

Course Name : Electronics Engineering Group
Course Code : ET/EJ/EN/EX/IE/IU
Semester : Sixth for ET/EJ/EN/EX/IE and Seventh for IU
Subject Title : Mechatronics (Elective)
Subject Code : 17660

Teaching and Examination Scheme:

| Teaching Scheme | | | Examination Scheme | | | | | |
|-----------------|----|----|--------------------|-----|----|----|-----|-------|
| TH | TU | PR | PAPER HRS | TH | PR | OR | TW | TOTAL |
| 03 | -- | 02 | 03 | 100 | | -- | 25@ | 125 |

NOTE:

- Two tests each of 25 marks to be conducted as per the schedule given by MSBTE.
- Total of tests marks for all theory subjects are to be converted out of 50 and to be entered in mark sheet under the head Sessional Work (SW).

Rationale:

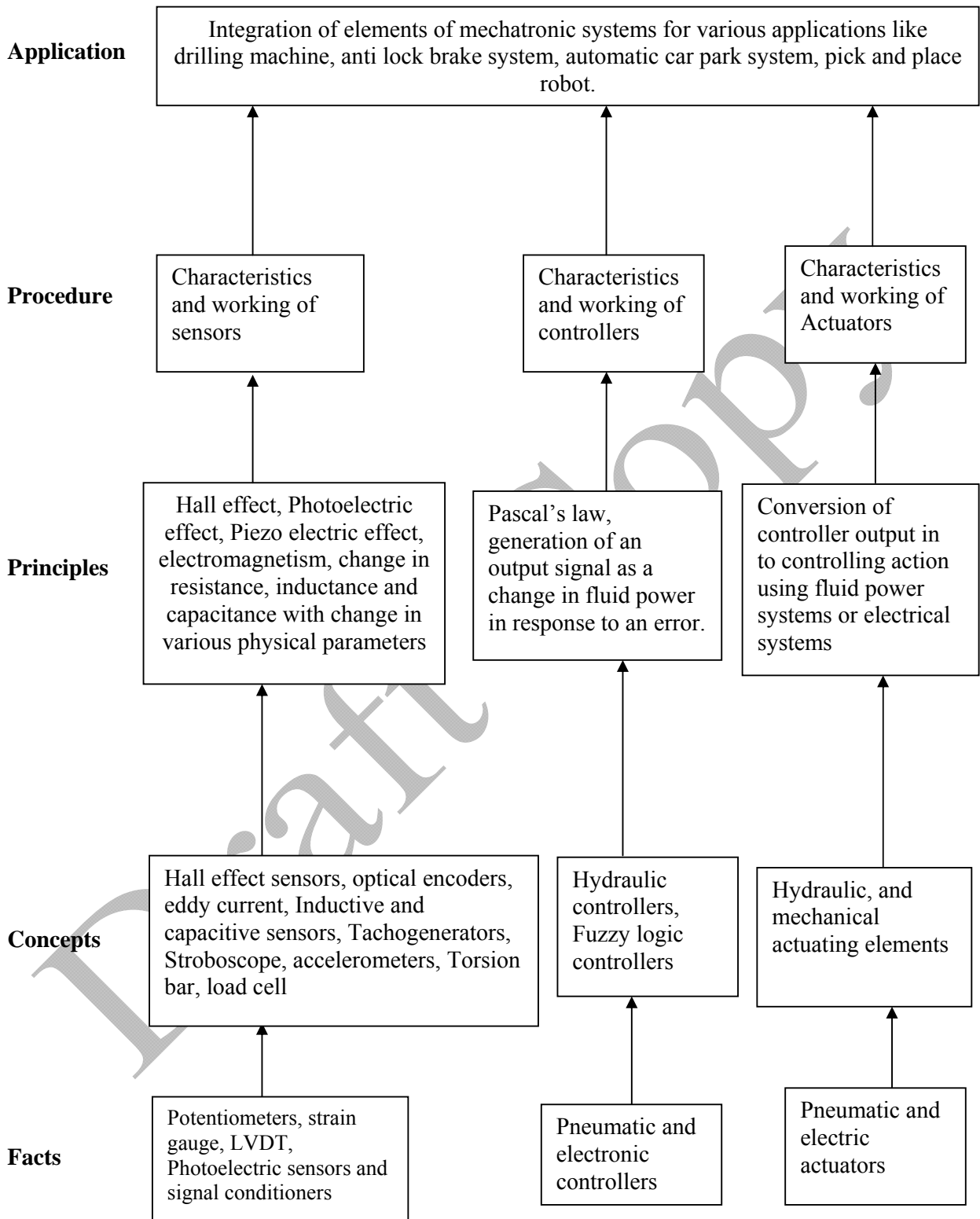
Mechatronics is a rapidly developing interdisciplinary field of engineering, which comprises of development of various computer integrated electro mechanical systems. It is an integration of mechanical engineering, electronic engineering, computer technology and control and instrumentation engineering. This integration facilitates the production of complex engineering systems with a high level of performance, reliability and value at a low price. Due to these aspects, industrial sector is rapidly adopting such integrated systems in manufacturing processes. To adopt such systems, industries are in need of the engineers with knowledge of this integration. Hence it is essential for the students to have knowledge of this multidisciplinary field. Students will be able to select sensors and actuators, develop control algorithms and use or develop advanced functional materials for the design of mechanical systems such as anti-lock brakes, engine control units, disk drives, cameras, service and surgical robots and artificial hearts.

