIT I:

Introduction to finite element method, stress and equilibrium, strain –displacement relations, stress–strain relations, plane stress and plane strain conditions, variational methods.

## UNIT II:

Weighted residual methods, solving differential equations using weighted residual methods, concept of potential energy, one dimensional problems.

## UNIT III:

Bar element formulation, Discretization of domain, element shapes, discretization procedures, assembly of stiffness matrix, band width, node numbering, mesh generation, interpolation functions, local and global coordinates, convergence requirements, treatment of boundary conditions.

## UNIT IV:

Finite element modeling of two dimensional stress analysis with constant strain triangles and treatment of boundary conditions.

Finite element modeling of four noded rectangular element.

## UNIT V:

Higher order and iso-parametric elements: One dimensional, quadratic and cubic elements in natural coordinates, two dimensional four node diso-parametric elements and numerical integration.

## TEXT BOOKS:

1. The Finite Element Methods in Engineering /SSRao/Pergamon.

## REFERENCES:

1. Finite Element Method with applications in Engineering / YM Desai, Eldho& Shah /Pearson publishers
2. An introduction to Finite Element Method /JNReddy/McGrawHill
3. The Finite Element Method for Engineers–KennethH.Huebner, Donald L. Dewhirst, Douglas E. Smith and TedG. Byrom/John Wiley & sons (ASIA)PteLtd.

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**B.TECH MECHANICAL ENGINEERING**

**(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)**

4. Finite Element Analysis: Theory and Application with Ansys, Saeed Moaveniu, Pearson Education
5. Finite Element Methods / Chen
6. Finite Element Analysis: for students & Practicing Engineers / G.LakshmiNarasaiah / BSP Books Pvt. Ltd.

**COURSE OUTCOMES: At the end of the course, student will be able to**

- CO1** Understand the concepts discretization procedures and convergence requirements
- CO2** Identify the application and characteristics of FEA elements such as bars and beams.
- CO3** Understand the finite element method for the two dimensional stress analysis.
- CO4** Apply FEM for one dimensional and two dimensional higher order and iso-parametric elements
- CO5** Identify how the finite element method can apply for steady state heat transfer analysis.

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**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA**  
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**B.TECH MECHANICAL ENGINEERING**  
**(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)**

IV Year-I Semester	<b>INTRODUCTION TO MECHATRONICS</b> (Open Elective - III)	<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
		<b>3</b>	<b>0</b>	<b>0</b>	<b>3</b>

**COURSE OBJECTIVES:** The student will acquire the knowledge

1. To understand the use the various mechatronics systems, measurement systems, sensors and transducers.
2. To apply the concepts of solid state electronic devices.
3. To identify the components in the design of electro mechanical systems.
4. To apply the concepts of digital electronics and applications of PLCs for control.
5. To understand system interfacing, data acquisition and design of mechatronics

**UNIT I:**

Mechatronics systems – elements & levels of mechatronics system, Mechatronics design process, system, measurement systems, control systems, microprocessor-based controllers, advantages and disadvantages of mechatronics systems. Sensors and transducers, types, displacement, position, proximity, velocity, motion, force, acceleration, torque, fluid pressure, liquid flow, liquid level, temperature and light sensors.

**UNIT II:**

Solid state electronic devices - PN junction diode, BJT, FET, DIAC, TRIAC and LEDs. Analog signal conditioning, operational amplifiers, noise reduction, filtering

**UNIT III:**

Hydraulic and pneumatic actuating systems - Fluid systems, Hydraulic systems, and pneumatic systems, components, control valves, electro-pneumatic, hydro-pneumatic, electro-hydraulic servo systems. Mechanical actuating systems and electrical actuating systems – basic principles and elements.

**UNIT IV:**

Digital electronics and systems, digital logic control, microprocessors and micro controllers, programming, process controllers, programmable logic controllers, PLCs versus computers, application of PLCs for control.

**UNIT V:**

System and interfacing and data acquisition – Data Acquisition Systems, Analog to Digital and Digital to Analog conversions; Digital Signal Processing – data flow in DSPs, block diagrams, typical layouts, Interfacing motor drives. Design of mechatronics systems & future trends.

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**TEXT BOOKS:**

1. MECHATRONICS Integrated Mechanical Electronics Systems/KP Ramachandran, GK Vijaya Raghavan& MS Balasundaram/WILEY India Edition

**REFERENCES:**

1. Mechatronics /Smaili A, Mrad F/ Oxford Higher Education, Oxford University Press
2. Mechatronics Source Book / Newton C Braga/ThomsonPublications, Chennai.
3. Mechatronics – N. Shanmugam / Anuradha Agencies Publishers.
4. Mechatronics System Design / Devdas shetty/Richard/Thomson.
5. Mechatronics/M.D.Singh/J.G.Joshi/PHI.
6. Mechatronics – Electronic Control Systems in Mechanical and Electrical Engg. 4th Edition / W. Bolton/ Pearson,2012
7. Mechatronics – Principles and Application / Godfrey C. Onwubolu/Elsevier, Indianprint

**COURSE OUTCOMES: At the end of the course, student will be able to**

- CO1** Understand the use the various mechatronics systems, measurement systems, sensors and transducers.
- CO2** Apply the concepts of solid state electronic devices.
- CO3** Identify the components in the design of electro mechanical systems.
- CO4** Apply the concepts of digital electronics and applications of PLCs for control.
- CO5** Understand system interfacing, data acquisition and design of mechatronics systems.

