**AALIM MUHAMMED SALEGH COLLEGE OF ENGINEERING**

**DEPARTMENT OF MECHANICAL ENGINEERING**

**QUESTION BANK**

**DEPARTMENT: MECH SEMESTER: VII**

**SUBJECT CODE / Name: ME 2401/MECHATRONICS**

**PART-A**

**UNIT –I**

**MECHATRONICS, SENSORS AND TRANSDUCERS**

**1**. **What are the elements in typical mechatronics systems**?

1. Actuators and Sensors
2. Signals and Conditioning

c) Digital Logic Systems

1. Software and Data Acquisition systems
2. Computers and Display devices.

**2. What are the types of mechatronics systems?**

1. Class I: Primarily mechanical products with electronics incorporated to enhance functionality.
2. Class II: Traditional mechanical systems with significantly updated internal devices incorporating electronics. The external user interfaces are unaltered.
3. Class III: Systems that retain the functionality of the traditional mechanical system, but the internal mechanisms are replaced by electronics.
4. Class IV: Products designed with mechanical and electronic technologies trough synergistic integration.

**3. What are the main applications of mechatronics?**

1. NC & CNC machine tools, rapid prototyping & robots
2. Computers disk drives & VCR/DVD drives
3. Photocopiers, Laser printers & fax machines
4. Automatic washing machines, dish washer, rice cooker, & automatic ovens
5. Automatic teller machine (ATM)
6. Automatic/digital camera, digital watch

**4. How the control systems are classified?**

Control systems are classified into two groups:

1. Open loop control systems
2. Closed loop or feedback control systems

**5. What are the basic functions of control systems?**

1. To minimize the error between the actual and the desired output;
2. To minimize the time response to load changes in the system.

**6. What are the advantages and disadvantages of mechatronics systems?**

Advantages:

1. Cost effective and good quality products
2. High degree of flexibility to modify or redesign

3. Very good performance characteristics

4. Wide area of application

5. Greater productivity in case of manufacturing organization.

6. Greater extend of machine utilization.

Disadvantages:

1. High initial coast
2. Multi- disciplinary engineering background required to design and implementation.
3. Need of highly trained workers.
4. Complexity in identification and correction of problems in the systems.

**8. What is transducer? How the transducer differs from sensor?**

Transducers axe devices which converts an input of one form of energy' into an output of another form of energy. The term transducer is often used synonymously with sensors. However, ideally, the word 'transducer' is uses for the sensing element itself whereas the term 'sensor' is used for the sensing element plus any associated signal conditioning circuitry.

**9. How do you classify the sensors?**

 Based on its power requirement sensors are generally classified into types: 1. Passive sensors and 2. Active sensors

Based on the type of output signal sensors can also be classified also be classified as : 1. Analog sensors and 2. Digital sensors

Based on the relationship between the input and output sensors are generally classified into two types: 1. Primary sensors and 2. Secondary sensors.

Based on the Quantity to be measured sensors are classified as

1. Displacement sensors, and 2. Proximity sensors, 3. Force, torque, and pressure sensors, 4. Velocity, and acceleration sensors, 5. Flow sensors, 6. Level sensors 7. Temperature sensors, 8. Light sensors

**10. State the difference between primary and secondary transducers.**

Primary sensors produce the output which is the direct measure of the

 input phenomenon. Secondary sensors on the other hand produce output

 which is not the direct representation of the physical phenomenon. Mostly

 active sensor are referred as primary sensors where as the passive

 sensors are referrer secondary sensors.

**11. What do you understand by the term static and dynamic characteristics of transducers?**

 Static characteristics of an instrument are the parameters which are more or less constant or varying slowly with time.

 Dynamic characteristics of an instrument are the parameters which are varying with time.

**12. Define error.**

Error is the difference between a measured value and the true input value.

Error = Measured value – True input value

**13. What is meant by steady state and transient state?**

 An output whose magnitude has a definite repeating time cycle is called steady state periodic. An output whose magnitude does not repeat with time is known as transient.

