

SUBJECT NAME: MECHATRONICS

QUESTION BANK
UNIT-I
INTRODUCTION TO MECHATRONICS
(2 MARK QUESTIONS)

1) Define mechatronics?

Mechatronics brings together the areas of technology involving sensors and measurement system, drive and actuation system, analysis of behavior of the system, control system and microprocessor system.

2) What is meant by system in mechatronics?

The system is a group of physical component combined to perform a specific function. Any mechatronics devices consist of system.

3) What are the main applications of mechatronics?

Washing machines, dish washers, micro ovens, cameras, atm and camcorders.

4) What are the types of control systems?

- a) Closed loop system
- b) Open loop system

5) Obtain the basic function of control system?

- a) To minimize the error between the actual and desired output
- b) To minimize the time response to load changes in the system.

6) List down the requirements of control system?

- a) Stability
- b) Accuracy
- c) Response

7) Give example for closed loop system and open loop system?

- a) Closed loop system-automatic water level controller
- b) Open loop system-electric fire.

8) Mention the examples of automatic system?

- 1) Furnace pressure control system
- 2) Temperature control in a metal melting furnace

9) Name elements of feed back system?

- a) Forward path
- b) Feed back path
- c) Error detecting device
- d) Amplifier
- e) Compensating network

10) Name few elements of engine management system?

- a) Engine temperature
- b) Solenoid

- c) Fuel injection nozzle
- d) Spark timing

11) What is a sensor?

A sensor is an element in measurement system that acquires a physical parameter and changes it into signal.

12) What is transducer?

Transducer is related to conversion of energy from one form to another form, especially between two physical parameters.

13) Define error?

Error may be defined as the difference between the measured value and the true value.

14) What is hysteresis?

Hysteresis is defined as the difference in the output for a given input when this value is approached from the opposite direction.

15) What is resolution?

It is the smallest increment in the measured value that can be detected with certainty by the instrument.

16) State the dynamic characteristics of simplified measuring system?

- 1) Speed of response
- 2) Lag
- 3) Fidelity
- 4) Dynamic error

17) State the purpose of using potentiometer in displacement sensor?

A potentiometer can be used to convert rotary or linear displacement to a voltage.

18) What are the types of strain gauge?

- a) Unbounded strain gauge
- b) Bonded strain gauge
- c) Fine wire strain gauge

19) Mention the types of electrical strain gauges?

- 1) Inductive
- 2) Capacitive
- 3) Piezo electric
- 4) Resistance types

20) Name few materials used in binding of strain gauge?

- a) Ceramic cement
- b) Epoxy
- c) Nitrocellulose

21) What is tachogenerator?

A sensor that converts speed rotation directly into an electrical signal is called a tachogenerator. It is used to convert angular speed into a directly dependent voltage signal.

22) Write the advantages of tachogenerator?

- a) Direction of rotation is directly indicated

b) Conventional type dc voltmeters are sufficient to use with.

23) What are the instruments used to measure linear velocity?

- 1) Electromagnetic transducer
- 2) Digital transducer
- 3) Transducers with Doppler Effect.

24) Mention some instruments that measure angular velocity?

- a) Hand speed indicators
- b) DC and AC tachogenerator
- c) Photoelectric tachometer
- d) Stroboscope

25) what are the types of bimetallic sensors?

- a) Spiral type
- b) Helix type
- c) Flat type
- d) Cantilever type

(8MARK QUESTIONS)

1. What are the basic elements of a closed loop control system?

2. What is a RTD?.Explain the relationship between resistance and temperature for the RTD with temperature resistance curve?

3. Identify the various elements of a closed loop control system in an automatic water level controller and describe their functions.

4. Explain the function of a capacitive sensor in a robot end effectors?

5. Compare and contrast the control system for the domestic central heating system involving a bimetallic thermostat and that involving a microprocessor?

Explain the static characteristic of a sensor?

6. Write short notes on

- (a) Thermocouple
- (b) Piezoelectric transducer
- (c) Incremental encoder
- (d) Photovoltaic transducer

(7) Briefly explain any two mechatronics system with example

(8) Explain the following terms

- (i) Sensitivity
- (ii) Hystereisis error
- (iii) Stability
- (iv) Resolution

(9) Explain the working principle of

- (I) light sensor
- (ii) Fluid sensor to determine the level of fluid in a container
- (iii) Velocity sensor

(10) Explain with a neat sketch the working principle of tachogenerator

(11) Explain wit a neat sketch microprocessor based controllers.

(12) Explain the different methods by which fluid pressure can be measured.

UNIT 2
ACTUATION SYSTEMS
(2 MARK QUESTIONS)

1) Mention various components of hydraulic system?