General Objectives:

The student will be able to:

1. Understand the elements of Mechatronics systems.
2. Understand the significance of sensors & transducers in Mechatronics.
3. Understand the different types of controllers used in Mechatronics.
4. Understand the fundamentals of Robotics & micro electro mechanical systems.
5. Develop the skills to integrate the Mechatronics system with the help of case studies.

Learning Structure:



Theory:

| Topic and Contents | Hours | Marks |
|--|-------|-------|
| <p>Topic 1: Elements of Mechatronic System</p> <p>Specific Objectives:</p> <ul style="list-style-type: none"> ➤ Explain the importance of mechatronics systems ➤ Draw the block diagram and identify the elements of mechatronics systems. <p>Contents:</p> <p>Importance of mechatronics in various fields of engineering, Evolution of mechatronics, Block diagram of mechatronic systems and identification of elements (Sensors, signal conditioners, controllers, Actuators), Advantages and disadvantages of mechatronic systems</p> | 04 | 08 |
| <p>Topics 2: Sensors and Transducers in Mechatronics Systems</p> <p>Specific Objectives:</p> <ul style="list-style-type: none"> ➤ Differentiate between transducers and sensors. ➤ Classify the transducers. ➤ Explain the sensors used for displacement, proximity, velocity, acceleration, and force and torque measurement. ➤ Appreciate the importance of signal conditioner. ➤ Review of transducers and sensors, classification and selection parameters for transducers, Review of displacement sensors: Potentiometer, Resistance strain gauge and LVDT (no marks) <p>Contents:</p> <p>2.1 Proximity and position Sensors: [06] Photo electric sensors, hall effect sensors, optical encoder, eddy current proximity sensor, Inductive sensor, Capacitive sensor (construction, principle of operation and application)</p> <p>2.2 Velocity, Motion, Acceleration, Force and Torque Sensors (construction, principle of operation and application) [10]</p> <ul style="list-style-type: none"> • Velocity Sensors: Electromagnetic transducers, Tacho generators. • Motion Sensors: Stroboscope, Pyroelectric Sensors • Acceleration sensors: Strain gauge accelerometer, Piezo electric accelerometer, LVDT accelerometer. • Torque sensors : Torque measurement using strain gauge, torque measurement using torsion bar (optical method, capacitive method, proximity sensor method, stroboscope method) <p>2.3 Signal conditioners : [04] Need of Isolators, Filters, amplifiers and data converters in mechatronic systems</p> | 10 | 20 |

| | | |
|--|----|----|
| <p>Topic 3: Controllers in Mechatronic Systems</p> <p>Specific Objectives:</p> <ul style="list-style-type: none"> ➤ Explain the principles of controllers ➤ Differentiate between Electronic, Pneumatic and Hydraulic controllers ➤ Explain the application of PLC,CNC and microcontrollers in Mechatronics <p>Contents:</p> <p>3.1 [08]</p> <ul style="list-style-type: none"> • Electronic and Pneumatic controllers: Characteristics and implementation of P,PI,PD,PID, • Hydraulic controllers: advantages, disadvantages and implementation of proportional type <p>3.2 Digital Logic Control: [12]</p> <ul style="list-style-type: none"> • Block diagram of Fuzzy logic controllers , function of each block, application of fuzzy logic control in fully automatic washing machine (only block diagram) • Review of PLC architecture and ladder logic programming, application of PLC for control of process tank and conveyor motor, advantages of PLC • General configuration of CNC system , advantages of CNC, part programming of CNC machines, G codes and M codes, Small application programs • Review of architecture of Micro controller, application of microcontroller for stepper motor control, DC motor speed control, advantages of Micro controller | 10 | 20 |
| <p>Topic 4: Actuating Elements</p> <p>Specific Objectives:</p> <ul style="list-style-type: none"> ➤ Differentiate between pneumatic and hydraulic systems ➤ Explain Pneumatic, Hydraulic and electro-pneumatic actuators ➤ Explain various mechanical actuating systems <p>Contents:</p> <p>4.1 Hydraulic systems, pneumatic systems and actuators: [08]</p> <ul style="list-style-type: none"> • Hydraulic systems: Physical components of hydraulic systems: Hydraulic pumps, filters and pressure regulation • Pneumatic systems: Air compressors, filters and regulators, Air treatment • Actuators :Principle of operation of Linear actuators (single acting cylinder, double acting cylinder) Rotary actuators(rotating vane, gear type) and direction Control valves (Poppet valve, spool valve) <p>4.2 Electric actuators: [04] Stepper motor, DC motor, Solenoid valves, Relays (Principle of operation and application)</p> <p>4.3 Mechanical Actuating Systems [08] Cams, Gear, Belt , Rack and Pinion and Bearings (Principle of operation, types, and application)</p> | 10 | 20 |

