M.S. Ramaiah University of Applied Sciences

New BEL Road, MSR Nagar, Bangalore – 560054

RAMAIAH UNIVERSITY OF APPLIED SCIENCES

PO, PSO, PEO & CO

Programme: B.Tech.in Robotics

Programme Code: 409

Programme Outcome (PO)
Programme Specific Outcome (PSO)
Program Educational Objectives (PEO)
Course Outcomes (CO)

Dean
Faculty of Engineering and Technology
M.S. Ramaiah University of Applied Sciences

Registrar
M.S. Ramaiah University of Applied Sciences
Bangalore - 560 054

Approved in 23rd ACM (Resolution 23.05) held on 15th July 2021

Faculty of Engineering and Technology (FET)

Programme Name: B.Tech. (Robotics)

Programme Outcomes (POs)

B. Tech. graduates will be able to:

PO-1. Apply knowledge of mathematics, science, basic engineering fundamentals and engineering specialization concerned for the solution of complex engineering problems

PO-2. Identify, formulate and analyze engineering problems using first principles of mathematics, science and engineering to interpret data and reach substantiated conclusions

PO-3. Provide solutions to engineering problems by designing systems, components or processes to meet the specified needs considering public health, safety, societal and the environmental considerations

PO-4. Apply the knowledge of laboratory techniques and research methods to solve complex engineering problems through experimental investigations, analysis and interpretation of results

PO-5. Gain proficiency in modelling complex engineering activities by selecting appropriatetechniques and IT Tools and utilize available resources effectively

PO-6. Understand the effect of engineering solutions on legal, cultural, social, public healthand safety aspects and the consequent responsibilities

PO-7. Develop sustainable engineering solutions and assess their effect on society and environment

PO-8. Understand and apply ethical principles to engineering practices and professional responsibilities

PO-9. Function effectively as an individual or a team player to handle diverse problems in multi-disciplinary settings

PO-10. Make oral and written presentations to communicate technical ideas effectively to engineering community and society at large

PO-11. Apply the knowledge of engineering and management principles to manage projectsin multi-disciplinary environment with consideration to cost and time.

PO-12. Recognize and engage in lifelong learning to adapt to changing needs and advancements in technology

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Programme Specific Outcomes (PSOs)

At the end of the B. Tech. (Robotics) program, the graduate will be able to:

PSO-1. Apply the knowledge of Mechanical Design, Control Systems and Robot Programmingto develop efficient and customized robotic solutions for any given application

PSO-2. Design and develop sustainable robotic solutions using the principles and concepts of Mechanical, Electrical, Electronics, Computer Engineering through experimentation and usage of modern tools to address industry and societal requirements

PSO-3. Demonstrate ethics, leadership qualities, communication, entrepreneurial skills and involvement in lifelong learning for the betterment of organization, environment and society

Programme Educational Objectives (PEOs)

The objectives of the B. Tech. (Robotics) Programme are:

PEO-1. To provide students with knowledge in mathematics, science and core engineering area to enable them to deliver efficient solutions for complex engineering problemsusing analytical and cognitive skills

PEO-2. To enable students to design and develop sustainable innovative solutions for industry and societal requirements by conducting engineering investigations through experimentation and usage of modern tools

PEO-3. To inculcate ethics, communication, leadership, soft, managerial and entrepreneurial skills for a successful career in industries and to engage in lifelong learning

Course Outcomes (COs)

Course Title & Code: Engineering Mathematics - 1 (MTB101A)

After the successful completion of this course, the student will be able to:

CO-1. State and discuss basic concepts related to single, two variable calculus and matrix algebra
CO-2. Perform basic operations of matrix algebra and apply them to solve systems of linear equations
CO-3. Solve simple mathematical problems associated with linear algebra, single and two variable calculus
CO-4. Demonstrate competence with the basic ideas of linear systems, independence, bases and dimension, linear transformations, eigenvalues, eigenvectors and diagonalization
CO-5. Solve complex real-world problems associated with linear algebra, single and two variable calculus

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Course Outcomes (COs)

Course Title & Code: Engineering Mathematics - 2 (MTB102A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Describe the fundamentals of ordinary differential equations and Laplace transform
- **CO-2.** Solve standard forms of ordinary differential equations
- **CO-3.** Solve simple problems in ordinary differential equations and Laplace transform
- **CO-4.** Model real world problems using ordinary differential equations and solve complex problems associated with ordinary differential equations using Laplace transform
- **CO-5.** Apply Laplace transform in solving complex real world engineering problems

Course Outcomes (COs)

Course Title & Code: Engineering Physics and Laboratory (PYB102A)

After the successful completion of this course, the student will be able to:

- **CO-1.** State, explain the concepts of mechanics, electrical conductivity, quantum mechanics, crystal structure and material science, laser and fiber optics
- **CO-2.** Derive standard relationships in mechanics, electrical conductivity, quantum mechanics, crystal structure and material science, laser & fiber optics, and interpret them
- **CO-3.** Discuss the applications of mechanics, electrical conductivity, quantum mechanics, crystal structure and material science, laser and fiber optics
- **CO-4.** Solve problems in mechanics, electrical conductivity, quantum mechanics, crystal structure, material science, laser and fiber optics
- **CO-5.** Plan the experimental set-up, conduct experiments, calculate and plot the graphs to obtain the results and write a laboratory report as per the prescribed format.