- a) Motor b) filter
- c) Pump d) pressure regulator
- e) Control valve.

2) What is called pneumatic system?

Systems using gas for power transmission are called pneumatic system and industrial systems are usually based on air.

3) List the various components of pneumatic system?

- a) Motor driven compressor
- b) Air receiver
- c) Directional control
- d) Pneumatic cylinder

4) what is the purpose of using filter in hydraulic system ?

Filters are used to prevent dirt and dust entering important elements of the hydraulic system like valves, seals etc. filters are used to remove very finer particles.

5) What are the factors to be considered for selecting compressors?

The type of air compressors is selected dependent upon quality of air , pressure, and cleanliness.

6) List the types of compressor?

- a) Reciprocating compressor?
- b) Rotary compressor?
- c) Flow compressor?

7) State the purpose of providing air dryer?

The aim is to reduce the temperature of the air to a dew point which ensures that the water in the air condenses and drops out easily.

8) List different control valves?

- a) Direction control valve
- b) Non return valve
- c) Flow control valve
- d) Pressure control valve
- e) Solenoid valve

9) Write objectives of DCV's?

The directional control valves are used for controlling the passage of a fluid signal. This is done by generating, canceling or redirecting signals.

10) How are DCV's classified?

- a) Signaling elements
- b) Processing elements
- c) Power elements or final control elements.

11) What do you mean by logic values?

A processing element is normally known as logic values. They generate or cancel, redirect signals depending on the desired control conditions.

12) Define actuator?

An actuator is an output device which performs useful work.

13) What is meant by cylinder sequencing?

Process control pneumatics involves control problems where simple actions follow each other in an order.

14) List types of pneumatic control valve?

- 1) The pressure to close or air to close or fail open control valve
- 2) The pressure to open or air to open or fail closed control valve.

15) Define degrees of freedom?

The minimum number of independent displacement required to specify the system completely is called degrees of freedom.

16) What is gear train? State its function.

A gear train is a combination of two or more gears used to transmit motion from one shaft to another.

17) Classify gear trains.

- 1) Simple gear train
- 2) Compound gear train
- 3) Reverted gear train
- 4) Planetary gear train.

18) Where are belt drives used?

Belt drives are used to transmit power from one shaft to another by means of pulleys for longer distance.

19) List the types of belts

- a) Flat belt
- b) v-belt
- c) Circular belt or rope
- d) Timing or synchronous belt.

20) What is bearing?

A bearing is a stationary machine element which supports rotating shafts or axles and confines the motion.

21) Note the materials used for bearings

- a) Lead base Babbitt
- b) Tin base Babbitt
- c) Leaded bronze

22) What are the factors to be considered for selecting solenoids?

- a) The size of mechanical load
- b) The movement distance of plunger

- c) The type of electrical connections.
- 23) What is the principle of relay?
Relay is used for many control functions and essentially an electromechanical switch. It uses basic switching principles and solenoid actuation.
- 24) List the features of JFET?
a) Very high impedance
b) Less operational variation with respect to temperature
c) Noise problem-minimized
- 25) List the features of synchronous motor.
1) It operates at a current speed from load to full load.
2) Power factor of the motor can be controlled easily.

(8MARK QUESTIONS)

- (1) Two cylindrical parts of different height are produced and made to move in a conveyor and randomly placed. Tolerance in height is specified for both the parts. Give the schematic diagram for measuring the height of both the parts and counting them by the proper sensor.
- (2) Explain ratchet and pawl mechanisms
- (3) Explain the function of air filter with a neat sketch
- (4) Write short notes on linear actuator with a neat sketch
- (5) Discuss the following actuation system
(i) Self excited wound field shunt configuration dc motor
(ii) Self excited wound field series configuration dc motor
(iii) Stepper motor
(iv) Induction motor
- (6) A flat belt, 7mm thick and 95mm wide transmits power between two pulleys running at 1500 rpm/min. The mass of the belt is .85kg/mlength. The angle of lap in the smaller pulley is 155 and the coefficient of friction between the belt and pulley is 0.25. If the maximum permissible stress in the belt is 2MN/m^2 , find the maximum power transmitted and initial tension in the belt.
- (7) Compare the functions of series wound D.C. motor and shunt wound D.C. motor.
- (8) Explain the specification of a stepper motor. In detail
- (9) A hydraulic cylinder is to be used to move a work piece in a manufacturing operation through a distance of 50mm in 10sec. A force of 10KN is required to move the workpiece. Determine the required working pressure and hydraulic liquid flow if a cylinder with a piston diameter of 100mm is available.