**14. State the dynamic characteristics of simplified measuring system.**

1. Response time, ii) Time constant, iii) Rise time, iv) Setting time

**15. State the purpose of using potentiometer in displacement sensors.**

 Potentiometer is a primary sensor which converts the linear motion or the angular motion of a shaft into changes in resistance.

**16. What are the factors to be considered while selecting the potentiometers?**

1. Operating temperature
2. Shock and vibration
3. Humidity
4. Contamination and seals
5. Life cycle

**17. How the output of strain gauge is measured?**

 The change of resistance of strain gauge is very small and is usually

Measured using a Wheatstone bride circuit where the strain gauge is connected into the circuit with a combination of four active gauges for full bridge, two gauges for half bridge, or a single for quarter bridge.

**18. How the strain gauges are classified based on its construction?**

 Bonded foil types – They consist of a pattern of resistive foil which is mounted on a backing material.

 Wire wound gauges are made of round wire of copper nickel, chrome nickel or cancel iron alloys, about 0.0025 in diameter.

**19. What is meant by RVDT?**

 Rotational Variable Differential Transformer (RVDT) is used to measure rotational angels and operates under the same principles as the LVDT sensor. Whereas the LVDT uses a cylindrical iron core, the RVDT uses a rotary ferromagnetic core.

**20. Explain “Hall effect” as stated by E.R.Hall.**

 When a current-carrying conductor is placed into a magnetic field, a voltage will be generated perpendicular to both the current and the field. This principle is known as the Hall Effect.

**21. What is photoelectric sensor?**

 A photoelectric sensor is a device used to detect the distance, absence, or presence of an object by using a light transmitter, often infrared or LED, and a photoelectric receiver.

**22. Define: Optical encoder.**

 An optical encoder is a device that converts motion into electrical pulses. Theses electrical pulses are encoded into required form for the measurement of displacement.

**23. Briefly explain the working principle of temperature sensor.**

Most of the temperature measuring system uses the principle of expansion or contraction of liquids. Gases, or solids when the temperature varies. There are also other techniques such as change in electrical resistance of conductors and semiconductors, and thermoelectric e.m.f.s. used to measure the temperature.

**24. What is the principle of operation of RTD?**

 When a metal wire is heated the resistance increases. So, a temperature can be measured using the resistance of a wire.

**25. What are the laws of thermocouples?**

1. Law of intermediate metals
2. Law of intermediate temperature
3. Law of homogeneous material

**UNIT – II**

**ACTUATION SYSTEMS**

**1. Write down the applications of fluid systems.**

Fluid power technology over the years has continuous development involved the applications of pneumatic and hydraulic systems in several areas, like

1. Manufacturing,
2. Process industries,
3. Transportation systems, and
4. Utilities.

**2. State the advantages of fluid systems.**

1. Air is available everywhere in enormous quantities.
2. Transporting air and hydraulic fluid will be easy through pipe line over large distances.
3. Storing of compressed air will be easy in a reservoir and removed as required. Hydraulic oil can be stored in accumulators.
4. Compressed air is too sensitive with temperature fluctuation but hydraulic fluids are insensitive.
5. Compressed air offers minimal risk of explosion or fire.
6. The construction of components in fluid system is simple in construction and cheap.

**3. What are the disadvantages of fluid systems?**

1. Good preparation of compressed air and hydraulic fluid required remove the dirt and condensate.
2. Speed fluctuation will always be with pneumatic systems.
3. The working pressure of compressed air is limited to 6-7 bar.
4. The exhaust -tir will release with very high noise thereby leading noise pollution.
5. Producing compressed air and hydraulic fluid are expensive.

**4. Mention various components of a hydraulic system.**

1. Hydraulic pump unit
2. Control valves
3. Reciprocating or rotary unit.

**5. What is called hydraulic accumulator?**

A hydraulic accumulator is an energy storage device. It is a pressure storage reservoir in which a fluid is held under pressure by compressed gas or a sprit raised weight.