| | | |
|---|-----------|------------|
| <p>Topic 5: Robotics and Micro Electro Mechanical Systems (MEMS) Specific Objectives:</p> <ul style="list-style-type: none"> ➤ Draw the block diagram and identify basic elements of a robot ➤ Classify robots based on work space ➤ Draw and identify the basic elements of micro electro mechanical systems <p>Contents:</p> <p>Robotics: [08] 5.1 Block diagram and function of each component (Sensors, drive system, control system, end effectors), Construction and degrees of freedom of Cylindrical, Spherical and Cartesian Robots, Applications of Robot</p> <p>5.2 MEMS : [08] Block diagram and Identify the Basic Blocks of MEMS (Micro sensors, Micro actuators, signal conditioners), construction of MEMS Accelerometer, MEMS accelerometer as airbag sensors for car safety.</p> | 08 | 16 |
| <p>Topic 6: Integration of Mechatronic Systems Specific Objectives:</p> <ul style="list-style-type: none"> ➤ Explain the application areas of mechatronics ➤ Integrate and interface various components of mechatronic systems <p>Contents:</p> <p>6.1 Block diagram, working and operation of following systems</p> <ul style="list-style-type: none"> • CNC based Drilling machine • Microcontroller based Antilock Brake system • PLC based Automatic car park barrier systems • Microcontroller/PLC based Pick and place robot | 06 | 16 |
| TOTAL | 48 | 100 |

Practical:

Skills to be developed:

Intellectual Skills:

- Proper selection of measuring instruments on the basis of range, least count, precision and accuracy required for measurement.
- Read and interpret the graph.
- Use these results for parallel problem

Motor Skills:

- Proper handling of instruments.
- Measuring physical quantities accurately.
- Observe the phenomenon and to list the observations in proper tabular form.
- Adopt proper procedure while performing the experiment.

List of Practicals:

1. Measurement of torque using torsion bar.
2. Measurement of speed using stroboscope.
3. Characteristics of linear, equal percentage and quick opening control valve.
4. Write and verify ladder program for ON-Off control of Lamp.
5. Write and verify ladder program for control of conveyor belt motor.

6. Write and verify ladder program for control of process tank.
7. Demonstration of CNC lathe operation.
8. Temperature controller with PID controller.
9. Stepper motor control using microcontroller.
10. Study of single acting and double acting cylinder.

List of Assignments:

1. Identify and write a report on different types of robots used in various industries.
2. Write a report on any three applications of MEMS in auto motive field.

List of Equipments:

1. PID Controller for Temperature control.
2. Micro controller kits and stepper motor interface card.
3. Single acting and double acting cylinder.
4. 8 DI / DO programmable logic controller.
5. CNC lathe machine

Learning Resources:

Books:

| Sr. No. | Author | Title | Publisher |
|---------|--|---|---------------------------------|
| 01 | K. P. Ramachandran, G. K. Vijayaraghavan, M. S. Balasundaram | Mechatronics - Integrated Mechanical electronic systems | Wiley-India |
| 02 | M. D. Singh J. G. Joshi | Mechatronics | PHI Learning Private Limited |
| 03 | W. Bolton | Mechatronics | Pearson |
| 04 | Nitaigour Premchand Mahalik | Mechatronics Principles, Concepts and Applications | Tata McGraw Hill |
| 05 | Appuu Kuttan K.K | Introduction to Mechatronics | Oxford |
| 06 | A.Smaili, F. Mrad | Mechatronics Integrated technologies for Intelligent Machines | Oxford |

Websites:

www.sc.leadix.com/mechatronics
www.cncsimulator.com
www.users.bergen.org/idefalco/CNC
www.plctutor.com