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KAKINADA-533003, Andhra Pradesh, India

B.TECH MECHANICAL ENGINEERING

(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)

IV Year-I Semester	PRODUCT DESIGN AND DEVELOPMENT (Open Elective - III)	L	T	P	C
		3	0	0	3

**COURSE OBJECTIVES:** The student will acquire the knowledge:

1. To introduce the fundamental concepts of the product design and development
2. To develop material specifications, analysis and process.
3. To Learn the Feasibility Studies & reporting of product design and development.
4. To study the New product qualification and Market Survey on similar products of product design and development
5. To learn Reverse Engineering. Cloud points generation, converting cloud data to 3D model

## UNIT I:

**FUNDAMENTALS OF PRODUCT DESIGN AND DEVELOPMENT:** Introduction – Reading of Drawing – Grid reading, Revisions, ECN (Engg. Change Note), Component material grade, Specifications, customer specific requirements – Basics of monitoring of NPD applying Gantt chart, Critical path analysis – Fundamentals of BOM (Bill of Materials), Engg. BOM & Manufacturing BOM. Basics of MIS software and their application in industries like SAP, MS Dynamics, Oracle ERP Cloud – QFD.

## UNIT II:

**MATERIAL SPECIFICATIONS, ANALYSIS & PROCESS:** Material specification standards – ISO, DIN, JIS, ASTM, EN, etc. – Awareness on various manufacturing process like Metal castings & Forming, Machining (Conventional, 3 Axis, 4 Axis, 5 Axis, ), Fabrications, Welding process. Qualifications of parts mechanical, physical & Chemical properties and their test report preparation and submission. Fundamentals of DFMEA & PFMEA, Fundamentals of FEA, Bend Analysis, Hot Distortion, Metal and Material Flow, Fill and Solidification analysis.

## UNIT III:

**ESSENTIALS OF PRODUCT DESIGN AND DEVELOPMENT:** RFQ (Request of Quotation) Processing – Feasibility Studies & reporting – CFT (Cross Function Team) discussion on new product and reporting – Concept design, Machine selection for tool making, Machining – Manufacturing Process selection, Machining Planning, cutting tool selection – Various Inspection methods – Manual measuring, CMM – GOM (Geometric Optical Measuring), Lay out marking and Cut section analysis. Tool Design and Detail drawings preparation, release of details to machine shop and CAM programing. Tool assembly and shop floor trials. Initial sample submission with PPAP documents.

## UNIT IV:

**CRITERIONS OF PRODUCT DESIGN AND DEVELOPMENT:** New product qualification for Dimensions, Mechanical & Physical Properties, Internal Soundness proving through X-Ray, Radiography, Ultrasonic Testing, MPT, etc. Agreement with customer for testing frequencies. Market Survey on similar products, Risk analysis, validating samples with simulation results, Lesson

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B.TECH MECHANICAL ENGINEERING

(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)

Learned & Horizontal deployment in NPD (New Product Development).

## UNIT V:

**REPORTING & FORWARD-THINKING OF NPD:** Detailed study on PPAP with 18 elements reporting, APQP and its 5 Sections, APQP vs PPAP, Importance of SOP (Standard Operating Procedure) – Purpose & documents, deployment in shop floor. Prototyping & RPT - Concepts, Application and its advantages, 3D Printing – resin models, Sand cores for foundries; Reverse Engineering. Cloud points generation, converting cloud data to 3D model – Advantages & Limitation of RE, CE (Concurrent Engineering) – Basics, Application and its advantages in NPD (to reduce development lead time, time to Market, Improve productivity and product cost.)

## TEXT BOOKS:

1. Product Development – Sten Jonsson
2. Product Design & Development – Karl T. Ulrich, Maria C. Young, Steven D. Eppinger

## REFERENCES:

1. Revolutionizing Product Development – Steven C Wheelwright & Kim B. Clark
2. Toyota Product Development System – James Morgan & Jeffrey K. Liker
3. Winning at New Products – Robert Brands 3rd Edition
4. Product Design & Value Engineering – Dr. M.A. Bulsara & Dr. H.R. Thakkar

## COURSE OUTCOMES: At the end of the course, student will be able to

- CO1 Discuss fundamental concepts and customer specific requirements of the product design and development
- CO2 Discuss the Material specification standards, analysis and fabrication, manufacturing process.
- CO3 Develop Feasibility Studies & reporting of product design and development
- CO4 Analyzing the New product qualification and Market Survey on similar products of new product development
- CO5 Develop Reverse Engineering. Cloud points generation, converting cloud data to 3D model

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**B.TECH MECHANICAL ENGINEERING**

**(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)**

IV Year-I Semester	ADVANCED MATERIALS (Open Elective - III)	L	T	P	C
		3	0	0	3

**COURSE OBJECTIVES:** The students will acquire the knowledge

1. To classify the composite materials and identify the applications
2. To understand manufacturing methods of PMC, MMC & CCC and their applications
3. To understand macro-mechanical analysis of a lamina
4. To interpret the functionally graded materials and their properties
5. To understand types of nano materials and their properties

**UNIT I:**

**METALS & ALLOYS:**

Metallic materials- super alloys, Aluminium, Magnesium, titanium and Nickel based alloys and intermetallics, Materials for cryogenic application, Materials for space environment, Evaluation of materials for extreme environment, Introduction to metallic foams.

**UNIT II:**

**Polymers:** Natural Polymers-Synthetic polymers- Chemical & Physical structure, properties-glass-transition temperature-Thermosets-Thermoplastics- characteristics & applications of polymers-Elastomers- Processing of plastics.