**6. State the reasons why accumulator is used in hydraulic systems.**

1. The pump does not need to be so large to cope with extremes of demand.
2. The supply circuit can respond more quickly to any temporary demand and to smooth pulsations.

**7. What is the function of hydraulic pumps in a hydraulic system?**

A pump is a device which converts the mechanical energy supplied in to hydraulic energy by lifting water to higher levels. Here, hydraulic energy refers to potential and kinetic energy of a liquid. Hydraulic pumps are the energy-absorbing machines.

**8. State any four advantages and disadvantages of hydraulic systems.**

Advantages of hydraulic systems

1. It is easy to produce and transmit hydraulic power.
2. Hydraulic systems are uniform and smooth.
3. Balancing hydraulic forces is easier.
4. Weight-to-power ratio is less.

Disadvantages of hydraulic systems

1. Manufacturing cost of the system is quiet high.
2. Hydraulic elements should be kept free from dirt, corrosion, rust etc.,
3. Petroleum based hydraulic systems more prone to fire hazards.
4. Hydraulic power is not readily available as pneumatic.

**9. State the advantages of belt drives?**

1. Easy, flexible equipment design, as tolerances are not important.
2. Isolation from shock and vibration between driver and driven system.
3. Driven shaft speed conveniently changed by changing pulley sizes.
4. Belt drives require no lubrication.
5. Maintenance is relatively convenient
6. Very quiet compared to chain drives, and direct spur gear drives.

**10. List down the types of belt drives.**

1. Open belt drive
2. Crossed belt drive
3. Belt drive with idler pulleys

**11. State the reason why crossed belts transmit more power than open belts.**

The power transmitting capacity of a crossed belt drive is more than an open belt drive as the angle of wrap is more.

**12. Classify belts.**

1. Flat belt
2. V- belt
3. Round belt
4. Timing belt.

**13. How do chain drives differ from rope and belt drives?**

In a belt, and rope drive, there is a chance of slipping and hence a constant velocity ratio cannot be obtained. A belt can be replaced by a chain whenever there is a need to have a constant velocity ratio or positive drive. There is no slipping in case of a chain drive.

**14. State the advantages of chain drives.**

1. As no slip takes place during chain drive, hence perfect velocity ratio is obtained.
2. Since the chains are made of metal, therefore they occupy less space in width than a belt or rope drive.
3. It may be used for both long as well as short distances.
4. It has the ability to transmit motion to several shafts by one chain only.

**15. List down the factors to be considered for the selection of bearings.**

1. The load-carrying capacity and the nature of the load.
2. The speed of shaft in r.p.m.
3. The type of service under given conditions such as temperature, humidity, dustiness, acidity, etc.
4. The anticipated life of the bearing.
5. Magnitude and direction of loads.
6. The proportion of thrust to radial load.

**16. What is an actuator?**

A mechanical device which has motion (or) movement is known as actuator.

**17. What is electrical actuator?**

An actuator which can receive electrical energy for motion is known as electrical actuator.

**18. Write the examples for electrical actuators?**

1. Solenoid,
2. Electrical motors,
3. D.0 motor,
4. A.0 motor,
5. Stepping motor.

**19. What are the two major parts in solenoid?**

Coil and movable iron core.

**20. What are the types of D.0 motors?**

1. Series wound motor,
2. Shunt wound motor,
3. Compound motor,
4. Separately excited motor.

***21.* 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.

**22. What is Zeller voltage?**

In the reverse direction, the diode conducts very little when the voltage is below the breakdown value. This critical, limiting value of reverse voltage is known as Zener voltage.

**23. How are inputs or output connections made in transistor configuration?**

In a common base configuration, emitter is the input terminal, collector is the output terminal and base is the common terminal.

In a common emitter configuration scheme, base is the input terminal, collector is the output terminal and emitter is the common terminal.

In a common collector configuration, base is the input terminal, emitter is the output terminal and collector is the common terminal.