Course Outcomes (COs)

Course Title & Code: Engineering Mechanics (CEF101A)

After the successful completion of this course, the student will be able to:

- **CO-1.** State and describe the laws of Statics, Friction and Dynamics and their contexts of application.
- **CO-2.** Interpret standard mathematical relationships and apply for solving simple static and dynamic problems in engineering mechanics
- **CO-3.** Calculate moment of inertia, determine centroid, center of gravity for the structural members
- **CO-4.** Apply the laws of statics and dynamics for the equilibrium analysis of rigid bodies with and without friction
- **CO-5.** Apply energy methods in analyzing of static and dynamic aspects of engineering structures made of rigid bodies

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Course Outcomes (COs)

Course Title & Code: Elements of Electronics Engineering and Laboratory (ECF102A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Explain working principles of PN junction diode, Zener diode, transistors, amplifier configurations, Op-Amps, power supply, logic gates and electronic displays
- **CO-2.** Derive mathematical relationships for electronic devices and circuits
- **CO-3.** Solve simple numerical and design problems related to analog / digital circuits as well as devices
- **CO-4.** Design and analyze operation of standard analog / digital circuits for a given application
- **CO-5.** Conduct experiments as per the standard procedures and tabulate/calculate/plot the measured values

Course Outcomes (COs)

Course Title & Code: Engineering Drawing (MEF103A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Describe the conventions used in projections of geometric entities and interpret the same
- **CO-2.** Draw orthographic projections for the geometric entities in specified positions
- **CO-3.** Develop lateral surfaces of un-sectioned and sectioned regular solids
- **CO-4.** Develop orthographic projections for given applications
- **CO-5.** Draw isometric projections for the solids and their combinations
- **CO-6.** Demonstrate competency in using CAD tool for drawing projections of geometric entities

Course Outcomes (COs)

Course Title & Code: Constitution, Human Rights and Law (LAN101A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Explain the key principles of the Indian Constitution
- **CO-2.** Explain Indian legal system and judicial structure that govern the citizens
- **CO-3.** Discuss UN Declaration of Human Rights
- **CO-4.** Discuss the scope and application of Human Rights Principles and Law
- **CO-5.** Suggest strategies for protection of human rights and resolving legal issues incompliance with applicable laws

Course Outcomes (COs)

Course Title & Code: Engineering Chemistry and Laboratory (CYB104A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Explain the basic concepts of electrochemistry, conversion of chemical energy into electrical energy, theory of corrosion and principles of metal finishing
- **CO-2.** Differentiate renewable - nonrenewable fuels, primary - secondary electrodes & primary - secondary batteries, batteries - fuel cells, electroplating – electro less plating, thermosetting

– thermoplastic polymers and dry corrosion - wet corrosion

CO-3. Discuss the reaction chemistry and stoichiometry of combustion of fuels, remedial measures to control oxides of nitrogen, sulphur and carbon, polymerization – methods, mechanism, preparation, properties and applications of some polymers, concepts of nano science and nanotechnology

CO-4. Identify the types of corrosion and methods to prevent corrosion, suitable polymers and nanocomposite materials for engineering applications

CO-5. Derive kinetic rate equations for various chemical systems and equation for electromotive force

CO-6. Analyze the suitability of polymers & composites for various applications and solve problems related to storage devices, chemical kinetics, electro chemistry, corrosion and metal finishing

CO-7. Plan the experimental set up, conduct experiments, calculate and plot the graphs to obtain results, and write a laboratory report as per the prescribed format

Course Outcomes (COs)

Course Title & Code: Elements of Mechanical Engineering and Workshop Practice (MEF104A)

After the successful completion of this course, the student will be able to:

CO-1. Demonstrate the understanding on Classification of energy sources, energy conversion systems, mechanical power transmission systems, machine tools and processes

CO-2. Describe various energy conversion systems, mechanical power transmission systems and machine tools

CO-3. Explain the working principle of refrigeration systems, biomass conversion technologies and machining operations

CO-4. Solve numerical problems on IC engines and mechanical power transmission systems

CO-5. Apply principles of energy conversion systems, power transmission systems, machining processes and mechanical joints to practical applications

Course Outcomes (COs)

