

ME8791 - MECHATRONICS
UNIT – 1 INTRODUCTION

PART-A

- 1. Write an example for a transducer and state its transduction principle.**

(N/D 2012)

Transducer is a device which converts an input of one form of energy (pressure, temperature, displacement, force, etc.) into an output of another form of energy (mechanical, electrical, magnetic, etc.). For example, thermocouple is a transducer which converts change in temperature into a voltage.

- 2. State the advantages of capacitive type proximity sensor.**

(N/D 2012)

The advantages of capacitive type proximity sensor are:

- The system responds to average displacement of a large area in a moving electrode
- Excellent linearity over entire dynamic range when area is changed
- Capacitors are noiseless
- High accuracy, sensitivity and resolution

- 3. What is meant by RTD? State its applications.**

(N/D 2011)

Resistance Temperature Detector (RTD) is a resistance thermometer which is used to measure temperature by correlating the resistance of the RTD element with temperature.

- Precision process temperature control (Textile, chemical, food, brewing)
- Automatic temperature control (Test chambers, oven temperature, plastic extruders)

- 4. Distinguish between measurement system and control system.**

(N/D 2010)

S.No	Measurement system	Control system
1.	A measurement system involves the precise measurement and display/recording of physical, chemical, mechanical, electrical	A control system in mechatronics refers to a group of physical component connected or related in such a manner as to command direct or regulate itself or

	or optical parameters.	another system.
2.	Various elements of a measurement system are sensor or transducer, signal processor, display or recording device.	Several elements of a control system are reference variable, output, feedback, comparison element, correction element.

5. What are the key elements of a mechatronics system? (A/M 2010)

The key elements of a mechatronics system are:

- Actuators and sensors
- Signals and conditioning
- Digital logic systems
- Software and data acquisition system
- Computers and display devices

6. State the application of position and proximity sensor. (A/M 2010)

The applications of position sensor are

- IC engine ignition system timing
- Brushless DC motors to detect the position of permanent magnet
- Detection of moving parts
- Indexing of rotational or translational motion

The applications of proximity sensor are

- Computer mouse buttons and arcade game joysticks
- Door and window closure sensors in security applications

7. How is precision machine achieved in mechatronics system? (N/D 2009)

The use of nano-materials in manufacturing machine components by using mechatronics systems leads to more accuracy and high precision.

8. Define – Hysteresis (N/D 2009)

It is defined as the maximum differences in output for a given input when his value approached from the opposite direction. It is phenomenon which shows different outputs when loading and unloading. ‘

9. What is the working principle of an eddy current proximity sensor? (N/D 2008)

It detects the presence of a target by sensing the magnetic fields generated by a reference coil. An eddy current is a local electric current induced in a conductive material by the magnetic field produced by the sensor or active coil. This is sensed by a reference coil to create an output signal. When the distance between the target and the probe changes, the impedance of the coil changes. This change in impedance can be detected by a bridge circuit.

10. Write the different mechatronics systems used in automobiles. (ND 2008)

Automobile applications mechatronics include electronic engine management system, collision detection system, antilock braking system, keyless entry system, cruise control system and parking assistance system.

11. Write two factors that need to be considered in selecting a sensor for a particular application. (A/M 2008)

i. Accuracy required: It is difference between the measured value and the true value. Accuracy of the sensor should be as high as possible.

ii. Precision: It is the ability to reproduce repeatedly with a given accuracy. It should be very high. Error between sensed and actual value should approach zero.

iii. Sensitivity: It is the ratio of change in output to a unit change of the input. It should be chosen to allow sufficient output.

12. Distinguish between open-loop and closed loop system. (N/D 2007)

S.No.	Open-loop	Closed-loop
1.	It does not use a feedback to control the operation of the system	Closed loop operation uses a negative feedback
2.	The effects of known disturbances alone can be countered	The effects of disturbances are countered by virtue of negative feedback
3.	Less accurate	More accurate
4.	Simple in construction	Complicated in construction
5.	Slow response because of manual control	Closed loop can perform a task faster than open-loop

13. What is meant by signal conditioning? (N/D 2007)

A signal conditioning means manipulating an analog signal in such a way that it meets the requirements of the next stage for further processing. It performs filtering and amplification functions.