**24. Name three output characteristics of transistor configuration.**

1. Saturation region
2. Active region
3. Cut-off region

**25. List down the features of JFET.**

1. Very high impedance.
2. Less operational variation with respect to temperature.
3. Noise problem in communication is minimized.
4. Operating-frequency bandwidth is small.

**UNIT – III**

**SYSTEM MODELS AND CONTROLLERS**

**1. What is a mathematical model?**

 A mathematical model is used to understand the behavior of the system. It gives the relationship between the input and output of the systems by means of equations.

**2. What s a lumped parameter system?**

 The overall input, output relationship of the system can be obtained by combining the building blocks in an appropriate way. This type of obtained the mathematical model for a system is known as lumped parameter system.

**3. What is pneumatic Resistance?**

It is defined in terms of rim and (P1 — P2)

P R = (Pi P2

 m

**4. Define pneumatic Inertance?**

Pneumatic Inertance is due to the pressure drop necessary to celebrate lock. It is denoted by Ip. Ip = L

 A

**5. Define pneumatic capacitance.**

The capacitance which is due to the compressibility of the gas is pneumatic capacitance and it is denoted by Cp.

**6. What are the basic building blocks of thermal system?**

Resistance, Capacitance is the two building blocks of the thermal system

**7. What are electromechanical devices? Give examples.**

Electromechanical devices are used to transform electrical signal into motion (or) vice versa. Examples: potentiometers, motors, generators.

**8. What is a DC motor?**

D.0 motor is used to convert an electrical signal into mechanical output the current through the coil, the shaft is rotated. So, load is also rotated.

**9. What is a hydraulic power system?**

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

The input displacement of spool valve is translated into an output displacement of piston rod.

**10. What is hydraulic servo mechanism?**

The hydraulic power system can be converted into a feedback device with certain modifications and this forms hydraulic servo mechanism.

**11. What are reflective codes?**

A code is said to be reflective when the code for 9 is the complement of the code for 0, 8 for 1, 7 for 2, 6 for 3 and 5 for 4. Examples: 2421, 5211 and excess-

**12. What are sequential codes?**

A code is said to be sequential when each succeeding code is one binary number greater than its preceding code. This greatly helps mathematical manipulation data. Example: 8421 and excess-3 code.

**13. What are non-weighted codes?**

Non-weighted codes are codes that are not positionally weighted. This means that each position within a binary number is not assigned a fixed value. Example: gray code.

**14. Explain gray codes.**

Gray codes belong to a class of codes called minimum change codes, only one bit in the code group changes when moving from one step to the n(

**15. What are error detecting codes?**

During the process of binary data transmission, error may occur. In order to detect the errors, they are used.

**16. What is called parity check?**

The most simple and commonly used error detecting code method is the parity check in which an extra parity bit is included with the message to make the number of l's either odd or even resulting in two methods.

1. Even parity method (Number of 1's are even)
2. Odd parity method (Number of l's are odd)

**17. Explain Hamming code?**

R.M.Harnming developed a system that provides a methodical way to add one or more parity bits to a data character in order to detect and correct errors.

**18. Define sum of product [SOP]?**

The logical sum of two or more logical product terms is called a sum of products expression.

Example: Y = AB + BC + AC

**19. Define product of sums [P0S]?**

A product of sums expression is a logical product of two or more logical terms.

 \_\_

Example: Y = (A+ B) + (B+C) + (C +A)

**20. Define minterm.**

A product term containing all the variables of the function in complemented or uncomplemented form is called minterm.

**21. Define maxterm?**

A sum term containing all the variables of the function in either complemented or uncomplemented form is called maxterm.

**22. What are combinational circuits?**

The logic circuits whose output at any time depends only on the input signal present at that time are known as combinational circuits.

**23. What are sequential circuits?**

The logic, circuits whose output at any time depends not only on the present, input but also on the past outputs are called sequential circuits.