Course Title & Code: Elements of Electrical Engineering and Laboratory (EEF105A)

After the successful completion of this course, the student will be able to:

CO-1. State and explain various laws of electric circuits, magnetic circuits and their significance, phasor diagrams for electrical elements

CO-2. Explain construction, principle of operation, working and characteristics of DC machines, transformers, AC rotating machines and their applications

CO-3. Derive equations for electrical circuits, magnetic circuits and performance of various AC and DC machines

CO-4. Solve problems on electric circuits, magnetic circuits, DC machines, transformers and AC rotating machines

CO-5. Conduct experiments as per the standard procedures and tabulate/calculate/plot the measured values

CO-6. Interpret and compare with standard results, and draw conclusions and Write report as per the prescribed format

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Course Outcomes (COs)

Course Title & Code: Elements of Computer Science and Engineering and Laboratory (CSF106A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Describe the elements and methodology of Computer Science and Engineering
- **CO-2.** Explain the basic principles and techniques of algorithms and programming
- **CO-3.** Select appropriate approach to solve a computational problem
- **CO-4.** Design an algorithmic solution and draw a flow chart of the solution
- **CO-5.** Develop computer programs for moderately complex problems
- **CO-6.** Test and validate developed computer programs

Course Outcomes (COs)

Course Title & Code: Professional Communication (TSN101A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Apply the concepts of grammar for communication
- **CO-2.** Compose precise paragraphs
- **CO-3.** Demonstrate professional etiquette
- **CO-4.** Demonstrate appropriate verbal and non-verbal communication in the givencontext
- **CO-5.** Develop professional written document

Course Outcomes (COs)

Course Title & Code: Engineering Mathematics - 3 (MTF201A)

After the successful completion of this course, the student will be able to:

- **CO-1.** State and explain the important theorems in Fourier series, transforms and vector integral calculus
- **CO-2.** Solve simple problems in Fourier series, transforms and vector calculus
- **CO-3.** Apply Fourier series, transforms and vector calculus in solving complex real world engineering problems
- **CO-4.** Implement the programs to solve system of linear equations and non-linear equations of single variable using MATLAB
- **CO-5.** Apply interpolation and numerical integration method in analyzing some real world problems

Course Outcomes (COs)

Course Title & Code: Strength of Materials (ROC201A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Describe various types of forces, stresses, strains and elastic constants
- **CO-2.** Explain Hooke's law, stress strain behavior of materials, bending of beams, torsion of shafts, shear force and bending moments, thick and thin cylinders, columns and struts

CO-3. Derive standard mathematical relationships for structural elements subjected to different loading and boundary conditions to analyze stresses, strains and deflections
CO-4. Solve numerical problems on stress/strain/deflection analysis for various structuralelements
CO-5. Apply principles of strength of materials to solve problems of practical importance

Course Outcomes (COs)

Course Title & Code: Measurements, Data Acquisition and Processing (ROC202A)

After the successful completion of this course, the student will be able to:

CO-1. Explain measurement systems, display devices, recording devices, embedded controller architecture and programming methods
CO-2. Discuss DAS, Signal processing techniques, embedded controllers, embedded communication protocols and data processing techniques
CO-3. Describe the functions of digital mustimeter, cathode ray oscilloscopes and transducers in the measurement of physical variables
CO-4. Choose embedded protocols applicable in the design of an embedded system
CO-5. Develop an instrumentation system to measure various physical parameters and other relevant quantities using sensors and transducers

Course Outcomes (COs)

Course Title & Code: Introduction to Robotics and Mechatronics (ROC203A)

After the successful completion of this course, the student will be able to:

CO-1. Explain the basic terminology of robots and end effectors
CO-2. Describe the specifications, applications and current trend in robots
CO-3. Discuss the key elements of mechatronics system and its representation in terms of block diagram
CO-4. Discuss the microcontroller concepts, sensors and actuators for robot
CO-5. Integrate and demonstrate the working of a mechatronic system for a robot

Course Outcomes (COs)

Course Title & Code: Electrical Machine Drives and Actuators (ROC204A)

After the successful completion of this course, the student will be able to:

CO-1. Explain the working of DC and AC machines and drives for automotive and residential applications
CO-2. Describe the working of brushless DC motors, stepper motor, switched reluctance motor and its drives
CO-3. Analyze the characteristics of AC and DC machine drives
CO-4. Evaluate and select AC and DC drives for a given application using speed and torque characteristics
CO-5. Design, model, simulate and analyze appropriate drives for a given application
CO-6. Use suitable software tools to develop a drive for an application

Course Outcomes (COs)

