

**BASICS OF MECHATRONICS****Course Code : 314017**

**Programme Name/s** : Mechanical Engineering  
**Programme Code** : ME  
**Semester** : Fourth  
**Course Title** : BASICS OF MECHATRONICS  
**Course Code** : 314017

**I. RATIONALE**

Mechanical diploma engineer has to work on various multidisciplinary systems under the umbrella of Mechatronics. The goal of the course is to develop an understanding of basic elements underlying mechatronics systems viz. sensors, actuators, PLC, and control software etc.

**II. INDUSTRY / EMPLOYER EXPECTED OUTCOME**

Use appropriate sensors, actuators and controller for given mechatronics system(s).

**III. COURSE LEVEL LEARNING OUTCOMES (COS)**

Students will be able to achieve & demonstrate the following COs on completion of course based learning

- CO1 - Identify basic elements of mechatronics system such as sensors, actuators, controllers etc.
- CO2 - Use sensors for different mechatronics systems
- CO3 - Use actuators for different mechatronics systems
- CO4 - Develop PLC program for various mechatronics systems
- CO5 - Use microcontroller for different mechatronics systems

**IV. TEACHING-LEARNING & ASSESSMENT SCHEME**

| Course Code | Course Title           | Abbr | Course Category/s | Learning Scheme          |     |     |                |        | Credits | Assessment Scheme |     |                  |       |       |    |             |    |       |   |     |  | Total Marks |
|-------------|------------------------|------|-------------------|--------------------------|-----|-----|----------------|--------|---------|-------------------|-----|------------------|-------|-------|----|-------------|----|-------|---|-----|--|-------------|
|             |                        |      |                   | Actual Contact Hrs./Week | SLH | NLH | Paper Duration | Theory |         |                   |     | Based on LL & TL |       |       |    | Based on SL |    |       |   |     |  |             |
|             |                        |      |                   |                          |     |     |                |        |         |                   |     | Practical        |       |       |    |             |    |       |   |     |  |             |
|             |                        |      |                   |                          |     |     |                | CL     |         | TL                | LL  | FA-TH            | SA-TH | Total |    | FA-PR       |    | SA-PR |   | SLA |  |             |
|             |                        |      |                   |                          |     |     |                |        |         |                   |     |                  |       |       |    |             |    |       |   |     |  |             |
| Max         | Max                    | Max  | Min               | Max                      | Min | Max | Min            | Max    | Min     | Max               | Min |                  |       |       |    |             |    |       |   |     |  |             |
| 314017      | BASICS OF MECHATRONICS | BOM  | AEC               | -                        | -   | 2   | -              | 2      | 1       | -                 | -   | -                | -     | 25    | 10 | 25@         | 10 | -     | - | 50  |  |             |

**Total IKS Hrs for Sem. : 0 Hrs**

Abbreviations: CL- ClassRoom Learning , TL- Tutorial Learning, LL-Laboratory Learning, SLH-Self Learning Hours, NLH-Notional Learning Hours, FA - Formative Assessment, SA -Summative assessment, IKS - Indian Knowledge System, SLA - Self Learning Assessment

Legends: @ Internal Assessment, # External Assessment, \*# On Line Examination , @\$ Internal Online Examination

Note :

1. FA-TH represents average of two class tests of 30 marks each conducted during the semester.
2. If candidate is not securing minimum passing marks in FA-PR of any course then the candidate shall be declared as "Detained" in that semester.
3. If candidate is not securing minimum passing marks in SLA of any course then the candidate shall be declared as fail and will have to repeat and resubmit SLA work.
4. Notional Learning hours for the semester are (CL+LL+TL+SL)hrs.\* 15 Weeks
5. 1 credit is equivalent to 30 Notional hrs.
6. \* Self learning hours shall not be reflected in the Time Table.
7. \* Self learning includes micro project / assignment / other activities.