**Ceramics:** Applications - characteristics- classification-Processing of ceramics- Powder preparations- consolidation- hot compaction-drying- sintering-finishing of ceramics-Areas of application.

**UNIT III:**

**INTRODUCTION TO COMPOSITE MATERIALS:** Introduction, classification: polymer matrix composites, metal matrix composites, ceramic matrix composites, carbon-carbon composites, fiber- reinforced composites and nature-made composites, and applications

**REINFORCEMENTS:** Fibres- glass, silica, kevlar, carbon, boron, silicon carbide, and boron carbide fibres.

**UNIT IV:**

**SHAPE MEMORY ALLOYS:** Introduction-shape memory effect-classification of shape memory alloys-composition-properties and applications of shape memory alloys.

**FUNCTIONALLY GRADED MATERIALS:** Types of functionally graded materials-classification different systems-preparation-properties and applications of functionally graded materials.

**UNIT V:**

**NANO MATERIALS:** Introduction-properties at nano scales-advantages & disadvantages applications in comparison with bulk materials (nano – structure, wires, tubes, composites). state of art nano advanced- topic delivered by student.

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**TEXT BOOKS:**

1. Nano material /A.K. Bandyopadyay/New age Publishers
2. Material science and Technology: A comprehensive treatment/Robert W.Cahn,/VCH
3. Engineering Mechanics of Composite Materials / Isaac and M Daniel/Oxford University Press

**REFERENCES:**

1. Mechanics of Composite Materials / R. M. Jones/ Mc Graw Hill Company, New York, 1975.
2. Analysis of Laminated Composite Structures / L. R. Calcote/Van NostrandRainfold,NY 1969
3. Analysis and performance of fibre Composites /B. D. Agarwal and L. J. Broutman /Wiley- Interscience, New York, 1980
4. Mechanics of Composite Materials - Second Edition (Mechanical Engineering) /AutarK.Kaw /CRC Press

**COURSE OUTCOMES: At the end of the course, student will be able to**

- CO1** Classify the composite materials and identify the applications
- CO2** Identify the aerospace materials and their applications
- CO3** Understand macro-mechanical analysis of a lamina
- CO4** Interpret the functionally graded materials and their properties
- CO5** Understand types of nano materials and their properties

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**B.TECH MECHANICAL ENGINEERING**  
**(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)**

IV Year-I Semester	SMART MANUFACTURING (Open Elective - III)	L	T	P	C
		3	0	0	3

**COURSE OBJECTIVES:** The students will acquire the knowledge:

1. To define smart manufacturing and understand its key characteristics, corporate adaptation processes, and the role of Industry 4.0 technologies in minimizing the Six Big Losses in manufacturing.
2. To explore the role and applications of smart machines and sensors in IIoT, focusing on their function, ecosystem, and integration within industrial processes.
3. To understand the 5C architecture of Cyber-Physical Systems (CPS) and its role in enhancing manufacturing processes in Industry 4.0 environments.
4. To introduce Digital Twin technology, explore its applications in manufacturing, and understand the integration of Machine Learning (ML), AI, and predictive maintenance in enhancing industrial operations.
5. To study the IoT communication infrastructure and protocols required for Industry 4.0, focusing on connectivity standards and the selection of appropriate IoT protocols for industrial applications.

**UNIT I:**

**Concepts of Smart Manufacturing:** Definition and key characteristics of smart manufacturing, Corporate adaptation processes, manufacturing challenges, challenges vs technologies, Stages in smart manufacturing. Minimizing Six big losses in manufacturing with Industry 4.0, and their benefits

**UNIT II:**

**Smart Machines and Smart Sensors:** Concept and Functions of a Smart, Machine Salient features and Critical Subsystems of a Smart Machine, Smart sensors; smart sensors ecosystem, need, benefits and applications of sensors in industry, Sensing for Manufacturing Process in IIoT, Block Diagram of aIoT Sensing Device, Sensors in IIoT Applications, Smart Machine Interfaces

**UNIT III:**

**Architecture of Cyber- Physical system (CPS):** Functions of CPS, 5C Architecture; Smart Connection Level, Data-to- Information Level, Cyber Level, Cognition Level, Configuration Level. Design of PHM based CPS systems. Comparison of today's factory and Industry 4.0 factory by the implementation of 5C CPS architecture

**UNIT IV:**

**Digital Twin:** Introduction, applications of digital twins, impact zones of digital twins in manufacturing (factories/plants and OEMs), advantages of digital twins, basic steps of digital twin technology

**Machine Learning (ML) and Artificial Intelligence (AI) in Manufacturing:** Introduction, benefits and applications of ML in industries, common approaches of ML; supervised and unsupervised, semi-supervised and reinforced ML

**Predictive Maintenance:** Introduction of predictive maintenance, difference between preventive and predictive maintenance, working and various components of

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B.TECH MECHANICAL ENGINEERING

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predictive maintenance, benefits and tools of predictive maintenance. Common approaches to IoT predictive maintenance; Rule-based (condition monitoring) and AI (artificial intelligence) based predictive maintenance.

