SCHEME and SYLLABUS

for

MINOR DEGREE/ SPECIALIZATION

in

ROBOTICS

(w.e.f. session 2023-2024)

DEPARTMENT OF MECHANICAL ENGINEERING

J. C. BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA, FARIDABAD

The scheme and Syllabus approved in 22nd BOS (UG) held on 27.09.2023; Item No. BOS/22/03

J. C. BOSE UNIVERSITY OF SCIENCE AND TECHNOLOGY, YMCA, FARIDABAD

VISION

"J.C. Bose University of Science and Technology, YMCA, Faridabad aspires to be a nationally and internationally acclaimed leader in technical and higher education in all spheres which transforms the life of students through integration of teaching, research and character building."

MISSION

- To contribute to the development of science and technology by synthesizing teaching, research and creative activities.
- To provide an enviable research environment and state-of-the-art technological exposure to its scholars.
- To develop human potential to its fullest extent and make them emerge as world class leaders in their professions and enthuse them towards their social responsibilities.

DEPARTMENT OF MECHANICAL ENGINEERING

VISION

"To be a centre of excellence by producing high caliber, competent and self-reliant mechanical engineers, who possess scientific temperament and would engage in activities relevant to industries with ethical values and flair to research."

MISSION

- To provide efficient engineers for global requirements by imparting quality education.
- To explore, create and develop innovations in various aspects of engineering through industries and institutions.
- To emphasize on practical skills and socially relevant technology.

Minor Degree/ Specialization in ROBOTICS

Offered by Mechanical Engineering Department

Robotics is the science and study of robots and is an interdisciplinary field that integrates engineering, science & technology. Robotics is a fascinating new field of study and is efficiently growing one as robots are being employed more & more in various fields, including industry, research laboratories and even in the houses. Government is emphasizing and supporting the study and adoption of these newer technologies and the Institutions and Universities must adopt these technologies for education, training and research.

Keeping in view of the above, Department of Mechanical Engineering has started Minor Degree/ Specialization in "ROBOTICS" from the session 2023-24 with a view to enhance the employability skills of the students and impart deep knowledge in emerging areas, usually not being covered in Undergraduate Degree framework. These emerging areas will help students in capturing the plethora of employment opportunities available in these domains.

This Minor Degree/ Specialization will require the earning of 19 credits. This scheme shall be an addition to the regular undergraduate program implying that its passing/failure shall not affect the result of regular undergraduate program being pursued by the student. Upon successful completion of the course, Minor / Specialization Degree shall be awarded to the candidate.

General Information:

Eligibility/ Target Students	B.Tech. II year all Branches except Robotics and Artificial Intelligence (Specialization for B.Tech Mechanical Engineering and Minor Degree for other branches)
Duration of program	4 Semesters
Intake	30
Mode of Delivery (Class room / MOOC)	Class room/ MOOC
Proposed Fee	As per University Norms

SCHEME OF STUDIES

Minor Degree/ Specialization in ROBOTICS

Course Structure										
S. No.	**Course Code**	**Title**	**Hours per Week**			**Credits**	**Semester**	**Marks for Sessional**	**Marks for End Term Examination**	**Total**
			L	**T**	**P**					
1	MD-RO-401	Kinematics of Robots	3	1	-	4	4	25	75	100
2	MD-RO-402	Mechatronics System Design	3	-	-	3	4	25	75	100
3	MD-RO-501	*MOOC	3	-	-	3	5	25	75	100
4	MD-RO-502	Robotics Lab	-	-	2	1	5	15	35	50
5	MD-RO-601	Microprocessor & Microcontroller	3	-	-	3	6	25	75	100
6	MD-RO-602	Microprocessor & Microcontroller Lab	-	-	2	1	6	15	35	50
7	MD-RO-701	Project	-	-	8	4	7	30	70	100
Total			**12**	**1**	**12**	**19**	**-**	**160**	**440**	**600**

*Massive Open Online Course:
The students have to undergo an Online MOOC course of 3 credits offered through NPTEL/ Swayam Portal. They may select from the following list relevant to the program:

1. Modern Digital Communication Techniques
2. Introduction to Wireless and Cellular Communications
3. Fiber Optic Communication Technology

This list is not exhaustive and can be updated as per the availability on NPTEL/Swayam Portal.