**V. THEORY LEARNING OUTCOMES AND ALIGNED COURSE CONTENT**

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| Sr.No | Theory Learning Outcomes (TLO's) aligned to CO's.                                                                                                                                                                                                                                    | Learning content mapped with Theory Learning Outcomes (TLO's) and CO's.                                                                                                                                                                                                                                                             | Suggested Learning Pedagogies.                                                           |
|-------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------|
| 1     | TLO 1.1 Compare traditional system and mechatronics systems with the help of block diagram<br>TLO 1.2 Identify sensor, actuators in the given diagram of the mechatronic system with justification                                                                                   | <b>Unit - I Fundamental of Mechatronics</b><br>1.1 Introduction : Definition of Mechatronics, Mechatronics in Manufacturing products<br>1.2 Comparison between Traditional and Mechatronics approach<br>1.3 Block diagram representation of General Mechatronics system showing various components with suitable example            | Chalk board<br>Display charts                                                            |
| 2     | TLO 2.1 Explain the working of the given sensor<br>TLO 2.2 Select the relevant sensor for the given application<br>TLO 2.3 Differentiate between sensor and transducer<br>TLO 2.4 Explain with sketches working principle of given type of thermal, optical, electric sensors        | <b>Unit - II Sensors and Transducers</b><br>2.1 Sensors and transducers: Definition, difference, classification<br>2.2 Thermal, optical, electric sensors<br>2.3 Transducers: Need of transducers, types of transducers: primary, secondary, active, passive, analog and Digital<br>2.4 Selection criteria of sensor and transducer | Demonstration of actual devices<br>Chalk board<br>NPTEL Video                            |
| 3     | TLO 3.1 Explain with sketches the working of the given Pneumatic actuator with sketch and block diagram<br>TLO 3.2 Explain with sketches the working of the given Hydraulic actuator with sketch and block diagram<br>TLO 3.3 Select the relevant actuator for the given application | <b>Unit - III Actuators</b><br>3.1 Introduction and Classification of Actuators Need and Scope<br>3.2 Pneumatic Actuation system: Single and Double acting actuators<br>3.3 Hydraulic Actuation system: Single and Double acting actuators<br>3.4 Electric Actuation system: Solenoid, relay, stepper motors                        | Pneumatic trainer kit<br>Hydraulic trainer kit<br>Video<br>Demonstrations<br>Chalk board |
| 4     | TLO 4.1 Explain with the block diagram working of PLC<br>TLO 4.2 Select the PLC for the given application<br>TLO 4.3 Write a simple program using ladder diagram for the given application                                                                                           | <b>Unit - IV Programmable Logic Controller (PLC)</b><br>4.1 Introduction, definition, PLC block diagram, Manufacturers of PLC<br>4.2 Power supply, Input/output modules<br>4.3 Ladder logic symbols<br>4.4 Basic PLC Ladder logic programming, timers, counters                                                                     | Chalk board<br>Hands-on activity on PLC trainer kit                                      |
| 5     | TLO 5.1 Explain the working of the given microcontroller with block diagrams<br>TLO 5.2 Explain with the circuit diagram interfacing of stepper motor<br>TLO 5.3 Explain with the circuit diagram interfacing of Relay                                                               | <b>Unit - V Microcontroller</b><br>5.1 Comparison of Microprocessor and Microcontroller<br>5.2 Introduction, architecture, I/O ports<br>5.3 Interfacing of stepper motor, relay                                                                                                                                                     | Chalk board<br>Video<br>Demonstrations                                                   |

**VI. LABORATORY LEARNING OUTCOME AND ALIGNED PRACTICAL / TUTORIAL EXPERIENCES.**

| Practical / Tutorial / Laboratory Learning Outcome (LLO) | Sr No | Laboratory Experiment / Practical Titles / Tutorial Titles             | Number of hrs. | Relevant COs |
|----------------------------------------------------------|-------|------------------------------------------------------------------------|----------------|--------------|
| LLO 1.1 Identify sensor, transducer and actuator         | 1     | *Identification of Sensors, actuators available in the laboratory      | 2              | CO1          |
| LLO 2.1 Identify PLC and microcontroller                 | 2     | *Identification of PLC and microcontroller available in the laboratory | 2              | CO1          |