Unit-3

SYSTEM MODELS AND CONTROLLERS

(2 MARK QUESTIONS)

1. What is damper?
A damper is a mechanical component that provides damping in the motion control and is a force experienced when an object is moved through a fluid.
2. Define the term electromechanical systems.
The device which converts electrical input signal into a mechanical output signal is known as electromechanical systems.
3. Define thermal capacitance.

This is the measure of an object to store heat and is related to the rise in temperature with heat transfer.

4. What is the function of hydraulic power system?

A hydraulic power system converts the hydraulic pressure into translational or rotational motion.

5. How do you define pneumatic system?

A pneumatic system supplies air to the pressure vessel through a pipe line and resistance to flow is provided by a constriction.

6. What is a block diagram?

A block diagram is a pictorial representation of the cause and effect relationship between the input and output of a physical system.

7. Define transfer function.

The ratio of the lap lace transform of the output variable to the lap lace transform of the input variable with all initial conditions assumed to be zero.

8. State the purpose of control system.

The aim of the control system is to maintain the fluid level in the tank at the desired value. The fluid level in the tank can be controlled by changing the water flow.

9. What is meant by steady state error?

The difference between the steady state value and the input value is known as steady state error. It is a measure of the accuracy of a control system

10. What does marginally stable invariant system mean?

A linear time invariant system is marginally stable if the natural response neither decays nor oscillates as time approaches infinity.

11. Define control law.

The relationship between the output and the input to the controller is often called the control law.

12. Define proportional band.

The constant gain tends to exist only over a certain range of errors, this range being called the proportional band.

13. Mention the advantages of integral control.

An advantage of integral control is that the type number of the system is increased by due to the introduction of an s term denominator. However, the relative stability of the system has been reduced.

14. Why do we need to take care while using derivative control?

Derivative control is thus must be used with great care and usually with small gain as rapid change of error can cause large, sudden changes of controller output.

15. How can adaptive controllers be defined?

The controllers which change the controller's parameter to adapt to the changes and fit the circumstances prevail.

16. Where are self-tuning necessary?

Self tuning control is essentially implemented in discrete time and is an auto-tuning controller.

17. What is a gray code?

The gray code is a code in which only one bit in the code group changes in going from one number to the next.

18. What is meant by logic gate?

A logic gate performs a logical operation on one or more logic inputs and produces a single logic output.

19. What does truth table refer

A truth table is a table that describes the behavior of a logic gate. It lists the value of the output for every possible combination of the input.

20. Define encoding and decoding processes.

Encoding is the process of generating the code for any given symbol. Decoding is the process of determining the symbol for any given code.

21. What is a microcomputer?

When a microprocessor is packaged in a printed circuit board with other components, such as interface and memory chips, the resulting assemble is referred to as a microcomputer.

22. How are microcontrollers described?

When a microprocessor is packaged in a same chip with other components, such as I/O interface and memory, the resulting assembly is known as microcontrollers.

23. What is memory mapping?

Allocating addresses for the memory or I/O is called memory mapping

(8MARK QUESTIONS)

(1)Derive a mathematical equation for a machine mounted on the ground to study the effects of ground disturbances on the machine bed displacement.

(2) Compare the control system performance for a system with proportional control and s sytem with integral control.

(3)Derive a mathematical differential equation for governing a system of electric motor.

(4) Explain the characteristics of PID controller.

(5)A hot object with capacitance C and temperature T , cools in a large room at temperature T_a . If the thermal system has a resistance R , derive an equation describing how the temperature of the hot object changes with time and give an electrical analogue of the system.

(6)Prepare a model for a stepped shaft used to rotate a mass and derive an equation relating the input torque and the angular rotation. Neglect the damping effect.

(7)Describe and compare the characteristics of proportional controller and proportional plus integral controller.

(8) Describe adaptive control and digital logic controller

(9) What are the functions of interfacing circuit

(10)Explain the difference between a parallel and serial interface.

(11) Explain the term hand shaking in microprocessor.

UNIT-4

PROGRAMMING LOGIC CONTROLLERS

(2 MARK QUESTIONS)

1. Define a programmable logic controller.

A programmable logic controller (PLC) is a microprocessor based controller that uses a programmable memory to store instructions and to implement functions such as logic, sequencing, timing, counting and arithmetic in order to control machines and process

2. What are the main component parts of a PLC?

1. Central processing unit (CPU)
2. The input/output unit
3. The programming device
4. Memory unit.

3. What is the function of programming devices?

The programming device is used to enter the required program using ladder logic into the memory of the processor. The sequence of operation and ultimate control of equipment or machinery is specified and determined by ladder programme.