This MOOC course has to be different from the one claimed for honors in regular degree program.

Detailed Syllabus

Course Code :	**MO-RO-401**
Course Title :	**KINEMATICS OF ROBOTS**
Semester:	**IV**
Number of Credits :	Credit 4 (L: 3; T: 1 ; P:0)
Course Category :	Core
Offered by Department:	**Mechanical Engineering**

Course Objective:

The objective of studying this course is to understand and apply the concepts of kinematics and dynamics of robotics for analysing the problems.

Course Contents:

Unit 1

Introduction to Mechanism and Machine: Links, Kinematic pairs, Degree of freedom, Kinematic Chain, Binary, Ternary, Quaternary Links and Joints, types of mechanism, Mechanical Manipulators, Open kinematic Chain, Inversions of slider crank mechanism.

Unit 2

Robotic configuration: Robot configuration and its different types, robot orientation, types of robots, applications of industrial robots.

Unit 3

Spatial descriptions and transformations: Introduction, Descriptions: Positions, orientation and frames; Mappings: Changing description from frame to frame; Operators: translations, rotations, and transformations; Interpretations, Transformation Arithmetic, Transform equations, representation of orientation, transformation of free vectors, computational considerations.

Unit 4

Manipulator Kinematics: The inverse kinematics problem, General properties of solutions. Tool configuration, Inverse kinematics of four axis SCARA robot and three and five axis, Articulated robot. Inverse Manipulator Kinematics, standard frames, (8)

Unit 5

Gear & CAM: Technical terms, types of gear, gear law, interference in gear, minimum number of teeth to avoid interference, Concept of Helical gears, spiral gears, Bevel gear, Gear Trains**:** Types of gear trains: simple gear train, compound gear train, Reverted gear train, Epicyclic gear train. Introduction to CAM, types of follower, types of motion of follower.

Unit 6

Jacobians; velocities and static forces: Introduction, Notation for time varying position and orientation, linear and rotational velocity of rigid bodies, angular velocity, motion of the links of the robots, Velocity "Propagation" from link to link, Jacobians, Singularities, Static forces in manipulations, Jacobians in force domain, Cartesian transformation of velocities and static forces.

Unit 7

Manipulator dynamics: Introduction, acceleration of rigid bodies, mass distribution, Newton's equation, euler equation, Iterative newton – euler dynamic formulation, iterative vs closed form, Example of Closed form dynamic equation, structure of a manipulator's dynamic equation, Lagrangian formulation of manipulator dynamics, Formulating manipulator dynamic in Cartesian space, Inclusion of non-rigid body effects, dynamic simulation, computational considerations.

Course Outcomes: After completion of this course, students would be able:

- **CO1-** Understand the basic concepts of coordinate system.
- **CO2-** Perform kinematic analysis of robots.
- **CO3-** Study inverse kinematics of robots.
- **CO4-** To study manipulator dynamics.

Text Books/References:

1. John J. Craig, Introduction of Robotics, Pearson Education International
2. Robert J. Schilling, Fundamentals of Robotics Analysis and Control, PHI Learning., 2009.
3. Richard D. Klafter, Thomas. A, Chri Elewski, Michael Negin, Robotics Engineering an Integrated Approach, Phi Learning., 2009.
4. P.A. Janaki Raman, Robotics and Image Processing an Introduction, Tata Mc Graw Hill Publishing company Ltd., 1995.
5. Francis N-Nagy Andras Siegler, Engineering foundation of Robotics, Prentice Hall Inc., 1987.
6. Subir Kumar Saha, Introduction of Robotics, 2008.

Course Code :	**MD-RO-402**
Course Title :	**MECHATRONICS SYSTEM DESIGN**
Semester:	**IV**
Number of Credits :	Credit 3 (L: 3 ; T:0 ; P:0)
Course Category :	Core
Offered by Department:	**Mechanical Engineering**

Course Objectives:

To study essential concepts of a system model in a mechanical system. To study interfacing of various hardware in mechatronics product design for enhancing mechanical product design values.

Course Contents:

Unit 1

Introduction to Mechatronics systems and components, Mechatronics product design, Applications, Principles of basic electronics with their applications in Mechanical Engineering, Mechatronics in robots, Analogy between mechanical and electrical system.