Course Title & Code: Strength of Materials Laboratory (ROL205A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Plan the experimental setup to achieve the stated aim
- **CO-2.** Conduct experiments as per the standard procedures and tabulate the measured values
- **CO-3.** Calculate the required parameters and tabulate the results
- **CO-4.** Interpret, compare with standard results and draw conclusions
- **CO-5.** Write laboratory report as per the prescribed format

Course Outcomes (COs)

Course Title & Code: Measurements Laboratory (ROL206A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Plan the experimental setup to achieve the stated aim
- **CO-2.** Identify the type of sensors and instruments used based on the type of measurement to be conducted
- **CO-3.** Conduct experiments as per the standard procedures and tabulate the measured values
- **CO-4.** Study the characteristics of various sensors
- **CO-5.** Interface a sensor with data acquisition system
- **CO-6.** Write laboratory report as per the prescribed format

Course Outcomes (COs)

Course Title & Code: Machine Drawing (MEL205A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Describe ISO notations used in machine drawings
- **CO-2.** Create 3-D models of machine elements/components and produce detailed drawings
- **CO-3.** Create 3-D assembly models and draw 2-D detailed drawings with sectional details wherever required and prepare BOM for standard assemblies
- **CO-4.** Create 3-D assembly models and draw 2-D detailed drawings with sectional details wherever required and prepare BOM for standard assemblies
- **CO-5.** Demonstrate competency in using CAD software for machine drawing

Course Outcomes (COs)

Course Title & Code: Environmental Studies (BTN101A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Define the multidisciplinary nature of environmental studies and recognize the need for public awareness
- **CO-2.** Classify and explain the various natural resources and their associated problems,ecosystem

and environmental pollution

CO-3. Describe biodiversity at local, national and global levels

CO-4. Discuss various social issues pertaining to environment including sustainable development and energy issues

CO-5. Assess the impact of human population on the environment

Course Outcomes (COs)

Course Title & Code: Additional Mathematics - 1 (MTB103A)

After the successful completion of this course, the student will be able to:

CO-1. State and explain the important theorems and solve simple mathematical problems in one variable calculus and vector algebra

CO-2. State theorems and solve simple problems in two variable calculus

CO-3. Solve complex real world problems associated with one and two real analysis

CO-4. Illustrate fundamentals of MATLAB programming and write simple programs

CO-5. Solve complex mathematical problems associated with linear algebra and compare the results with that of solutions obtained using MATLAB

Course Outcomes (COs)

Course Title & Code: Entrepreneurship Development (22MCM201A)

After the successful completion of this course, the student will be able to:

CO-1. Discuss the concepts and process of entrepreneurship

CO-2. Construct and apply the idea generation techniques

CO-3. Examine the opportunities for launching of new venture and various entry strategies

CO-4. Acquire the skills for creation and management of entrepreneurial venture

CO-5. Present a viable business plan, for business success

Course Outcomes (COs)

Course Title & Code: Engineering Mathematics - 4 (MTF202A)

After the successful completion of this course, the student will be able to:

CO-1. Define and explain the concepts of correlation, regression, random variables, probability distribution, partial differential equations and complex analysis

CO-2. State theorems and solve simple problems in partial differential equations, complex analysis , probability , probability distributions

CO-3. Apply numerical methods to solve ordinary and partial differential equations using MATLAB

CO-4. Solve complex engineering problems associated with numerical methods using MATLAB

CO-5. Analyze real world problems associated with probability, probability distributions, partial differential equations and complex analysis

CO-6. Construct Bar chart, pie chart, Histogram, Box-plot and fitting of curves using MATLAB

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Course Outcomes (COs)

Course Title & Code: Analog and Digital Electronics (ROC207A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Explain the principles, characteristics and properties of various amplifier configurations
- **CO-2.** Describe the principles of stability of an amplifier, oscillators, wave shaping circuits and multi vibrators
- **CO-3.** Design of the amplifiers, oscillators and wave shaping circuits
- **CO-4.** Solve simple problems on logic design and logic minimization
- **CO-5.** Analyze various combinational and sequential circuits for digital design
- **CO-6.** Apply digital design concepts for applications

Course Outcomes (COs)

Course Title & Code: Machine Dynamics and Laboratory (ROC208A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Describe basic concepts and principles of kinematics and dynamics of machines, mechanical vibrations, model and analyze simple mechanical systems for vibrationbehavior
- **CO-2.** Illustrate kinematic construction and working of commonly used planar mechanismsDiscuss models of sound waves, sound sources and solid structure interaction with sound waves.
- **CO-3.** Solve for displacement, velocity and accelerations in planar mechanisms using graphicaland
- **CO-4.** Construct gear drive for the desired kinematic motion.
- **CO-5.** Develop simulation model of planar mechanisms and analyze for position, velocity, accelerations and inertia forces of links using ADAMS.