4. List various types of PLC programming devices.

1. Use of hand held programmer
2. Terminal with video display unit
3. A personal computer with appropriate software.

5. List down the types of buses required in a PLC.

1. Data buses for communications data between elements.
2. The address buses to read the address of locations for accessing stored data.
3. Control buses for internal control actions.

6. What is ALU? State its function.

The ALU is responsible for data manipulation and performs arithmetic and logical operations such as addition and subtraction. In addition, the ALU contains a number of control inputs, which specify the data manipulation function to be performed. ALU is combinational logic circuit, whose output is an instantaneous function of its data and control inputs.

7. Highlight the important role of control unit.

The control unit is used to control the timing of operation and to control the units within the microprocessor to ensure that operations are carried out in the correct order.

8. What is RAM?

Random access memory is for the user's program and data storage is designed so that information can be written into or read from the memory and normally incorporated in the solid-state form contained in a integrated circuit.

9. What is meant by program scan?

A PLC does control the machine by taking repeated snapshots of the input state and reads to take the values, and energize or de-energize outputs according to the user programme. This process is known as a program scans.

10. What is meant by a "retentive timer"?

A retentive timer accumulates time as and when it receives the power and time due to loss of power which will not be accounted for the timer coil operation. Retentive on delay timer will hold its accumulated value when the timer rung goes false and will continue timing where it left off when the timer rung goes true again.

11. What are counters?

Counters allow a number of occurrences of input signals to count or record the number of times some event occurs. PLCs include some form of counting element and are set to some preset number value. When this value of input pulse has been received, it will operate its contact, the normally open contacts would be closed and a normally closed contact would be opened.

12. Write down various types of counters.

1. Down counters
2. Up-counters

13. When are cascaded counters needed?

In some applications, it may be required to count events that exceed the maximum number allowable per counter instruction. The counters are programmed in series to produce an output in way that the output of first counter is programmed into the input of the second counter.

14. At what conditions master control is used?

It is often necessary to provide means of executing sections of the control logic when certain criteria are realized. They include instructions comprising the override instruction.

15. How does jump control work?

The jump instruction is an output instruction enabling part of a ladder program to be jumped over. With jump instruction, the processor scan time can be reduced by jumping over instructions not pertinent to the machine operation thereby missing intermediate program and can skip instruction when a production fault occurs.

16. Categorize data manipulation in shift registers.

1. Data transfer
2. Data comparison.

17. List down PLC programming methods.

1. Structured text
2. Ladder diagrams
3. Function block diagram
4. Sequential function charts
5. Instruction list

18. What are the types of memory?

1. Random Access Memory
2. Read Only Memory (ROM)

19. Mention various tasks of CPU.

1. Provide a mechanism for fetching instruction from memory prior to execution.

2. Include logic which decodes the operation code of each instruction to generate low level control signal which perform data manipulation specified by the instruction.

20. List down the different types of timers.

1. On delay timer
2. Off delay timer
3. Retentive timer
4. Pulse delay.

(8MARK QUESTIONS)

(1) Sketch the basic architecture of a PLC and explain the function of each element.

(2) Explain how a PLC can be used to handle an analog input.

(3) Draw the ladder diagram to represent

(i) Two switches are normally open and both have to be closed for a motor to operate.

(ii) Either of two, normally open, switches has to be closed for a coil to be energized and operate an actuator.

(iii) a motor is switched on by pressing a spring –return push button start switch and the motor remains on until another spring –return push button stop switch is pressed.

(4) Derive a system using, using a PLC that could be used with a conveyor belt which is used to move an item to work station. The presence of item, at the work station IS DETECTED BY means of breaking a contact activated by a beam of light type a photosensor. there it stops for 100 sec

UNIT – 5

DESIGN OF MECHATRONICS SYSTEMS

(2 MARK QUESTIONS)

1. What are the stages in designing a mechatronic system?

Or

Mention the stages in designing a mechatronics system.

- i. Need for design
- ii. Analysis of problem
- iii. Preparation of specification
- iv. Generation of possible solution
- v. Selection of suitable solution or Evaluation
- vi. Production of detailed design
- vii. Production of working drawing

2. Mention any four statements about the problem definition.

- ❖ Mass and dimensions of design
- ❖ Type and range of motion required
- ❖ Accuracy of the element
- ❖ Input and output requirements of elements.

3. Generation of possible solution stage is called as

Conceptualization stage.

4. Distinguish between traditional design approach and Mechatronics approach.

The design of Mechatronic system is different from that of traditional systems.

Justify.