Unit 2

Microcontrollers applications in design of mechanical equipment's. Interfacing. amplifiers applications in mechatronics product design. Low pass and high pass filters.

Unit 3

Sensors –sensors and transducers. Displacement, position proximity sensors, velocity, force sensors. Fluid sensors, Temperature sensors, Liquid level and Light sensors. Selection of sensors, Actuators: Pneumatic and hydraulic systems, Electrical actuation system.

Unit 4

Principles of Electronic system communication, Signal conditioning, Interfacing, A.D. and D.A. convertors, Software and hardware principles and tools to build mechatronic systems, Basic system models, Mathematical models.

Unit 5

Control System – Proportional, Derivative and Integral control, Controller tuning, PID Controllers, System Transfer functions, First and second order.

Unit 6

Design and selection of Mechatronics components namely encoders, stepper and servomotors, ball screws, solenoids, application to CNC system. PLC and Ladder programming.

Course Outcomes: At the end of the course, the student shall be able to:

- **CO1-** Understand conceptual design for mechatronics products based on potential custom requirements.
- **CO2-** Analyze appropriate sensors and transducers for mechatronics applications.
- **CO3-** Calculate transfer function for first order and second order system.
- **CO4-** Develop system model for mechanical system.

Text Books/ Reference Books:

1. Mechatronics by W. Bolton, published by Pearson Education, 4th Ed.
2. Automation Production System and CIMS by Mikel P Groover, Prentice Hall of India New Delhi.

Online Resources: http://nptel.ac.in, Mechatronics Engineering

Note: It is recommended that some part of the syllabus is to be covered in online mode.

Course Code :	**MD-RO-502**
Course Title :	**ROBOTICS LAB**
Semester:	**V**
Number of Credits :	Credit 1 (L: 0 ; T:0 ; P:2)
Course Category :	Core
Offered by Department:	**Mechanical Engineering**

Course Objectives:

The objective of the robotics lab is to demonstrate the basic principles in the area of robotics working safety and programming and ability to interpret the data from the experiments.

List of Experiments:

1. To study an introduction to Robot configuration.
2. To get knowledge of various safety points in robotics lab.
3. To teach robotic arm a point in space by using teach pendant.
4. To draw a triangle in particular frame by using KR-16 robotic arm.
5. To draw a circle in particular frame by using KR-16 robotic arm.
6. To make a complicated shape involving arcs and circle by using teach pendent.
7. To perform a mig welding operation by using KR-16 robotic arm.
8. To perform pick and place operation by using KR-16 robotic arm.

Course Outcomes (COs): At the end of the course, the student shall be able to:

CO1- Differentiate the various types of Robots and their architecture.

CO2- Ooperate basic instruments in robotic lab.

CO3- Understand the concepts of robotics working safety and programming and ability to interpret the data from experiments.

CO4- Perform the various types of robot operations.

Course Code :	**MD-RO-601**
Course Title :	**MICROPROCESSOR & MICROCONTROLLER**
Semester:	**VI**
Number of Credits :	Credit 3 (L: 3 ; T:0 ; P:0)
Course Category :	Core
Offered by Department:	**Mechanical Engineering**

Course Objectives:

On successful complete of this course, the students should be able to:

1. To acquire insight into architectural details of microprocessors, assembly language programming, and different bus structures.
2. To acquire insight into architectural details of microcontrollers, assembly language programming, and different bus structures.
3. To understand various types of interrupts of the microprocessors and microcontrollers, along with implement the interfacing of external devices.
4. To analyse the hardware/software trade-offs involved in the design of microprocessor and microcontroller-based systems.

Course Contents:

Unit 1

Microprocessor 8086: Architecture, Overview of 8086 microprocessor-Functional Diagram, Register Organization, Memory Segmentation, Signal Descriptions-Common Function Signals, Minimum and Maximum Mode Signals, Timing Diagrams, Interrupts of 8086.

Unit 2

Assembly language of 8086: Instruction Set, Addressing Modes, Assembler directives, 8086 Assembly Programming- simple programs involving logical, branch and call instructions, sorting, evaluating arithmetic expressions, string manipulations.