Course Outcomes (COs)

Course Title & Code: Artificial Intelligence for Robotics (ROC209A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Explain the techniques of solving problems by searching, adversarial search and constraint satisfaction problems
- **CO-2.** Discuss intelligent agents, knowledge, reasoning and planning as well as uncertain knowledge and reasoning
- **CO-3.** Apply Learning from examples, knowledge in learning, learning from probabilistic models and elementary concepts of reinforcement learning
- **CO-4.** Discuss principles of Robotics; communicating, perceiving and acting
- **CO-5.** Explain principles of localization, tracking and control with a focus on examples from Robotics/Self-driving cars/Aviation

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Course Outcomes (COs)

Course Title & Code: Digital Signal Processing (ROC210A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Explain discrete-time signals, periodic sequences, Sampling theorem, discrete Fourier transform, inverse discrete Fourier transform and its properties
- **CO-2.** Describe filter design techniques, prototype transformation, Bilinear Realization, FIR and IIR realization of filters and Brain Computer Interface in signal process
- **CO-3.** Solve simple problems in signal operations, DFT,FFT, FIR and IIR filters
- **CO-4.** Apply principles of Fourier transforms for spectral analysis of digital signals and systems
- **CO-5.** Design digital FIR and IIR filters with structures
- **CO-6.** Use standard software tool to analyze discrete signals for various applications

Course Outcomes (COs)

Course Title & Code: Fluid Power Systems for Robots (ROC211A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Explain the principles and components of fluid power systems
- **CO-2.** Describe the working of components of fluid power systems
- **CO-3.** Select the different component such as cylinders, actuators and control valves to arrive at the fluid power circuit
- **CO-4.** Develop simple hydraulic or pneumatic circuit and draw circuit diagrams
- **CO-5.** Design and analyze hydraulic / pneumatic circuit for a particular application usingsimulation software

Course Outcomes (COs)

Course Title & Code: Analog and Digital Electronics Laboratory (ROL212A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Estimate the voltages and currents in a network consisting of resistors, voltage andcurrent csources, and BJTs
- **CO-2.** Recognize the common emitter amplifiers and be able to calculate gain and input/output impedance
- **CO-3.** Estimate the oscillation frequency of an oscillators
- **CO-4.** Recognize the multiplexer and demultiplexer circuits for their operation
- **CO-5.** Recognize the four different flip flop configurations, shift register for their operation
- **CO-6.** Write laboratory report as per the prescribed format

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Course Outcomes (COs)

Course Title & Code: Mechanical Dissection (MEL206A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Dissect a given machine/product and identify components
- **CO-2.** Examine components for form, features, functionality and material
- **CO-3.** Develop 2D/3D sketches of components
- **CO-4.** Explain the construction and working of the machine/product
- **CO-5.** Write laboratory report as per the prescribed format

Course Outcomes (COs)

Course Title & Code: Additional Mathematics - 2 (MTB104A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Describe the fundamentals of ordinary differential equations State theorems and solve simple problems in two variable calculus
- **CO-2.** Solve standard forms of ordinary differential equations Illustrate fundamentals of Linear algebra
- **CO-3.** Model real world problems using ordinary differential equations and solve complex problems associated with ordinary differential equations
- **CO-4.** Apply numerical methods to solve nonlinear equations in one variable, system of linear equations, interpolation and numerical quadrature, and implement the same using MATLAB
- **CO-5.** Solve complex problems associated with nonlinear equations and linear systems, interpolation and numerical integration using MATLAB

Course Outcomes (COs)

Course Title & Code: Design of Machine Elements (ROC301A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Describe basic concepts and principles of machine component design
- **CO-2.** Identify the loading conditions on a machine element and predict state of stress at critical locations
- **CO-3.** Calculate design stress based on appropriate failure theory and select suitable material
- **CO-4.** Design machine elements like shafts, keys and couplings, power screws, gears, chains
- **CO-5.** Perform iterative design calculations to achieve induced stress values well within design

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Course Outcomes (COs)

Course Title & Code: Embedded Processor and Controllers (ROC302A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Explain architectures of microprocessors microcontrollers, embedded development boards and their applications
- **CO-2.** Describe concepts of peripheral interfacing and programming of microprocessors and microcontrollers
- **CO-3.** Design an application using microprocessors, microcontrollers and embedded board with external peripherals
- **CO-4.** Program and verify functionality of given application using microprocessor or microcontroller
- **CO-5.** Perform external peripheral interfacing using microprocessor or microcontroller for a given application Demonstrate the understanding of digital logic design
- **CO-6.** Develop applications using embedded boards such as Arduino board Classify and describe types of digital circuits

Course Outcomes (COs)