14. Define – Gauge factor (N/D 2010)

Gauge factor is the ratio of changes of the resistance per unit resistance to the strain.

15. Why are three concentric tracks used in an optical incremental encoder?

(A/M 2010)

The incremental encoder consists of two tracks and two sensors whose outputs are called channels A and B. As the shaft rotates, pulse train occur on these channels at a frequency proportional to the shaft speed and the phase relationship between the signals yields the direction of the rotation. Incremental encoders often have third channel called index channel with a single segment slot or reference yields one pulse per revolution which is useful in counting full revolutions. It is also useful as a reference to define a home base or zero position.

16. Define Mechatronics.

The term Mechatronics is used for the integration of microprocessor control system, electrical systems and mechanical systems. Mechatronics is defined as the integration of precision mechanical & electronic control or the development of smart products & process.

17. What are the various elements of a closed loop system for a person controlling the temperature?

The various elements of a closed loop system are,

- Controlled variable
- Comparison element
- Error signal
- Control unit
- Measuring device

For example,

Controlled variable - The room temperature Reference value (The required room temperature)

Comparison element - The measured value compared with the required value of temperature.

Error signal - The difference between the measured and required temperatures
Control unit - The person
Correction unit - The switch on the fire
Process - The heating by the fire
Measuring device - A thermometer

18. What is the larger scale application of Mechatronics?

A larger scale application of Mechatronics is a Flexible Manufacturing engineering System (FMS) involving computer – controlled machines, robots, automatic material conveying and overall supervisory control.

19. List some of the applications of Mechatronics?

- Home Appliances: Washing machine, Bread machines etc
- Automobile: Electrical fuel injection, Antilock brake system
- Aircraft: Flight control, Navigation system
- Automated Manufacturing

20. What are the two types of feedback loop?

The two types of feedback loop are,

- Positive feedback loop
- Negative feedback loop.

The feedback is said to be negative/positive feedback when the signal; which is feedback, subtracts/adds from the input value. It is required to control a system. The control elements decide what action to take when it receives an error signal"

UNIT-2 MICROPROCESSOR AND MICROCONTROLLER

PART-A

1. What is meant by microprocessor?

A microprocessor is a multipurpose, programmable, clock driven, registers –based electronic device that reads binary instructions from a storage device called memory, accepts binary data as input and processes data according to those instructions, and provides results as output.

2. What are the four components of a programmable machine?

A typical programmable machine can be represented with four components.

- Microprocessor
- Memory
- Input
- Output

3. Define - Bus

A group of lines used to transfer bits between the microprocessor and other components of the computer system.

4. What are the types of languages?

The types of languages used are,

- Machine language
- Assembly language
- Low – level language
- High – level language

5. What are the two parts of an instruction?

An instruction has two parts.

- Opcode – Operation to be performed.

- Operand – The operand can be data (8 – or 16 – bit), address, or register, or it can be implicit. The method of specifying an operand (directly, indirectly, etc.,) is called the addressing mode.

6. What are the types of bus?

The types of bus are,

- Address bus
- Data bus
- Control bus.

7. Define - Address Bus

A group of lines that are used to send a memory address or a device address from the MPU to the memory location or the peripheral and is unidirectional. The 8085 microprocessor has 16 address lines.

8. Define - Data Bus

A group of bi-directional lines used to transfer data between the MPU and peripherals and is bi-directional. The 8085 microprocessor has eight data lines.

9. What is meant by 16 – bit register of 8085 microprocessor?

The 8085 has two 16 – bit registers.

- The program counter - The program counter is used to sequence the execution of a program.
- Stack pointer - The stack pointer is used as a memory pointer for the stack memory.