Unit 3

Interfacing with Microprocessors: Interfacing with RAMs, ROMs. Interfacing with peripheral ICs- programmable peripheral interface 8255, programmable interrupt controller 8259 and 8254 programmable timer. Interfacing with keyboards, LEDs, LCDs, ADCs, and DACs.

Unit 4

Microcontroller 8051: Overview of 8051 microcontroller- Architecture, memory organization, inbuilt modules- timers, serial communication module, port operation: special function registers, timing and control and interrupts.

Unit 5

Microcontroller, Instruction Set and Programming: Programming the 8051, Operand types, Operand addressing, Data transfer instructions, Arithmetic Instructions, Logic instructions, Control transfer instructions. 8051 Interfacing – memory and I/O interfacing. ()

Course Outcomes: At the end of the course, the student shall be able to:

- **CO1-** Acquaint with the architecture, operations, the addressing modes, instruction set and programming of the microprocessors.
- **CO2-** Accustom with the architecture, operations, the addressing modes, instruction set and programming of the microcontrollers.
- **CO3-** Recognize the various types of interrupts of the microprocessors and microcontroller along with implementation of the interfacing of external devices to the processor.
- **CO4-** Understand and apply the hardware/software trade-offs involved in the design of microprocessor and microcontroller-based systems.

Text Books/ Reference Books:

1. Ramesh S Gaonkar, "Microprocessor Architecture, Programming & Applications with 8085", Wiley Eastern Ltd.
2. A K Ray, K M Bhurchandi," Advanced Microprocessors and Peripherals", TMH Publications.
3. Kenneth J. Ayala, The 8051 Microcontroller, Penram International Publishing, 1996.
4. Hall, "Microprocessors and interfacing", TMH
5. Triebel, Singh,"The 8088 & 8086 Microprocessors-Programming, interfacing, Hardware & Applications", PHI
6. Yu-Chang Liu, Glenn A Gibson,"Microcomputer systems: the 8086/8088 Family: architecture, Programming & Design", PHI.
7. Barry B. Brey, "The Intel Microprocessors: Architecture, Programming & Interfacing" PHI, 6th Edition.
8. Uffenback, "The 8086 Family Design" PHI, 2nd Edition.
9. Muhammad Ali Mazidi "The 8051 Microcontroller and Embedded Systems" Pearson publications.

Note: It is recommended that some part of the syllabus is to be covered in online mode.

Course Code :	**MD-RO-602**
Course Title :	**MICROPROCESSOR & MICROCONTROLLER LAB**
Semester:	**VI**
Number of Credits :	Credit 1 (L: 0 ; T:0 ; P:2)
Course Category :	Core
Offered by Department:	**Mechanical Engineering**

Course Objectives:

The aim of this course is to familiarize students with Microprocessor & Microcontroller.

List of Experiments:

1. Study of architecture of microprocessors 8086 & familiarization with its hardware, commands & operation of Microprocessor kit.
2. Write a program using microprocessors and verify for :

   (i) Addition of two 8-bit numbers.

   (ii) Addition of two 8-bit numbers (with carry).
3. Write a program using microprocessors and verify for :

   (i) 8-bit subtraction (display borrow)

   (ii) 16-bit subtraction (display borrow)
4. Write a program using microprocessors for multiplication of two 8- bit numbers by repeated addition method and bit rotation method and verify.
5. Write a program using microprocessors for division of two 8- bit numbers by repeated subtraction method and bit rotation method and test for typical data.
6. Write a program using microprocessors and verify for:

   (i) Finding the largest number from an array.

   (ii) Finding the smallest number from an array.
7. Write a program using microprocessors for arranging an array of numbers in descending and ascending order and verify.
8. Write a program using microprocessors for finding square of a number using look-up table and verify.
9. Write a program to interface microprocessors with 8253 to generate square wave.
10. Write a program to interface microprocessors with 8253 to generate interrupt on terminal count.
11. Write a program to interface a two-digit number using seven-segment LEDs. Use microprocessor and 8255 PPI.

12. Write a program to control the operation of stepper motor using microprocessors and 8255 PPI.

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

CO1- Identify various modules embedded on the kit.

CO2- Write the assembly code for various operations on 8-bit and 16-bit numbers.

CO3- Interface various peripherals with microprocessor and to write the program for same.

CO4- Interface various devices such as seven segment LEDS & stepper motor with microprocessor through 8255 and to write the program for same.