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| <b>Practical / Tutorial / Laboratory Learning Outcome (LLO)</b>                                                                                                   | <b>Sr No</b> | <b>Laboratory Experiment / Practical Titles / Tutorial Titles</b>                               | <b>Number of hrs.</b> | <b>Relevant COs</b>      |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-------------------------------------------------------------------------------------------------|-----------------------|--------------------------|
| LLO 3.1 Develop ladder diagram for simple application using sensor and actuator<br>LLO 3.2 Execute PLC program for simple application                             | 3            | *Development of Ladder diagram and program PLC for simple application using sensor and actuator | 2                     | CO1<br>CO2<br>CO3<br>CO4 |
| LLO 4.1 Develop ladder diagram for logic gates<br>LLO 4.2 Execute PLC program for the logic gates                                                                 | 4            | *Verification of Logic gate functions for the given Ladder diagram by using PLC                 | 2                     | CO4                      |
| LLO 5.1 Develop ladder diagram for staircase lighting<br>LLO 5.2 Execute PLC program for staircase lighting                                                       | 5            | Development of Ladder diagram and program PLC for two-way switch logic for staircase lighting   | 2                     | CO1<br>CO2<br>CO3        |
| LLO 6.1 Develop ladder diagram for Timers and counters<br>LLO 6.2 Execute PLC program for Timers and counters                                                     | 6            | *Development of Ladder diagram and program PLC for Timers and Counters                          | 2                     | CO4                      |
| LLO 7.1 Develop ladder diagram for water level control<br>LLO 7.2 Execute PLC program for water level control                                                     | 7            | Development of Ladder diagram and program PLC for water level control                           | 2                     | CO1<br>CO2<br>CO3<br>CO4 |
| LLO 8.1 Develop ladder diagram for pedestrian light on off control<br>LLO 8.2 Execute PLC program for pedestrian light on off control                             | 8            | Development of Ladder diagram and program PLC for pedestrian light (green/red ) toggle control  | 2                     | CO1<br>CO2<br>CO3<br>CO4 |
| LLO 9.1 Develop ladder diagram for temperature control<br>LLO 9.2 Execute PLC program for temperature control                                                     | 9            | *Development of Ladder diagram and program PLC for on/off temperature control                   | 2                     | CO1<br>CO2<br>CO3<br>CO4 |
| LLO 10.1 Develop ladder diagram for lift/elevator control<br>LLO 10.2 Execute PLC program for lift/elevator control                                               | 10           | Development of Ladder diagram and program PLC for lift/ elevator control                        | 2                     | CO1<br>CO2<br>CO3<br>CO4 |
| LLO 11.1 Develop ladder diagram for single acting/double acting pneumatic system<br>LLO 11.2 Execute PLC program for single acting/double acting pneumatic system | 11           | Development of Ladder diagram and program PLC for single acting/double acting pneumatic system  | 2                     | CO1<br>CO2<br>CO3<br>CO4 |
| LLO 12.1 Develop ladder diagram for single acting/double acting Hydraulic system<br>LLO 12.2 Execute PLC program for single acting/double acting hydraulic system | 12           | Development of Ladder diagram and program PLC for single acting/double acting hydraulic system  | 2                     | CO1<br>CO2<br>CO3<br>CO4 |
| LLO 13.1 Develop ladder diagram for door open and close system<br>LLO 13.2 Execute PLC program for door open and close system                                     | 13           | Development of Ladder diagram and program PLC for door open and close application               | 2                     | CO1<br>CO2<br>CO3<br>CO4 |
| LLO 14.1 Develop ladder diagram for material rejection system<br>LLO 14.2 Execute PLC program for material rejection system                                       | 14           | *Development of Ladder diagram and program PLC for material rejection system                    | 2                     | CO1<br>CO2<br>CO3<br>CO4 |

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| Practical / Tutorial / Laboratory Learning Outcome (LLO)                                                                                   | Sr No | Laboratory Experiment / Practical Titles / Tutorial Titles            | Number of hrs. | Relevant COs      |
|--------------------------------------------------------------------------------------------------------------------------------------------|-------|-----------------------------------------------------------------------|----------------|-------------------|
| LLO 15.1 Develop 8051 microcontroller program for stepper motor control<br>LLO 15.2 Execute 8051 microcontroller program for stepper motor | 15    | Development of 8051 microcontroller program for stepper motor control | 2              | CO1<br>CO2<br>CO5 |
| LLO 16.1 Develop 8051 microcontroller program for relay interfacing<br>LLO 16.2 Execute 8051 microcontroller program for relay interfacing | 16    | *Development of 8051 microcontroller program for relay interfacing    | 2              | CO1<br>CO2<br>CO5 |

**Note : Out of above suggestive LLOs -**

- '\*' Marked Practicals (LLOs) Are mandatory.
- Minimum 80% of above list of lab experiment are to be performed.
- Judicial mix of LLOs are to be performed to achieve desired outcomes.