10. What are the two types of memories?

The two types of memories are,

- Static memory (SRAM)
- Dynamic memory (DRAM)

11. Write is meant by SRAM?

- This memory is made up of flip – flops, and it stores the bit as a voltage.
- Each memory cell requires six transistors.
- The memory chip has low density, but high speed.
- More expensive, and consumes more power.
- Also known as cache memory.

12. What are the advantages of DRAM?

The advantages of DRAM are,

- This memory is made up of MOS transistor gates and it stores the bit as a charge.
- It has high density.
- Low power consumption
- Cheaper than static memory
- Economic to use when the system memory size is at least 8K for small systems.

13. What are the disadvantages of DRAM?

The disadvantages of DRAM are,

- The charge (bit information) leaks.
- Stored information needs to be read and written again every few milliseconds this is called refreshing the memory.
- Requires extra circuitry, adding to the cost of the system.

14. What is meant by flash memory?

The flash memory must be erased either in its entirety or at the sector level. The memory chips can be erased and programmed at least a million times. The power supply requirement for programming these chips was around 12V, but now chips are available that can be programmed using a power supply as low as 1.8 V. Hence, this memory is ideally suited for low – power systems.

15. What are the instructions of an 8085 instruction set for data transfer from memory to the microprocessor?

The 8085 instruction set includes three memory transfer instructions.

They are,

- MOV R,M : Move from Memory to Register
- LDAX B/D : Load Accumulator Indirect
- LDA 16 – bit : Load Accumulator Direct

16. What are the instructions of an 8085 instruction set for data transfer from microprocessor to the memory?

The 8085 instruction set includes three memory transfer instruction.

They are,

- MOV. R,M : Move from Memory to Register
- STAX B / D : Store Accumulator Indirect
- STA 16 – bit : Store Accumulator Direct
- MVI M, 8 – bit: Load 8 – bit data in memory.

17. What are the opcodes related to rotating the accumulator bits?

The opcodes related to rotating the accumulator bits are,

- RLC – Rotate Accumulator Left through Carry
- RAL – Rotate Accumulator Left
- RRC – Rotate Accumulator Right through Carry
- RAR – Rotate Accumulator Right

18. Define - RAM & ROM

- RAM – Random Access Memory. Data is stored in a read / write memory.
- ROM – Read only Memory. A memory that stores binary information permanently. The information can be read from this memory but cannot be altered.

19. What are the advantages of the microprocessor controlled system?

The microprocessor controlled system can cope easily with giving precision and programmed control. The system is much more flexible. This improvement in flexibility is a common characteristic of mechatronics systems when compared with traditional systems.

20. What is meant by 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.

UNIT-3 PROGRAMMABLE PERIPHERAL INTERFACE

PART-A

1. What are the interfacing devices?

The bus drivers increase the current driving capacity of the buses, the decoder decodes the address to identify the output port, and the latch holds data output for display. These devices are called interfacing devices. The interfacing devices are semiconductor chips that are needed to connect peripherals to the bus system.

2. How will you interface the I/O devices?

I/O devices can be interfaced using two techniques. They are,

- Peripheral – mapped I/O
- Memory – mapped I/O.

3. What is meant by peripheral mapped I/O?

In peripheral – mapped I/O, a device is identified with an 8 – bit address and enabled by I/O related control signals.

4. What is meant by memory – mapped I/O?

In memory mapped I/O, a device is identified with a 16-bit address and enabled by memory – related control signals.

5. What is meant by A/D and D/A converter?

The electronic signal that translates the analog signal into digital signal is called analog to digital (A/D) converter. The electronic signal that translates the digital signal into analog signal is called digital to analog (D/A) converter.

6. What are the types of D/A converters?

Digital to analog converters can be broadly classified in three categories. They are,

- Current output

- Voltage output
- Multiplying type

7. What are the three types of D/A converters?

- Current output – It provides current as the output signal.
- Voltage output – Internally converts the current signal into the voltage signal. It is slower than the current output DAC because the delays in converting the current signal in to the voltage signal.
- Multiplying type – Its output represents the product of the input signal and the reference source and the product is linear over a broad range.