S.No	Traditional design	Mechatronics design
1.	It is based on a traditional system such as mechanical, hydraulic and pneumatic	It is based on mechanical, electronics, computer technology and control engineering.
2.	Less flexible	More flexible
3.	Less accuracy	More accuracy
4.	More complicated mechanism in design	Less complicated mechanism in design
5.	It involves more components and moving parts.	It involves fewer components and moving parts.

5. How a traditional design of temperature control of domestic central heating system is improved by mechatronic design?

The traditional design of the temperature control for a central AC system involves a bimetallic thermostat in a closed loop system. The basic principle behind this system is that the bending of the metallic strip changes as the temperature changes and is used to operate ON/OFF switch for the temperature control of the AC system. The same system can be modified by mechatronics approach. This system uses a microprocessor controlled thermo couple as the sensor. Such a system has many advantages over traditional systems. The bimetallic thermostat is less sensitive compared to the thermo diode.

6. What are the requirements satisfied before starting the timer?
- ❖ Start the pulse applied.
 - ❖ Check the timer whether it is ON or OFF condition.
 - ❖ The timer should be in OFF condition before triggering.

7. How can delay be varied in a simple program?

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DELAY      LDX      DATA
LOOP      DEX
          BNE      LOOP
          RTS

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8. What are the advantages of PLC system?

In PLC system, the time duration can be easily adjusted by changing the timer present values (i.e., DATA) in the program whereas the traditional system requires various size of the cams.

9. What is a windscreen wiper?

Windscreen wiper is a device which is used to clean the front glass of cars, buses train etc., during rainy days.

10. What are the configurations in operating stepper motor?
- Full-step configuration.
 - Half-step configuration.
11. Write the basic steps of the program to run a stepper motor.
- Advance a step by applying a data.
 - Call time delay routine to complete a step.

- Repeat step and step2 until the required number of steps completed in forward direction.
- To reverse the direction of stepper motor, the same steps given above are repeated in the reverse order of data.

12. What is the function of decoder?

Decoder is used to convert the data from micro controller into seven segment data to glow the LED segments.

13. What are the various movements of robots?

- Clockwise and anticlockwise rotation of robot unit in its base.
- Linear movement of the arm horizontally i.e., extension or contraction of arm.
- Up and down movement of the gripper.

14. Name the two barriers used in automatic car parking system and state its uses.

There are two barriers used namely in barriers and out barriers. In barriers is used to open when the correct money is inserted while out barrier opens when the car is detected in front of it.

15. List the various sensors contained in engine management system.

Temperature sensor hot wire anemometer oil and pressure sensors oxygen sensor.

16. What is an engine management?

An electronic engine management system is made up of sensors, actuators, and related wiring that is tied into a central processor called microprocessor or microcomputer (a small version of a computer).

17. What are the uses of sensors?

They detect a mechanical condition (movement or position), chemical state, or temperature conditioning and change it into electrical signals that can be used by the microcomputer which makes decisions based on information it receives from sensors.

18. Point out the two important operations categories of sensors in engine management.

i. Reference voltage sensors

Reference voltage sensors provide input to the microprocessor by modifying or controlling constant, predetermined voltage signal.

ii. Voltage generation sensors

This varying voltage signal, when received by the microprocessor enables the microprocessor to monitor and adjust for changes in the computerized engine control system.

19. List out the various sensors used in engine management system.

- I. Throttle-position sensors
- II. Exhaust Gas Oxygen (EGO) sensors
- III. Manifold Absolute Pressure (MAP) sensors
- IV. Temperature sensors
- V. Speed/Timing sensors
- VI. Engine position sensor
- VII. EGR diagnostic switch
- VIII. EGR Valve position sensor
- IX. Coolant temperature sensor
- X. Intake air temperature sensor
- XI. Mass Airflow (MAF) sensor
- XII. Crankshaft position sensors
- XIII. Knock sensor

(8MARK QUESTIONS)

- (1) What are the different stages in designing a mechatronics system, explain in detail?
- (2) Explain in detail what is the difference between Traditional and Mechatronic Design with an example?
- (3) Discuss the possible design solutions for a pick and place robot?
- (4) Design a mechatronics system for an automatic washing machine?
- (5) Design a mechatronics system for an automatic Car Park Systems?
- (6) Design a mechatronics system for an Engine Management Systems with a neat sketch?
- (7) Design a mechatronics system for a bottling system where bottles are segregated by height when moving on a conveyor system?
- (8) Design a mechatronics system for a bottling system where bottles are segregated by defect at the crown of the bottle when moving on a conveyor system?
- (9) Design a mechatronics system for an automatic windscreen wiper in Car Systems?
- (10) Design a mechatronics system for an automatic camera?
- (11) Design a mechatronics system for an automatic room heating system?