**24. What are the types of sequential circuits?**

Sequential circuits are of two types. They are

1. Synchronous (or) Clocked circuits.
2. Asynchronous (or) Unclocked circuits.

**25. Explain asynchronous sequential circuits?**

In asynchronous sequential circuits, events can occur after one event is completed and there is no need to wait for a clock pulse.

**UNIT – IV**

**PROGRAMMING LOGIC CONTROLLER**

**1. Define PLC.**

A programmable logic controller 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 inorder to control machines process.

**2. What are the components of a PLC.**

1. Central processing unit,
2. Input/Output modules, and
3. Programmer / Monitor.

**3. Draw the block diagram of PLC.**

 Programmer /

Monitor

 CPU

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| From sensor |  |  |  | Microprocessor |  |  |  |
|  |  |  |
| Input module | Output module |
| Memory |
|  |  |  |
|  |  |
|  |  |  |  |
| Power supply |
|  |  |  |

**4. 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.

**5. Define CPU**

The CPU is the brain of the PLC consists of a microprocessor which interprets the input signals and carriers out the control actions, according to the program stored in the memory.

**6. List out the various programming device.**

1. Keyboarded,
2. LCD unit, and
3. A Personal computer with appropriate software.

**7. Define memory unit.**

The Area of the CPU in which data and information is stored and retrieved. It holds the system software and user program.

 **8. What are the types of memory?**

1. Random-access Memory (RAM),
2. Read-only Memory (ROM),
3. Programmable Read Only Memory (PROM),
4. PROM and EEPROM.

**9. Compare PLC with computers.**

|  |  |  |
| --- | --- | --- |
| SI.No | PLC | Computers |
| 1 | PLC is very compact and not affected by the vibration and electrical effect etc. | Computer is very lessCompactable. |
| 2 | PLC can be easily handled by Unskilled persons. | Computers need the skilled persons with knowledge and software to handle. |

**10. List down the different types of timers. ( i) ON delay (TON),**

1. ON delay (TON)
2. OFF delay (TOFF)
3. Retentive timer (RTO)

**11. What is meant by retentive timer?**

Retentive on delay timer (RTO) will hold its accumulated value when the timer goes false and will continue timing where it left OFF when the timer rung goes again.

**12. What are counters?**

Counters allow a number of occurrences of input signals to count or record the fiber of times some event occurs. PLC includes some form of counting element are set to some preset number value.

**13. Write down the various types of counters.**

1. Down counters.
2. Up counters.

**14. What are the factors to be considered for selecting PLC?**

1. System definition,
2. Choosing the Input and Output hardware,
3. Analog Input/Output module,
4. Input and Output timing consideration,
5. Conversion speed
6. Analog closed control
7. Communications and choose the correct processor.

**15. What are the input/output devices used?**

Input devices:

1. Various sensors,
2. Switches like mechanical, proximity and photo-electric,
3. Encoders.

Output devices:

1. Motors,
2. Control valves,
3. Lamps, light etc.
4. Alarm.

**16. List down Input / Output modules interface.**

|  |  |  |
| --- | --- | --- |
| Sl. No. | Input interfaces | Output Interfaces |
|  | DC input unit. | Relay Output Unit. |
|  | AC Input unit. | Transistor Output Unit.i |
|  | ADC interface. | DAC interface |

**17. Define program scanning.**

The PLC control the whole process by reading the data from the input output is energised or deenergised according to the user program stored in the memory. This process is known as program scan.

**18. Draw the ladder diagram and truth table of NAND gate.**

 Symbol : Ladder login:

 IN1

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
|  YY |  |  |
|  |  |
|  |
|  | IN2 |

Truth Table:

|  |  |
| --- | --- |
|  Inputs |  |
| IN1 | IN2 | Output (Y) |
| 0011 | 0101 | 1110 |

**19. List down general application of PLCs for control.**

1. Control of a process motor, vibrating machine
2. Control of a two pneumatic pistons
3. Detection, sorting and packaging unit.