## Augmented Reality in Maintenance (Electrical & Mechanical)

### UNIT V:

**IoT connectivity for Industry 4.0:** Industrial communication requirement and its infrastructure, an overview of different types of networks, mesh network in industrial IoT, IoT protocols and the internet, TCP/IP (transmission control protocol/internet protocol) model, IoT connectivity standards: common protocols, application layer protocols, internet/network layer protocols, physical layer IoT protocols, choosing the right IoT connectivity protocol

### TEXT BOOKS:

1. Industry 4.0 The Industrial Internet of Things by Alasdair Gilchrist, Apress
2. Industrial Internet of Things, Cyber Manufacturing System by Sabina Jeschke, Christian Brecher, Houbing Song Danda B. Rawat, Springer

### COURSE OUTCOMES: At the end of the course, student will be able to

- CO1 Demonstrate a comprehensive understanding of smart manufacturing and explain how Industry 4.0 minimizes the Six Big Losses in manufacturing processes.
- CO2 Analyze and explain the function of smart machines and sensors, including their integration into IIoT and their impact on manufacturing processes.
- CO3 Explain the 5C architecture of CPS and how its implementation transforms manufacturing systems in the context of Industry 4.0.
- CO4 Describe the key benefits and applications of Digital Twin technology, ML, AI, and predictive maintenance in optimizing manufacturing processes.
- CO5 Identify and assess various IoT connectivity protocols, selecting the most suitable for specific industrial IoT applications in the context of Industry 4.0.

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**B.TECH MECHANICAL ENGINEERING**

**(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)**

IV Year-I Semester	OPTIMIZATION TECHNIQUES (Open Elective - IV)	L	T	P	C
		3	0	0	3

**COURSE OBJECTIVES:** The student will acquire the knowledge

1. To understand classification of optimization problem and apply classical optimization techniques
2. To apply unconstrained optimization techniques using various methods
3. To understand the characteristics and approaches of constrained optimization techniques
4. To obtain optimized solutions using constrained and unconstrained geometric programming
5. To understand integer programming methods

**UNIT I:**

**INTRODUCTION TO OPTIMIZATION:** Engineering applications of optimization- statement of an optimization problem- classification of optimization problem- optimization techniques.

**CLASSICAL OPTIMIZATION TECHNIQUES:** Single variable optimization- multivariable optimization with equality constraints- multivariable optimization with inequality constraints.

**UNIT II:**

**UNCONSTRAINED OPTIMIZATION TECHNIQUES:** Pattern search method- Rosenbrock's method of rotating coordinates- Simplex method- Descent methods- Gradient of function- Steepest Descent method.

**UNIT III:**

**CONSTRAINED OPTIMIZATION TECHNIQUES:** Characteristics of constrained problem methods of feasible directions - basic approach in the penalty function method- interior penalty function method- convex programming problem- exterior penalty function method.

**UNIT IV:**

**GEOMETRIC PROGRAMMING (G.P):** Solution of an unconstrained geometric programming, differential calculus method and arithmetic method. primal dual relationship and sufficiency conditions. Solution of a constrained geometric programming problem (G.P.P). Complimentary geometric programming (C.G.P)

**UNIT V:**

**INTEGER PROGRAMMING (I.P):** Graphical representation. Gomory's cutting plane method. Algorithm for zero-one programming problem. Integer non-linear programming.

**TEXT BOOK:**

1. Optimization Theory and Applications/ S.S.Rao/Wiley Eastern Limited, New Delhi.

**REFERENCES:**

1. Engineering Optimization / Kalyanmanai Deb/Prentice Hall of India, New Delhi.

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**JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA**

**KAKINADA-533003, Andhra Pradesh, India**

**B.TECH MECHANICAL ENGINEERING**

**(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)**

2. Optimization Techniques-Theory and applications/C.Mohan&Kusum Deep/New Age International
3. Operations Research /S.D.Sharma / MacMillan Publishers

**COURSE OUTCOMES: At the end of the course, student will be able to**

- CO1** Understand classification of optimization problem and apply classical optimization techniques
- CO2** Apply unconstrained optimization techniques using various methods
- CO3** Understand the characteristics and approaches of constrained optimization techniques
- CO4** Identify optimized solutions using constrained and unconstrained geometric programming
- CO5** Understand integer programming methods

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B.TECH MECHANICAL ENGINEERING

(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)

IV Year-I Semester	QUANTUM TECHNOLOGY (Open Elective - IV)	L	T	P	C
		3	0	0	3

**Prerequisites:** Basic Physics, Linear Algebra, and Introduction to Modern Physics

## COURSE OBJECTIVES:

1. To introduce fundamental concepts of quantum mechanics and its mathematical formalism.
2. To explore quantum computing and communication principles and technologies.
3. To understand the physical implementation and limitations of quantum systems.
4. To enable students to relate quantum theory to practical applications in computing, cryptography, and sensing.
5. To familiarize students with the emerging trends in quantum technologies.

## UNIT I:

**Fundamentals of Quantum Mechanics:** Historical background: Blackbody radiation, photoelectric effect, and Compton scattering; Dual nature of light and matter; De Broglie hypothesis; Schrödinger equation; Free particle, infinite potential well, step potential; Operators and observables: position, momentum, Hamiltonian; Commutation relations and uncertainty principle; Quantum postulates and measurement theory; Eigenvalues, eigenfunctions.