**VII. SUGGESTED MICRO PROJECT / ASSIGNMENT/ ACTIVITIES FOR SPECIFIC LEARNING / SKILLS DEVELOPMENT (SELF LEARNING) : NOT APPLICABLE****VIII. LABORATORY EQUIPMENT / INSTRUMENTS / TOOLS / SOFTWARE REQUIRED**

| Sr.No | Equipment Name with Broad Specifications                                                                                                                                                                                                                                                                                                                             | Relevant LLO Number                |
|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|
| 1     | Basic Electro-Pneumatic trainer kit 1) Single acting and double acting pneumatic cylinder 2) Bore size: minimum 8 mm bore 3) Stroke: minimum 15 mm 4) Operating pressure: compressed air up to 4 bar pressure 5) Solenoid: 24V DC connected with trainer kit                                                                                                         | 11                                 |
| 2     | Basic Electro-Hydraulic trainer kit 1) Single acting and double acting hydraulic cylinder 2) Bore size: minimum 12 mm bore 3) Stroke: minimum 40 mm 4) Operating pressure: up to 20 bar pressure 5) Solenoid: 24V DC connected with trainer kit                                                                                                                      | 12                                 |
| 3     | Door open and close module Electro-pneumatic operated door open and close facility of sensing arrival and departure of person/object within particular distance from door (Pneumatic actuator type: Single/double acting pneumatic cylinder, Bore: 8 mm, Stroke: 15 mm, Medium: Compressed air up to 4 bar pressure, Solenoid valve: +24V DC)                        | 13                                 |
| 4     | Raw Material rejection module 1) Raw material rejection module with facility to detect, sort and reject the object 2) The module with IR sensor and Electro-pneumatic actuator controlled by PLC (Pneumatic actuator type: Single/double acting pneumatic cylinder, Bore: 8 mm, Stroke: 15 mm, Medium: Compressed air up to 4 bar pressure, Solenoid valve: +24V DC) | 14                                 |
| 5     | 8051 microcontroller development board (Functional description and interfacing) 1) 16 x 2 characters LCD 2) Seven segment display 3) LED 4) Keypad 5) Steeper motor 6) Relay 7) facility for I/O port expansion                                                                                                                                                      | 15,16                              |
| 6     | PLC trainer kit 1) Digital input and output: 12 Nos. with toggle switches for applying 24 V DC inputs and outputs 2) Analog input and output: 02 Nos. 3) External power supply: 24V DC                                                                                                                                                                               | 3,4,5,6,7,8,9,10,11,12,13,14       |
| 7     | Desktop PC/Laptop with PLC software and I/O communication facility: Minimum System Requirements Intel Core i3,4GB RAM, 500 GB Hard Disk.                                                                                                                                                                                                                             | 3,4,5,6,7,8,9,10,11,12,13,14,15,16 |

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| Sr.No | Equipment Name with Broad Specifications                                                                                                                                                                                                                                                                                                                               | Relevant LLO Number |
|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| 8     | Tank Level Controller module: Water tank with ability to sense, indicate and control high and low level (Measuring water tank 1 no., Control panel enclosure: Metal frame with accessible front panel Push buttons red and green: 1 no. (each) Indicators red and green: 1 no. (each) Buzzer: 1 no, Manual drain valve: ½", Fluid solenoid valve: 1 no. Supply: 24V DC | 7                   |

**IX. SUGGESTED WEIGHTAGE TO LEARNING EFFORTS & ASSESSMENT PURPOSE (Specification Table) : NOT APPLICABLE****X. ASSESSMENT METHODOLOGIES/TOOLS****Formative assessment (Assessment for Learning)**

- Term work (Lab Manual)

**Summative Assessment (Assessment of Learning)**

- End semester practical examination

**XI. SUGGESTED COS - POS MATRIX FORM**

| Course Outcomes (COs) | Programme Outcomes (POs)                     |                       |                                       |                        |                                                                        |                         |                         | Programme Specific Outcomes* (PSOs) |       |       |
|-----------------------|----------------------------------------------|-----------------------|---------------------------------------|------------------------|------------------------------------------------------------------------|-------------------------|-------------------------|-------------------------------------|-------|-------|
|                       | PO-1 Basic and Discipline Specific Knowledge | PO-2 Problem Analysis | PO-3 Design/ Development of Solutions | PO-4 Engineering Tools | PO-5 Engineering Practices for Society, Sustainability and Environment | PO-6 Project Management | PO-7 Life Long Learning | PSO-1                               | PSO-2 | PSO-3 |
| CO1                   | 3                                            | -                     | 3                                     | 3                      | 1                                                                      | -                       | 3                       |                                     |       |       |
| CO2                   | 3                                            | -                     | 2                                     | 2                      | 1                                                                      | -                       | 2                       |                                     |       |       |
| CO3                   | 3                                            | -                     | 2                                     | 2                      | 1                                                                      | -                       | 2                       |                                     |       |       |
| CO4                   | 3                                            | -                     | 2                                     | 2                      | 1                                                                      | -                       | 2                       |                                     |       |       |
| CO5                   | 3                                            | -                     | 2                                     | 2                      | 1                                                                      | -                       | 2                       |                                     |       |       |