Course Title & Code: Robot Kinematics and Laboratory (ROC303A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Discuss basics of planar and spatial description, transformation, kinematics, path and trajectory planning and their importance in robotics
- **CO-2.** Apply D-H convention and arrive at parameters for given robotic manipulator
- **CO-3.** Derive forward and inverse kinematics equations for a given manipulator and analyze
- **CO-4.** Evaluate link velocity and acceleration required to operate manipulators
- **CO-5.** Solve problems on kinematics of robots and trajectory planning
- **CO-6.** Develop simulation model for a robot and analyze for position, velocity, accelerations of links using ADAMS

Course Outcomes (COs)

Course Title & Code: Computer Vision (ROC304A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Discuss fundamentals of Digital Images with Image Formation and processing
- **CO-2.** Discuss Image processing Techniques
- **CO-3.** Analyze and apply Image processing algorithms to solve recent computer vision problems
- **CO-4.** Gather a basic understanding about the geo-metric relationships between 2D images world.
- **CO-5.** Apply classification, clustering algorithms for a given computer vision application
- **CO-6.** Implement machine learning algorithms for computer vision applications

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Course Outcomes (COs)

Course Title & Code: Control System (ROC305A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Explain the basic concepts and types of control system
- **CO-2.** Obtain transfer function of various physical systems
- **CO-3.** Analyze the time and frequency response of a system
- **CO-4.** Determine the stability of a system represented as a transfer function using Routh- Hurwitz criteria and root locus techniques
- **CO-5.** Design controllers for given specifications
- **CO-6.** Model and simulate the controller for a given robotic system and analyze its time response

Course Outcomes (COs)

Course Title & Code: Control Systems Laboratory (ROL306A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Plan the experimental setup to achieve the stated aim
- **CO-2.** Identify the type of sensors and instruments used based on the type of measurement tobe conducted
- **CO-3.** Conduct experiments as per the standard procedures and tabulate the measured values
- **CO-4.** Study the characteristics of various sensors
- **CO-5.** Interface a sensor with data acquisition system
- **CO-6.** Write laboratory report as per the prescribed format

Course Outcomes (COs)

Course Title & Code: Embedded Processor and Controller Laboratory (ROL307A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Develop the assembly level program on a Microprocessor / Microcontroller for a given application
- **CO-2.** Interface external peripherals with Microprocessor / Microcontroller to realize the given application
- **CO-3.** Design circuits for performing given tasks using Arduino board
- **CO-4.** Interface external peripherals with Arduino board for given applications
- **CO-5.** Demonstrate the developed designs on for different applications
- **CO-6.** Write the report as per the prescribed format

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Course Outcomes (COs)

Course Title & Code: Robot Programming and Simulation (ROC308A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Explain integrated development environment (IDE) and basic control of robotic functions
- **CO-2.** Describe various robot languages and commands for robot operation, robot control system modules and their response
- **CO-3.** Design a controller to meet error, stability and relative stability specifications
- **CO-4.** Write programs using high level robotic programming languages to control robotic operations
- **CO-5.** Suggest suitable drives and control circuits for developing a physical control system

Course Outcomes (COs)

Course Title & Code: Robot Dynamics and Laboratory (ROC309A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Describe concept of dynamic model, equivalent system, free body diagrams, mass distribution, mass moment of inertia; Force and moments and their importance in robotics
- **CO-2.** Derive static and dynamic force equations and perform force analysis of a manipulator
- **CO-3.** Evaluate forces and torque required to operate manipulators.
- **CO-4.** Solve problems on robot manipulator statics and dynamics
- **CO-5.** Develop simulation model of robot and analyze for Joint forces and torques using ADAMS

Course Outcomes (COs)

Course Title & Code: Robotic System Design (ROC310A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Explain the functionality of various systems/subsystems/elements of a robot
- **CO-2.** Explain tools and criteria used in the mechanical design and performance evaluation of robots
- **CO-3.** Discuss importance of structural dynamic characteristics of Robot manipulators
- **CO-4.** Select critical design components like guide ways, bearings and transmissions
- **CO-5.** Identify suitable sensors and actuators for a particular robot application

Course Outcomes (COs)

Course Title & Code: Applied Control Systems (ROC311A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Obtain the mathematical model of a robotic system
- **CO-2.** Linearize a nonlinear robotic system to obtain the transfer function
- **CO-3.** Discuss the principles of state space analysis, phase plane analysis and singular points in

robotic control system

CO-4. Develop conventional controllers to meet the design requirements

CO-5. Design controllers and observers in state space using pole placement techniques

CO-6. Model and simulate the controller for a given robotic system and analyze its timeresponse

Course Outcomes (COs)

Course Title & Code: Digital Image Processing (ROC312A)

After the successful completion of this course, the student will be able to:

CO-1. Describe the underlying principles of image formation and processing techniques

CO-2. Discuss various mathematical and geometric manipulations on images

CO-3. Discuss the restoration, enhancement, segmentation, feature extraction concepts andtheir applications

CO-4. Solve problems on image manipulations in both time and frequency domains

CO-5. Use standard software tools to analyse digital images for various applications.