## UNIT II:

**Quantum Information Theory:** Classical vs. quantum information; Qubit representation using Bloch sphere; Quantum superposition and quantum entanglement; Dirac notation (bra-ket), tensor products, and composite systems; Bell states and EPR paradox; Quantum gates: Pauli-X, Y, Z; Hadamard; Phase; T; CNOT; Quantum circuit models and notation; Measurement in computational basis; Quantum teleportation and no-cloning theorem; Quantum state tomography (introductory)

## UNIT III:

**Quantum Computing:** Classical computing review and limitations; Quantum parallelism and interference; Deutsch and Deutsch-Jozsa algorithms; Grover's search algorithm, Oracle and amplitude amplification; Shor's factoring algorithm (overview and significance); Quantum Fourier Transform (QFT); Quantum error correction: Bit-flip, phase-flip, and Shor's 9-qubit code; Introduction to quantum programming: Qiskit, Cirq, IBM Quantum Experience (overview)

## UNIT IV:

**Quantum Communication:** Introduction to quantum cryptography; Quantum key distribution (QKD): BB84 protocol; Entanglement-based QKD: Ekert protocol (E91); Eavesdropping and security of QKD; Quantum teleportation (circuit and protocol); Quantum dense coding; Quantum networks and entanglement swapping; Role of quantum repeaters; Single-photon sources and detectors; Implementation challenges (loss, decoherence, noise)

## UNIT V:

**Quantum Technologies and Applications:** Quantum sensors: magnetometry,

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gravimetry; Quantum metrology: standard time, atomic clocks; Quantum imaging and lithography; Quantum materials: topological insulators, graphene, quantum dots; NV centers in diamonds for sensing; Hardware platforms: Superconducting qubits, Trapped ions, Photonic quantum processors; Quantum supremacy and NISQ era; Global initiatives: IBM, Google, D-Wave, IonQ, India's NQM; Ethical concerns and future prospects

## TEXT BOOKS:

1. "Quantum Computation and Quantum Information" by Michael A. Nielsen and Isaac L. Chuang
2. "Quantum Mechanics: Concepts and Applications" by Nouredine Zettili

**COURSE OUTCOMES:** After completing this course, students will be able to:

- CO1 Explain core principles of quantum mechanics and their technological implications.
- CO2 Analyze quantum phenomena like superposition and entanglement.
- CO3 Apply mathematical tools to model and solve quantum systems.
- CO4 Demonstrate understanding of quantum algorithms and quantum circuits.
- CO5 Evaluate potential applications and challenges in quantum communication and sensing.

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**KAKINADA-533003, Andhra Pradesh, India**

**B.TECH MECHANICAL ENGINEERING**

**(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)**

IV Year-I Semester	TOTAL QUALITY MANAGEMENT (Open Elective - IV)	L	T	P	C
		3	0	0	3

**COURSE OBJECTIVES:** The student will acquire the knowledge

1. To understand the concepts of TQM, Quality and Business performance
2. To understand importance of customer satisfaction and loyalty
3. To analyze Organizing for quality implementation
4. To learn the concept of cost of quality
5. To understand ISO 9000 universal standards of quality

**UNIT I:**

**INTRODUCTION:** The concept of TQM, Quality and Business performance, attitude and involvement of top management, communication, culture and management systems. Management of Process Quality: Definition of quality, Quality Control, a brief history, Product Inspection vs, Process Control, Statistical Quality Control, Control Charts and Acceptance Sampling.

**UNIT II:**

**CUSTOMER FOCUS AND SATISFACTION:** The importance of customer satisfaction and loyalty- Crating satisfied customers, Understanding the customer needs, Process Vs. Customer, internal customer conflict, quality focus, Customer Satisfaction, role of Marketing and Sales, Buyer – Supplier relationships. Bench Marketing: Evolution of Bench Marketing, meaning of Bench marketing, benefits of bench marketing, the bench marketing process, pitfalls of bench marketing.

**UNIT III:**

**ORGANIZING FOR TQM:** The systems approach, Organizing for quality implementation, making the transition from a traditional to a TQM organizing, Quality Circles. Productivity, Quality and Reengineering: The leverage of Productivity and Quality, Management systems Vs. Technology, Measuring Productivity, Improving Productivity Re-engineering.

**UNIT IV:**

**3-D OBJECT REPRESENTATION:** spline representation, Hermitem **THE COST OF QUALITY:** Definition of the Cost of Quality, Quality Costs, Measuring Quality Costs, use of Quality Cost Information, Accounting Systems and Quality Management.

**UNIT V:**

**ISO9000:** Universal Standards of Quality: ISO around the world, The ISO9000 ANSI/ASQCQ-Series Standards, benefits of ISO9000 certification, the third party audit, Documentation ISO9000 and services, the cost of certification implementing the system

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**B.TECH MECHANICAL ENGINEERING**

**(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)**

**TEXT BOOKS:**

1. Total Quality Management / Joel E.Ross/Taylor and Francis Limited
2. Total Quality Management/P.N.Mukherjee/PHI

**REFERENCES:**

1. Beyond TQM / Robert L.Flood
2. Statistical Quality Control / E.L. Grant / McGraw Hill.
3. Total Quality Management- A Practical Approach/H. Lal
4. Quality Management/KanishkaBedi/Oxford University Press/2011
5. Total Engineering Quality Management/Sunil Sharma/Macmillan

**COURSE OUTCOMES: At the end of the course, student will be able to**

- CO1** Understand the concepts of TQM, Quality and Business performance
- CO2** Understand importance of customer satisfaction and loyalty
- CO3** Analyze Organizing for quality implementation
- CO4** learn the concept of cost of quality
- CO5** Understand ISO 9000 universal standards of quality

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B.TECH MECHANICAL ENGINEERING

(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)

IV Year-I Semester	OPERATIONS MANAGEMENT (Open Elective - IV)	L	T	P	C
		3	0	0	3

**COURSE OBJECTIVES:** The student will acquire the knowledge

1. To develop skills of forecasting, Aggregate Planning and Scheduling.
2. To provide the knowledge of materials management and determining the optimum inventory.
3. To guide in learning the key concepts and issues of quality management in both manufacturing and service organizations.
4. To develop the knowledge and skill to find out the optimum solutions for a given situation using OR techniques.