8. What are the elements required for D/A converter?

A D/A converter circuit require three elements. They are,

- Resistor network with appropriate weighting
- Switches
- Reference source

9. What are the two techniques involved in A/D conversion?

The techniques involved in A/D conversion are, comparing a given analog signal with the internally generated equivalent signal. This group includes successive approximation, counter, and flash – type converters. Changing an analog signal into time or frequency and comparing these new parameters to known values. This group includes integrator converters and voltage to frequency converters.

10. What are the applications of A/D converters?

The A/D converters are used in applications such as data loggers and instrumentation, where conversion speed is important. The integrating type converters are used in applications such as digital meters, panel meters and monitoring systems, where the conversion accuracy is critical.

11. What are the functions of a microprocessor to be interfaced with an A/D converter?

To interface an A/D converter with the microprocessor, the microprocessor should,

- Send a pulse to the 'START' pin. This can be derived from a control signal such as write (WR)
- Wait until the end of the conversion. This period can be verified either by status checking (polling) or by using the interrupt.
- Read the digital signal at an input port.

12. What is meant by break point?

In a single – board computer, the break point facility is a software routine that allows executing a program in sections. The break point can be set in a program by using RST instructions. When the execute key is pushed, the program will be executed until the breakpoint, where the monitor takes over again. If the segment of the program is found satisfactory, a second breakpoint can be set at a subsequent memory address to debug the next segment of the program.

13. What are the advantages of the break point?

- Isolate the segment of the program with errors.
- Isolated segment can be debugged with the single – step facility.
- Check out the timing loop.
- Check the I/O section
- Check the interrupts.

14. What is meant by key debouncing?

When a key press is found, the microprocessor waits for at least 10 ms before it accepts the key as input. It is called key debouncing.

15. Define – PPI

8255 is a widely used, programmable, parallel I/O device. It can be programmed to transfer data under various conditions from simple I/O to interrupt I/O.

16. Distinguish between parallel data transfer and serial data transfer.

S.No	Parallel data transfer	Serial data transfer
1	Data is transferred as byte	Data is transferred as bit
2	More number of channels are required for data transfer	Only one channel is enough
3	No need of parallel to serial data conversion for transmission and reception	Needs parallel to serial data conversion for transmission and reception

17. What are the methods used for communication in 8085.

- Serial communication
 - (i) Simplex, half duplex and full duplex communication
 - (ii) Synchronous and asynchronous communication
- Parallel communication

18. What are the applications of D/A converter interfacing with 8255?

- Temperature control
- Air conditioning control
- Washing machine control
- Traffic light control

19. What is the bit set reset mode of 8255 PPI?

The individual bits of port C can be set or reset by sending out a single OUT instruction to the control register. When port C is used for control/ status operation, this feature can be used to set or reset individual bits.

20. What are the interface methods available in stepper motor?

- Universal
- Unipolar
- Bipolar

UNIT-4
PROGRAMMABLE LOGIC CONTROLLERS
PART-A

1. **What is meant by PLC?** (N/D 2012)

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 in order to control machines and process.

2. **What is an internal relay in a PLC?** (N/D 2012)

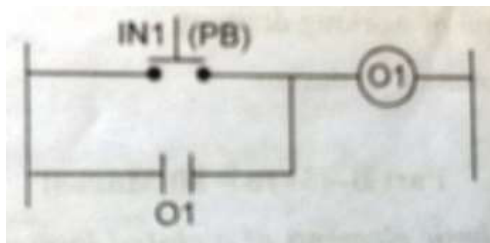
Most PLCs have an area of memory allocated for internal storage that are used to hold data which behave like relays. It is able to switch ON and OFF. But this is only for internal purpose. This will not exist in the real world.