Course Outcomes (COs)

Course Title & Code: Engineering Economics and Cost Estimation for Mechanical Engineers (ROC313A)

After the successful completion of this course, the student will be able to:

CO-1. Describe the basic aspects of business economics with respect to manufacturing industries, book keeping, depreciation of assets and its types

CO-2. Explain the concepts of cash flow diagram, law of supply and demand, principles of microeconomics, costing and economic analysis for manufacturing industries and industrial robots

CO-3. Discuss the behavior of manufacturing firms in a competitive market for short and long term

CO-4. Estimate the total cost incurred for implementing a manufacturing process and developing an industrial/service robot and evaluate its worthiness by calculating PBP, NPV, ARR, IRR and PI

CO-5. Analyze financial decisions mathematically using a production function and interpret financial information for an organization

Course Outcomes (COs)

Course Title & Code: Seminar (ROS314A)

After the successful completion of this course, the student will be able to:

CO-1. Prepare and deliver seminar on a given topic.

CO-2. Write a report on the seminar topic.

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Course Outcomes (COs)

Course Title & Code: CAE for Robotics and Laboratory (ROE411A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Describe basic concepts and principles of design
- **CO-2.** Specify and evaluate tools and techniques of CAE
- **CO-3.** Create geometric models of engineering components and sub-systems related to Robot
- **CO-4.** Develop finite element model of components for different types of analysis
- **CO-5.** Perform engineering analysis using geometric modelling tools like CATIA and ANSYS software

Course Outcomes (COs)

Course Title & Code: Statistical and Optimization Tools for Robotics (ROE412A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Describe basics of descriptive statistics, probability distributions and random number generations
- **CO-2.** Determine the confidence intervals for population parameters and test for the statistical significance
- **CO-3.** Design engineering problems using experimental designs and test for significance using ANOVA
- **CO-4.** Apply discrete and continuous stochastic models for analyzing engineering problems
- **CO-5.** Analyze the engineering problems using optimization techniques

Course Outcomes (COs)

Course Title & Code: Probability and Statistics (MTE301A)

After the successful completion of this course, the student will be able to

- **CO-1.** Explain the concepts of random variables, probability distribution, joint probability distribution and sampling distribution
- **CO-2.** Explain the principles of convex optimization, regression, confidence interval and hypothesis testing
- **CO-3.** Solve simple problems associated with probability distribution, regression, confidence interval and hypothesis testing
- **CO-4.** Model real word problems by using probability distribution and regression
- **CO-5.** Solve complex problems associated with probability distribution, regression, confidence interval and hypothesis testing

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Course Outcomes (COs)

Course Title & Code: Advanced Mathematics (MTE302A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Define and explain Legendre and Bessel differential equation, curvature, torsion, geodesics, manifolds and tensors
- **CO-2.** State the results and theorems and solve simple problems in Legendre differential equations, Bessel differential equation, theory of curves and surfaces
- **CO-3.** Apply differential geometry techniques to compute Gaussian curvature, mean curvature, principal curvature and torsion
- **CO-4.** Solve complex engineering problems associated with Bessel differential equation, theory of curves and surfaces, orthogonal curvilinear coordinates and spherical curvilinear system
- **CO-5.** Analyze real world problems associated with Bessel differential equation and curvature of space curves

Course Outcomes (COs)

Course Title & Code: Industrial Robotics and Automation (ROE421A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Explicate the role of robotics and automation in industrial applications
- **CO-2.** Describe the applications of robots in various industrial application
- **CO-3.** Identify the right Robot for a given industrial application
- **CO-4.** Explicate End effector design for typical applications
- **CO-5.** Illustrate robotic cell development procedure for given industrial applications

Course Outcomes (COs)

Course Title & Code: Multi-agent Systems for Robotics (ROE422A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Describe fundamental concepts of Agents, Multi-Agent Systems and Multi Agent Robotics
- **CO-2.** Discuss Behavior-Based Robotics, Collective Robotics, Evolutionary Robotics approachesand related issues
- **CO-3.** Discuss learning, evolution and adoption techniques for multiagent systems
- **CO-4.** Design learning models, methods and tools relevant for multi-agent systems
- **CO-5.** Apply concepts and tools relevant for multi-agent systems
- **CO-6.** Develop case studies on learning, adoption and self-organization

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Course Outcomes (COs)

Course Title & Code: Data Sciences Foundation (CSE411A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Describe the facilities—features, constructs, idioms, patterns and packages—of Python programming platform for building data science tasks
- **CO-2.** Explain the applicability of the Python programming constructs for a given task
- **CO-3.** Choose/recommend appropriate facilities of Python for data science tasks
- **CO-4.** Design data science tasks using the facilities of Python platform
- **CO-5.** Use parallelization and advanced programming constructs in the design of data sciencetasks
- **CO-6.** Synthesize and test data science tasks employing the Python platform facilities