## UNIT I:

**Forecasting:** Introduction, types of forecasting and their uses, General principles of forecasting, forecasting techniques: qualitative and quantitative methods of Forecasting.

**Production Systems:** Types of production systems: job, batch, mass and flow type production.

**Aggregate Planning:** Introduction, aggregate planning strategies, aggregate planning methods, problems

## UNIT II:

**Scheduling:** Introduction, difference with loading, scheduling policies, techniques, standard scheduling methods.

**Materials Management:** Introduction, functions of materials management, inventory, inventory management, types of inventories, Selective inventory control techniques: ABC analysis, VED analysis.

## UNIT III:

**Inventory Control:** P and Q Systems, Basic Economic Order Quantity model, Price break model, assumptions and problems

**Material Requirement Planning:** Introduction, Inputs, outputs and MRP logic.

**Contemporary management techniques:** Introduction to Lean, JIT, ERP and Supply chain Management.

## UNIT IV:

**Quality Management:** Quality engineering, Taguchi Principles, SQC – X bar, p and c charts, problems,

Juran's principles Introduction to quality acceptance sampling.

Deming's Philosophy, Introduction to Total quality management, Quality Function Deployment, Introduction to six sigma and ISO 9000 2015 standards.

## UNIT V:

**Optimization:** Linear Programming – Graphical and simplex method – problems, Demonstration of Transportation and Assignment Models, Travelling Salesman problem.

## TEXT BOOKS:

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B.TECH MECHANICAL ENGINEERING

(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)

1. Modern Production/ operations managements / Baffa& Rakesh Sarin
2. Operations Management – an Integrated Approach, International student Version, R. Dan Reid and Nada R. Sanders, John Wiley & Sons
3. Production and Operations management by K. C. Jain, Wiley
4. Operations Management by William J. Stevenson, McGraw-Hill Companies 2015
5. Operations Management by Jay Heizer , Barry Render, Chuck Munson , Amit Sachan Twelfth Edition, Pearson, 2017

## REFERENCES:

1. Maynard's Industrial Engineering Handbook, Kjell B. Zandin, Fifth Edition 2001, The McGraw-Hill Companies, Inc.
2. Operations Management S.N. Chary.
3. Inventory Control Theory and Practice / Martin K. Starr and David W. Miller.

## COURSE OUTCOMES: At the end of the course, student will be able to

- CO1** Apply appropriate forecasting techniques & Aggregate plans to schedule
- CO2** Apply Materials management analysis and inventory control techniques
- CO3** Apply quality management principles proposed by Taguchi, Juran&Demigs
- CO4** Apply optimization to LP model & transportation and assignment problems

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# JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

KAKINADA-533003, Andhra Pradesh, India

B.TECH MECHANICAL ENGINEERING

(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)

IV Year-I Semester	ENERGY AUDITING (Open Elective - IV)	L	T	P	C
		3	0	0	3

**COURSE OBJECTIVES:** The student will acquire the knowledge

1. To learn Quantifying the energy demand and energy supply scenario of nation and explaining the need for energy auditing for becoming environmentally benign
2. To Analyzing factors behind energy billing and applying the concept of demand side management for lowering energy costs
3. To learn Computing the stoichiometric air requirement for any given fuel and quantifying the energy losses associated with thermal utilities of industries
4. To Diagnosing the causes for under performance of various electrical utilities and suggesting remedies for improving their efficiency
5. To Applying CUSUM and other financial evaluation techniques to estimating the accruable energy savings/monetary benefits for any energy efficiency project

## UNIT I:

**INTRODUCTION:** Energy scenario of World, India and TN - Environmental aspects of Energy Generation – Material and Energy balancing - Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Basic instruments for Energy Auditing.

## UNIT II:

**ELECTRICAL SUPPLY SYSTEMS:** Electricity Tariff structures – Typical Billing - Demand Side Management - HT and LT supply - Power Factor – Energy conservation in Transformers – Harmonics

## UNIT III:

**ENERGY CONSERVATION IN MAJOR THERMAL UTILITIES:** Stoichiometry - Combustion principles. Energy conservation in: Boilers - Steam Distribution Systems - Furnaces - Thermic Fluid Heaters – Cooling Towers – D.G. sets. Insulation and Refractories - Waste Heat Recovery Devices.

## UNIT IV:

**ENERGY CONSERVATION IN MAJOR ELECTRICAL UTILITIES:** Energy conservation in: Motors - Pumps – Fans – Blowers - Compressed Air Systems - Refrigeration and Air Conditioning Systems - Illumination systems

## UNIT V:

**ENERGY MONITORING, TARGETING, LABELLING AND ECONOMICS:** Elements of Monitoring & Targeting System – CUSUM - Energy / Cost index diagram – Energy Labelling - Energy Economics – Cost of production and Life Cycle Costing - Economic evaluation techniques – Discounting and Non-Discounting - ESCO concept – PAT scheme

## TEXT BOOKS:

1. Guide book for National Certification Examination for “Energy Managers and Energy Auditors” (4 Volumes). Available at <http://www.em-ea.org/gbook1.asp>. This website is

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B.TECH MECHANICAL ENGINEERING

(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)

administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India.