Legends :- High:03, Medium:02,Low:01, No Mapping: -  
\*PSOs are to be formulated at institute level

**XII. SUGGESTED LEARNING MATERIALS / BOOKS**

| Sr.No | Author            | Title                                           | Publisher with ISBN Number                                   |
|-------|-------------------|-------------------------------------------------|--------------------------------------------------------------|
| 1     | Bolton, W         | Mechatronics                                    | Pearson Education, New Delhi, 2017, ISBN: 978-81-317-3253-3  |
| 2     | Petrusella, F. D. | Programmable Logic Controllers                  | Tata McGraw Hill, New Delhi, 2024, ISBN: 978-0-07-337384-3   |
| 3     | Ghosh, A. K.      | Introduction to Instrumentation and Control     | Prentice Hall of India, New Delhi, 2004, ISBN: 81-203-1626-6 |
| 4     | Majumdar, S.R.    | Pneumatics systems Principles and maintenance   | Tata McGraw Hill, New Delhi, 2013, ISBN: 978-0-07-463748-7   |
| 5     | Majumdar, S.R.    | Oil Hydraulic system- Principle and maintenance | Tata McGraw Hill, New Delhi, 2013, ISBN: 978-0-07-463748-7   |

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| Sr.No | Author        | Title                      | Publisher with ISBN Number                                    |
|-------|---------------|----------------------------|---------------------------------------------------------------|
| 6     | Rajput, R. K. | A Textbook of Mechatronics | S. Chand and Company New Delhi, 2022, ISBN: 978-81-219-2859-5 |

**XIII . LEARNING WEBSITES & PORTALS**

| Sr.No | Link / Portal                                                                                                               | Description                                                                               |
|-------|-----------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------|
| 1     | <a href="https://www.youtube.com/watch?v=J_KoRp8SnoE&amp;t=14s">https://www.youtube.com/watch?v=J_KoRp8SnoE&amp;t=14s</a>   | Types of Sensors                                                                          |
| 2     | <a href="https://www.youtube.com/watch?v=UrST-2yu8zQ">https://www.youtube.com/watch?v=UrST-2yu8zQ</a>                       | Lecture 1 : Introduction to Mechatronics (NPTEL course Mechatronics)                      |
| 3     | <a href="https://www.youtube.com/watch?v=YlmRa-9zDF8">https://www.youtube.com/watch?v=YlmRa-9zDF8</a>                       | Introduction to hydraulic system                                                          |
| 4     | <a href="https://www.youtube.com/watch?v=1lbdwPfFegY">https://www.youtube.com/watch?v=1lbdwPfFegY</a>                       | Relay System                                                                              |
| 5     | <a href="https://www.youtube.com/watch?v=5q7YasmwXC&amp;t=377s">https://www.youtube.com/watch?v=5q7YasmwXC&amp;t=377s</a>   | Pneumatic Control : Festo Didactics                                                       |
| 6     | <a href="https://www.youtube.com/watch?v=-MLGr1_Fw0c&amp;t=121s">https://www.youtube.com/watch?v=-MLGr1_Fw0c&amp;t=121s</a> | Working of Solenoid Valves - Basics actuator control valve working principle              |
| 7     | <a href="https://www.youtube.com/watch?v=eyqwLiowZiU">https://www.youtube.com/watch?v=eyqwLiowZiU</a>                       | Working of Stepper Motor work.                                                            |
| 8     | <a href="https://www.youtube.com/watch?v=qQoHQ0b-d1U">https://www.youtube.com/watch?v=qQoHQ0b-d1U</a>                       | Tank Level Control with PLC ladder Logic animated PLC Programming tutorials for beginners |

**Note :**

- Teachers are requested to check the creative common license status/financial implications of the suggested online educational resources before use by the students

**MSBTE Approval Dt. 21/11/2024****Semester - 4, K Scheme**