Course Outcomes (COs)

Course Title & Code: Optimization Techniques – 1 (MTE401A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Describe fundamentals of convex and concave functions, linear programming and constraint nonlinear optimization
- **CO-2.** State and explain important classical techniques and numerical methods of constraint optimization
- **CO-3.** Demonstrate the skill to analyze a problem by choosing effective optimization tools
- **CO-4.** Apply optimization techniques to model real world problems
- **CO-5.** Solve complex problems associated with linear programming and constraint optimization of function of several variables

Course Outcomes (COs)

Course Title & Code: Project Work -1 (ROP401A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Recognize the need for developing a new or improving an existing engineering product/system through an organized survey of literature
- **CO-2.** Define engineering design specifications.
- **CO-3.** Design, model, solve analyze the product/system to meet the design specifications.
- **CO-4.** Evaluate the performance of the modelled system and justify its performance.
- **CO-5.** Demonstrate the system working and make a presentation
- **CO-6.** Write a technical report.

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Course Outcomes (COs)

Course Title & Code: Internship (ROI401A)

After the successful completion of this course, the student will be able to:

CO-1. Write a report on experiences during internship.
CO-2. Make a presentation to a panel of examiners.

Course Outcomes (COs)

Course Title & Code: Autonomous Robots (ROE431A)

After the successful completion of this course, the student will be able to:

CO-1. Describe the introduction and working principles of autonomous robotic Systems
CO-2. Discuss the aspects of cognition, perception and Imaging Techniques used in Robotic Applications
CO-3. Discuss the various robot programming packages for display, tele-operation and other applications
CO-4. Develop algorithms for simultaneous localization and mapping based techniques and paradigms
CO-5. Analyze the various path planning techniques by briefing about the robot's environment and explaining about the programs

Course Outcomes (COs)

Course Title & Code: Systems Engineering (ROE432A)

After the successful completion of this course, the student will be able to:

CO-1. Describe engineering design, product lifecycles, various models and standards for robots
CO-2. Explain the role of system engineering methodologies in an orderly design process
CO-3. Identify and evaluate system and subsystem requirements and decompose system requirements into functions for robotic system
CO-4. Develop and verify the system to meet the requirements of a robotic System
CO-5. Release and maintain a robotic system

Course Outcomes (COs)

Course Title & Code: Data Analytics (CSE431A)

After the successful completion of this course, the student will be able to:

CO-1. Discuss data analytics application development using knowledge representation, data warehousing, machine learning and data mining techniques.
CO-2. Choose appropriate techniques and technology for data warehousing, machine learning and Data mining for knowledge discovery.
CO-3. Design data analytics processes using data warehousing, machine learning and data mining techniques for knowledge representation and discovery.
CO-4. Analyze the data and the performance of data analytics applications.
CO-5. Synthesize data analytics applications using machine learning and data mining techniques and enterprise platforms.
CO-6. Solve problems associated with large scale data analysis, machine learning and data

Course Outcomes (COs)

Course Title & Code: Advanced Numerical Methods (MTE403A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Illustrate various methods of numerical computation of Eigen values
- **CO-2.** Illustrate various methods to solve partial differential equations
- **CO-3.** Apply numerical methods to solve partial differential equations using MATLAB
- **CO-4.** Analyze real world problems associated with computing eigenvalues and partial differential equations
- **CO-5.** Solve complex problems arising in real world using finite volume and finite elements methods to solve partial differential equations

Course Outcomes (COs)

Course Title & Code: Optimization Techniques – 2 (MTE402A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Describe fundamental of integral equations, variational problems and unconstrained optimization
- **CO-2.** State and explain important classical techniques to solve integral equations and numerical methods of unconstrained optimization
- **CO-3.** Demonstrate the skill to analyze variational problem and choose effective optimizationtools
- **CO-4.** Apply optimization techniques to model real world problems involving linear and non-linear optimization
- **CO-5.** Solve complex problems associated with integral equations, calculus of variations and unconstrainted optimization of function of several variables

Course Outcomes (COs)

Course Title & Code: Project Work -2 (ROP402A)

After the successful completion of this course, the student will be able to:

- **CO-1.** Recognize the need for developing a new or improving an existing engineering product/system through an organized survey of literature
- **CO-2.** Define engineering design specifications.
- **CO-3.** Design, model, solve analyze the product/system to meet the design specifications.
- **CO-4.** Evaluate the performance of the modelled system and justify its performance
- **CO-5.** Demonstrate the system working in a virtual environment and make a presentation.
- **CO-6.** Write a technical report.

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