2. K. Nagabhushan Raju, Industrial Energy Conservation Techniques: (concepts, Applications and Case Studies), Atlantic Publishers & Dist, 2007.

## REFERENCES:

1. Abbi Y P, Shashank Jain., Handbook on Energy Audit and Environment Management, TERI Press, 2006.
2. Albert Thumann and Paul Mehta D, "Handbook of Energy Engineering", 7th Edition, The Fairmont Press, 2013.
3. Murphy.W.R. and McKay.G, "Energy Management", Butterworth, London 1982.
4. Paul W.O'Callaghan, Design and management for energy conservation: A handbook for energy managers, plant engineers, and designers, Pergamon Press, 1981.
5. Steve Doty, Wayne Turner C, Energy Management Handbook 7th Edition, The Fairmont Press, 2009

## COURSE OUTCOMES: At the end of the course, student will be able to

- CO1 Analyze the global and regional energy scenario and demonstrate the need and methodology of energy auditing in industries.
- CO2 Interpret electricity tariff structures and apply demand-side management techniques to reduce energy costs in electrical supply systems.
- CO3 Evaluate energy conservation methods in thermal utilities including boilers, furnaces, and steam systems with a focus on combustion and waste heat recovery.
- CO4 Identify and implement energy-saving measures in electrical utilities such as motors, fans, pumps, HVAC, and lighting systems.
- CO5 Apply energy monitoring, targeting techniques, and economic analysis tools like life cycle costing and PAT schemes for effective energy management.

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**B.TECH MECHANICAL ENGINEERING**

**(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)**

IV Year-I Semester	MECHATRONICS LAB	L	T	P	C
		0	0	4	2

**COURSE OBJECTIVES:** The student will acquire the knowledge

1. Measure load, displacement and temperature using analogue and digital sensors.
2. Develop PLC programs for control of traffic lights, water level, lifts and conveyer belts.
3. Simulate and analyse PID controllers for a physical system using MATLAB.
4. Develop pneumatic and hydraulic circuits using Automaton studio.

**LIST OF EXPERIMENTS:**

1. DYNA 1750 Transducers Kit :-

- a. Characteristics of LVDT
- b. Principle & Characteristics of Strain Gauge
- c. Characteristics of Summing Amplifier
- d. Characteristics of Reflective Opto Transducer

2. PLC PROGRAMMING & Simulation of Allen Bradley, Siemens or IEC Ladder Using Automation Studio

- a. Ladder programming on Logic gates ,Timers (TON,TOFF) &counters (UP,DOWN)
- b. Ladder Programming for digital &Analogy sensors
- c. Ladder programming & Simulations of Virtual System such as Traffic Light control, Washing machine, Garage Door, Water level control, Lift control, Conveyor Belt etc.
- d. Ladder programming to control circuits such as single solenoid spring return latch circuit, double solenoid Hydraulic / Pneumatic circuits, Self-Reciprocating Hydraulic / Pneumatic Circuit.

3. AUTOMATION STUDIO SOFTWARE (Design, Simulate & Analyze)

- a. Introduction to Automation studio & its control.
- b. Draw & Simulate Hydraulic circuits for series &parallel cylinders connection, Accumulator circuit, Pressure intensifier circuit, Simple Electro- Hydraulic

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Electro - Pneumatic circuits (Plot Waveforms for different parameters).

c. Design & Simulate Meter-in, Meter-out, Regenerative circuit, sequencing circuit, traverse and feed hydraulic circuit, hydraulic press and clamping.

d. Position Control of Proportional Servo Valve Circuit using PID Feedback controller.

**4. MATLAB Programming**

a. Sample programmes on Matlab

b. Simulation and analysis of PID controller using SIMULINK

**COURSE OUTCOMES: At the end of the course, student will be able to**

**CO1** Understand the Characteristics of LVDT

**CO2** Measure load, displacement and temperature using analogue and digital sensors.

**CO3** Develop PLC programs for control of traffic lights, water level, lifts and conveyor belts

**CO4** Simulate and analyse PID controllers for a physical system using MATLAB.

**CO5** Develop pneumatic and hydraulic circuits using Automaton studio.

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B.TECH MECHANICAL ENGINEERING

(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)

IV Year-I Semester	CONSTITUTION OF INDIA	L	T	P	C
		2	0	0	-

**COURSE OBJECTIVES:** The student will acquire the knowledge

1. To Enable the student to understand the importance of constitution
2. To understand the structure of executive, legislature and judiciary
3. To understand philosophy of fundamental rights and duties
4. To understand the autonomous nature of constitutional bodies like Supreme Court and highcourt controller and auditor general of India and election commission of India.
5. To understand the central and state relation financial and administrative.

## UNIT-I

Introduction to Indian Constitution: Constitution meaning of the term, Indian Constitution - Sources and constitutional history, Features - Citizenship, Preamble, Fundamental Rights and Duties, Directive Principles of State Policy.