3. **What is shift register? What is the data required for a shift register?** (N/D 2011)

Shift registers can be used where sequence of operations is required for movement or track the flow of parts and information.

The data required for the shift register are address of the bit array, address of the control structure, address of the source bit, number of bits in bit array.

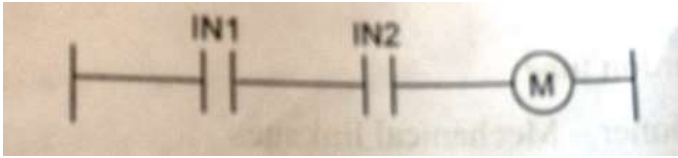
4. **Draw the general ladder rungs to represent a latch circuit.** (N/D 2009)



O1 – Output

IN1 – Push button

5. Draw the ladder logic diagram to represent two switches that are normally open and both have to be closed for a motor to operate. (N/D 2008)



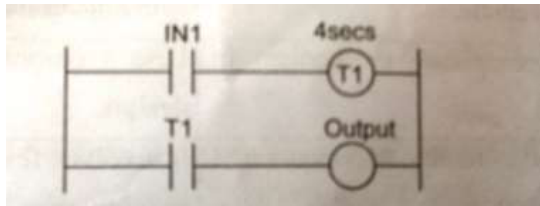
IN1 and IN2 – Input switches

M – Motor

6. Draw the ladder diagram of ON delay and OFF delay timer. (A/M 2008)

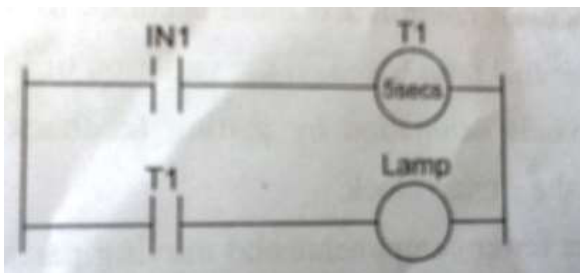
ON delay timer:

The timer is energized when the input IN1 becomes energized. The timer starts running after some present time.

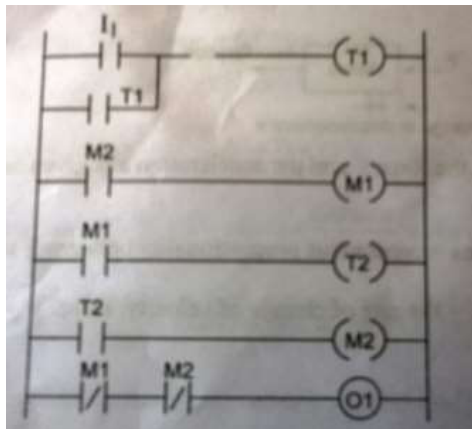


OFF delay timer:

When the contact IN1 is closed, the contact will energize the timer T1 and holds the output lamp ON for specified set value of 10 seconds. The action of an OFF delay timer is to delay setting the lamp OFF.



7. Draw a PLC timing circuit that will switch an output on for 10 seconds and then switch it off. (N/D 2007)



I1 – Input

T1 – Timer 1 for 1 second

T2 – Timer 2 for 10 seconds

M1, M2 – Memory coil

O1 – Output (light)

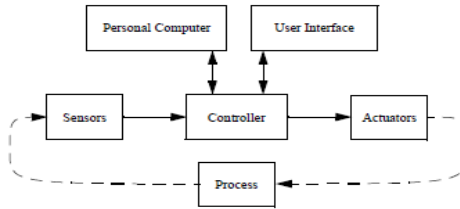
8. How does PLC differ from relay logic? (N/D 2010)

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

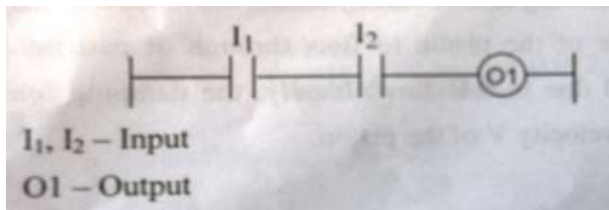
9. What is the use of JUMP control in PLC. (N/D 2010)