**20. How PLC differ from relay logic?**

1. Rewiring should be easily done in PLC
2. No vertical connections are allowed
3. In PLC, there must always be one output on each line.

**UNIT – V**

**DESIGN OF MECHATRONICS SYSTEM**

**1. What are the stages in designing a Mechatronics System?**

**or**

 **Mention the stages in designing a mechatronics system.**

1. Need for design
2. Analysis of problem
3. Preparation of specification
4. Generation of possible solution
5. Selection of suitable solution or Evaluation
6. Production of detailed design
7. Production of working drawing
8. Implementation of design

**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. Distinguish between traditional design approach and Mechatronics approach.**

|  |  |  |
| --- | --- | --- |
| **S. No** | **Traditional design** | **Mechatronics design** |
| 1 | It is based on a traditionalsystems such as mechanical, hydraulic and pneumatic systems. | It is based on mechanical,electronics, computer technologyand control engineering. |
| 2 | Less flexible. | More flexible. |
| 3 | Less accurate. | More accurate. |
| 4 | More complicate mechanism in design. | Less complicate mechanismdesign. |

**4. The design of Mechatronic Systems is different from that of traditional**

 **systems.**

In traditional design, the components are designed through mechanical, or pneumatic components and principles. But in a mechatronics mechanical, electronics, computer technology and control engineering principles are included to design a system.

**5. List the advantages of mechatronics design over traditional design.**

1. System serves the purpose effectively with high dimensional accuracy requirements.
2. It provides increased productivity in the industry.
3. It provides higher flexibility by presupplied programs which facilitates small volume production cycles.
4. Lead time in the manufacturing is reduced which results in lowering the production cost specially in mass production.
5. It facilitates automation in the production, assembly and quality control.
6. It facilitates in production of parts and products of international standards which gives better reputation and profit.
7. It improves the life of the system by proper maintenance and timely diagnosis of the faults.

**6. How traditional designs of temperature control of domestic central Heating wean is improved by mechatronic design?**

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

**7. 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

**8. How can delay be varied in a simple program?**

DELAY LDX DATA

LOOP DEX

BNE LOOP

RTS

**9. What are the advantages of PLC system in timed switch over traditional one?**

In PLC system, the time duration can be easily adjusted by changing the timer preset values in the program whereas the traditional system requires various sizes of the cams.

**10. What is a windscreen wiper?**

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

**11. What are the configurations in operating stepper motor?**

1. Full-step configuration.
2. Half-step configuration.

**12. Write the basic steps of the program to run a stepper motor.**

Step 1: Advance a step by applying a data.

Step 2: Call time delay routine to complete a step.

Step 3: Repeat step and step2 until the required number of steps completed in forward direction.

Step 4: To reverse the direction of stepper motor, the same steps given above are repeated in the reverse order of data.

**13. What is the function of decoder?**

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

**14. What are the various movements of robots?**

1. Clockwise and anticlockwise rotation of the robot unit on its base.
2. Linear movement of the arm horizontally i.e., extension or contraction of arm.
3. Up and down movement of the arm and
4. Open and close movement of the gripper.

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

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

**16. What is an electronic 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 smaller version of a computer).

**17. What are the uses of sensors in engine management?**

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

**18. What are the advantages of using a microprocessor in the p mechanical controller for a carburetor of an automobile**?

1. Microprocessor controller is more accurate in terms of supplying proper mixture air fuel ratio based on the variation of load.
2. It also avoids detonation by getting feedback from the knock sensor placed in the engine block.
3. It involves fewer components and moving parts and hence less wear and long life.

**19. Identify the sensor, signal conditioner and display elements in the bourdon pressure gauge.**

i) Sensor — Burdon tube is acting as sensor

ii) Signal conditioner — Ratchet & pinion mechanism is acting as signal conditioner

 iii) Display elements — Pointer is the display element.

**20. List down the various mechatronics elements in an automatic camera.**

1. Auto –focusing mechanism control
2. Aperture drive
3. Shutter drive
4. Mirror drive

v) Lens position encoder