### Learning outcomes:

After completion of this unit student will

- Understand the concept of Indian constitution
- Apply the knowledge on directive principle of state policy
- Analyze the History, features of Indian constitution
- Evaluate Preamble Fundamental Rights and Duties

## UNIT-II

Union Government and its Administration Structure of the Indian Union: Federalism, Centre- State relationship, President: Role, power and position, PM and Council of ministers, Cabinet and Central Secretariat, Lok Sabha, Rajya Sabha, The Supreme Court and High Court: Powers and Functions;

**Learning outcomes:-**After completion of this unit student will

- Understand the structure of Indian government
- Differentiate between the state and central government
- Explain the role of President and Prime Minister
- Know the Structure of supreme court and High court

## UNIT-III

State Government and its Administration Governor - Role and Position - CM and Council of ministers, State Secretariat: Organisation, Structure and Functions

**Learning outcomes:-**After completion of this unit student will

- Understand the structure of state government
- Analyze the role Governor and Chief Minister
- Explain the role of state Secretariat

Dr. D.Ravi Kumar

Dr. A.Venu Gopal

Dr. N.Ramanaiah

Dr. S.V.Ramana Murthy

Dr. G.R.K.Sastry

Dr. D.Lingaraju

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Dr. V.Jaya prasad

Dr. K.Prasad





# JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY KAKINADA

KAKINADA-533003, Andhra Pradesh, India

B.TECH MECHANICAL ENGINEERING

(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)

- Differentiate between structure and functions of state secretariat

## UNIT-IV

A. Local Administration - District's Administration Head - Role and Importance, Municipalities – Mayor and role of Elected Representative - CEO of Municipal Corporation PachayatiRaj: Functions PRI: ZilaPanchayat, Elected officials and their roles, CEO Zilla Panchayat: Block level Organizational Hierarchy - (Different departments), Village level - Role of Elected and Appointed officials - Importance of grass root democracy

**Learning outcomes:** - After completion of this unit student will

- Understand the local Administration
- Compare and contrast district administration role and importance
- Analyze the role of Myer and elected representatives of Municipalities
- Evaluate Zilla Panchayat block level organization

## UNIT-V

Election Commission: Election Commission- Role of Chief Election Commissioner and Election Commissionerate State Election Commission: Functions of Commissions for the welfare of SC/ST/OBC and women

**Learning outcomes:** - After completion of this unit student will

- Know the role of Election Commission apply knowledge
- Contrast and compare the role of Chief Election commissioner and Commissionerate
- Analyze role of state election commission
- Evaluate various commissions of viz SC/ST/OBC and women

## REFERENCES:

- 1) Durga Das Basu, Introduction to the Constitution of India, Prentice – Hall of India Pvt. Ltd..NewDelhi
- 2) SubashKashyap, Indian Constitution, National Book Trust
- 3) J.A. Siwach, Dynamics of Indian Government & Politics
- 4) D.C. Gupta, Indian Government and Politics
- 5) H.M.Sreevai, Constitutional Law of India, 4th edition in 3 volumes (Universal Law Publication)
- 6) J.C. Johari, Indian Government andPolitics Hans
- 7) J. Raj IndianGovernment and Politics
- 8) M.V. Pylee, Indian Constitution Durga Das Basu, Human Rights in Constitutional Law, Prentice
- 9) –Hall of India Pvt. Ltd.. New Delhi
- 10) Noorani, A.G., (South Asia Human Rights Documentation Centre), Challenges to Civil Right),Challenges to Civil Rights Guarantees in India, Oxford University Press 2012

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**E-resources:**

1. [nptel.ac.in/courses/109104074/8](https://nptel.ac.in/courses/109104074/8)
2. [nptel.ac.in/courses/109104045/](https://nptel.ac.in/courses/109104045/)
3. [nptel.ac.in/courses/101104065/](https://nptel.ac.in/courses/101104065/)
4. [www.hss.iitb.ac.in/en/lecture-details](https://www.hss.iitb.ac.in/en/lecture-details)
5. [www.iitb.ac.in/en/event/2nd-lecture-institute-lecture-series-indian-constitution](https://www.iitb.ac.in/en/event/2nd-lecture-institute-lecture-series-indian-constitution)

**Course Outcomes:**

At the end of the semester/course, the student will be able to have a clear knowledge on the following:

- 1) Understand historical background of the constitution making and its importance for building a democratic India.
- 2) Understand the functioning of three wings of the government i.e., executive, legislative and judiciary.
- 3) Understand the value of the fundamental rights and duties for becoming good citizen of India.
- 4) Analyze the decentralization of power between central, state and local self-government.
- 5) Apply the knowledge in strengthening of the constitutional institutions like CAG, Election Commission and UPSC for sustaining democracy.
- 6) Know the sources, features and principles of Indian Constitution.
- 7) Learn about Union Government, State government and its administration.
- 8) Get acquainted with Local administration and Panchayati Raj.
- 9) Be aware of basic concepts and developments of Human Rights.
- 10) Gain knowledge on roles and functioning of Election Commission

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**B.TECH MECHANICAL ENGINEERING**

**(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)**

IV Year-I Semester	EVALUATION AND INDUSTRY INTERNSHIP	L	T	P	C
		-	-	-	2

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**(R23 – III<sup>rd</sup> YEAR COURSE STRUCTURE & SYLLABUS)**

IV Year-II Semester	INTERNSHIP AND PROJECT	L	T	P	C
		0	0	24	12

Dr. D.Ravi Kumar      Dr. A.Venu Gopal      Dr. N.Ramanaiah      Dr. S.V.Ramana Murthy      Dr. G.R.K.Sastry  
Dr. D.Lingaraju      Dr. V.V.Subba Rao      Dr. B.Balakrishna      Dr. A.Gopala Krishna      Dr. A.Swarna Kumari  
Dr. N.Mohan Rao      Dr. K.Meera saheb      Sri M.Kumara Swamy      Dr. T. Lakshmana kishore      Dr. V.Jaya prasad  
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