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

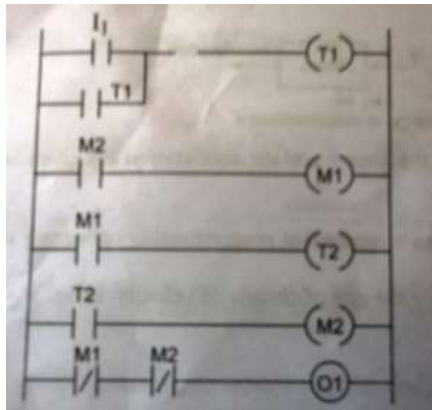
10. Draw the block diagram of PLC. (N/D 2004)



11. What are the logic functions that can be obtained by using switches in series? (N/D 2007)



12. Draw a timing circuit that will switch an output for ON for 1 sec then OFF for 20 seconds, then ON for 1 second, then OFF for 20 seconds and so on. (N/D 2008)



I_1 – Input

T_1 – Timer 1 for 1 second

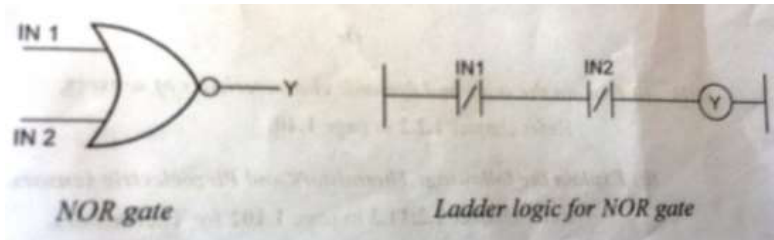
T_2 – Timer 2 for 20 seconds

M1, M2 – Memory coil

O1 – Output (light)

13. Draw NOR logic function using ladder diagram.

(A/M 2010)



14. What is the main advantage of PLC?

PLC's have great advantage that it is possible to modify a control system without having to rewire the connections to the input and output devices.

15. What are the features of PLC as a controller?

The features of PLC as a controller are,

- They are rugged and designed to withstand vibrations, temperature, humidity and noise.
- The interfacing for inputs and outputs is inside the controller.
- They are easily programmed and have an easily understood programming language.

16. What is meant by ladder programming?

The ladder programming involves each program task being specified as though a rung of a ladder. Thus such a rung could specify that the state of switches A and B, the inputs, be examined and if A and B are both closed then a solenoid, the output is energized.

17. What is meant by up counter?

An up counter would count up to the preset value. Events are added until the number reaches the set value. When the set value is reached the counters contact changes the state.

18. What is the criteria need for the selection of a PLC?

- Input / output capacity
- Types of inputs/outputs
- Size of memory
- Speed and power of the CPU

19. What is meant by internal relay in PLC?

Most PLCs have an area of memory allocated for internal storage that is used to hold the data, which behave like relays. It can able to switch ON and OFF. But this is for internal purpose. This will not exist in the real world.

20. What is meant by down counter?

Down counter counts down from the preset value to zero. Events are subtracted from the preset value. When zero is reached the counters contact changes state.

UNIT-5

ACTUATORS AND MECHATRONIC SYSTEM DESIGN

PART-A

- 1. List out the drawbacks of traditional design approach. (N/D 2012)**

The drawbacks of traditional design approach are:

- Less flexible
- Less accurate
- More complicate mechanism in design
- It involves more components and moving parts

- 2. What is the role of an opto-isolator in robot control? (N/D 2012)**

TRIAC opto-isolator consists of LED and TRIAC. If the input of the LED is 1, it glows and activates the TRIAC to conduct the current to the solenoid valve. Otherwise, TRIAC will not conduct the current to the solenoid.

- 3. What are the sensors used in engine management system? (N/D 2011)**

- Airflow sensor
- Ford-type MAP sensors
- Hall effect and AC excited sensors

- 4. How is a traditional design of flow control in a large pipe improved by mechatronics design? (N/D 2010)**

A traditional design of flow control system in large pipe line can be improved by using fluid flow sensors such as venture meter, turbine flow meter, etc., along with servo motor controlled valves.

- 5. Automatic camera is a mechatronics system – Justify. (N/D 2010)**

A typical mechatronics system should have some of the basic elements such as actuators, sensors, signal conditioning elements, digital logic systems, software, display devices, etc., As the automatic camera has all those elements, it is considered as mechatronics system.

6. Compare traditional design with mechatronics design.

(A/M 2010)

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

7. What are the mechatronics elements used in an automatic camera? (N/D 2007)

The various mechatronics elements in an automatic camera are:

- Auto-focussing mechanism control
- Aperture drive
- Shutter drive
- Mirror drive
- Lens position encoder
- Lens drive
- Film advance mechanism control

8. What are the advantages of using a microprocessor in the place of a mechanical controller for a carburettor of an automobile? (A/M 2008)

The advantages of using a microprocessor in the place of a mechanical controller for a carburettor of an automobile are:

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

9. Identify the sensor, signal conditioner and display elements in the Bourdon pressure gauge. (N/D 2008)

- Sensor – Bourdon tube
- Signal conditioner – Mechanical linkages
- Display elements – Pointer and scale

10. List out the seven modules of mechatronics design approach. (N/D 2009)

- Need for design
- Analysis of problem
- Preparation of specification
- Generation of possible solution
- Selection of suitable solution or evaluation
- Production of detailed design
- Production of working drawing
- Implementation of design

11. What is meant by timed switch? (N/D 2009)

The device which is used to start the pulse applied, check the timer whether it is ON or OFF condition and timer should be in OFF condition before triggering is called timed switch.

12. How is a traditional design of temperature control of domestic central heating system improved by mechatronics design? (A/M 2006)

The traditional design of the temperature control for a central AC system involves 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 is modified by mechatronics approach. This system uses a micro processor controlled thermocouple as the sensor. Such a system advantages over traditional system. The bimetallic thermostat is less sensitive compared to the thermodiode.

13. List out the advantages of mechatronics design over traditional design.

(N/D 2008)

The advantages of mechatronics design over traditional design are

- Mechatronics system serves the purpose effectively with high dimensional accuracy requirements

- It provides increased productivity in the industry
- It provides higher flexibility by pre-supplied programs which facilitate small volume production cycles

14. What are the factors to be considered while selecting a motor? (A/M 2013)

The factors to be considered while selecting a motor are

- Speed of a motor
- Starting torque and rotational torque of a motor
- Size and style of a motor.

15. What is meant by servomotor? (N/D 2012)

A servomotor is a rotary actuator that allows for precise control of angular position. It consists of a motor coupled to a sensor for position feedback, through a reduction gearbox.

16. What are the applications of a servomotor in mechatronics systems? (N/D 2010)

Servomotor are used in mechatronics systems for position control, velocity control and torque control in various applications such as CNC machine tools, robots etc.,

17. What are the applications of stepper motor in mechatronics system. (A/M 2010)

The applications of stepper motor in mechatronics system are

- High accuracy positioning applications in robotics
- Computer hard disc drives

18. What could be a suitable actuator for robot arm joint? Justify. (N/D 2008)

The actuator of a robot arm may be servomotor or pneumatic rotary actuator and hydraulic rotary actuator. The selection of actuator depends on the purpose of use of the robot. However, most of the robots uses servomotor as an actuator because of precise and easy control mechanism.

19. What are the performance specifications of servo motor?

- Shaft speed
- Terminal voltage
- Torque

20. What is meant by synthesis?

It is a process of taking elements of the concept and arranging them in the proper order, sized and dimensioned in the proper way.