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5th Sem./ Mechanical/Auto /Dip in Mech/Mech (Prod)/
Mech(Maint) /Mech(Ind Intg)/Mech(Switch) 2021(W)
Th-4   Mechatronics

Full Marks: 80   Time- 3 Hrs

Answer any **FIVE** Questions including **Q No.1&2**
Figures in the right-hand margin indicates marks

1   Answer **All** questions   2 x 10
   a.   Define the term "Mechatronics" and give two applications of Mechatronics system.
   b.   What is a transducer & classify them into its various types.
   c.   What is an actuator? List the various types of actuators.
   d.   What is a PLC? Mention its uses.
   e.   What do you mean by "Numerical Control"? Enumerate the various applications of NC machines.
   f.   State the functions of Robotics.
   g.   List the components of a Mechatronics system.
   h.   What is a displacement sensor and where it is used?
   i.   Define machine and mechanism.
   j.   Write down the basic components of a PLC.

2   Answer **Any Six** Questions   5x6
   a.   Explain in brief the advantages and disadvantages of Mechatronics.
   b.   What is temperature sensor and classify it? Discuss the different types of temperature sensor.
   c.   Explain the working of solenoid.
   d.   Explain briefly: (i) Mnemonics (ii)Jump Controller.
   e.   List the various features and applications of CAD/CAM.
   f.   Explain the differences between switches and relays.
   g.   Define robotics. Explain the laws of robotics.

3   (a)Discuss the different types of sensors.   [6]   10
       (b)With neat diagram explain slider crank mechanism. [4]
4   (a)Explain briefly the AC motor & DC motor.   10
       (b)Write the advantages and disadvantages of robots.
5   With a neat diagram, explain the architecture of PLC.   10
6   (a)Explain briefly the hardware and the software components of   10
       CAD/CAM.   [6]
       (b)What are Spindle & feed drives? [4]
7   (a) Discuss the various types of industrial robots.   10
       (b)Write the difference between Stepper motor & Servomotor.

*① mechatronics is the synergetic
a) combination of Mechanical Engg.
Electronics Engg. Electrical Engg and
control system.

Applications - Digital camera,
            copy machine, washing m/c.
b)
  T'

1) Define the term "Mechatronics" and give two applications of Mechatronics system.

) Mechatronics is a subject which integrates various branches of engineering namely mechanical, electrical, control and instrumention and computer science etC.

Application
i) Process control in schemical, mechanical, textile, paper, rubber and similar industries.
iv) Production centers in manufacturing, assembly and maintenance.

b) What is transducer & classify them into its various types.

) | A transducer is a device which converts the energy form one form to another form of energy "

Most of the transducers either convert electrical energy into mechanical displacement and convert some non-electrical physical quantity (force, sound, temperature etc.). to an electrical signal.

Type's
* Pressure sensor
* piezoelectricity
* Analog Transducer
* ultrasonic transducer
* Resistance thermometer

Two types
Active
passive.

C) what is an actuator? various types of actuators

→ A mechanical device or a system which holds motion or movement is called an actuator.

Type's of actuator's

* Pneumatic actuator
* Electric actuator
* Rotary actuator
* Ball screw actuators ✓
* MEMS magnetic actuator

d) what is PLC? Mention it's uses?

PLC- stands for programable logic control.

→ PLC are specialised industrial devices for interfacing to and controlling analong and digital devices.

Use's — uses- SPM industriay and

It is used in washing machine, elevators working and traffic signals control. It is used in aerospace for water tank quenching system.

e) what do you mean by "Numerical control"? Enumerate the various applications of NC machine?

→ Numerical control can be defined as a form of programmable automation in which the process is controlled by numbers, letters, and symbols.
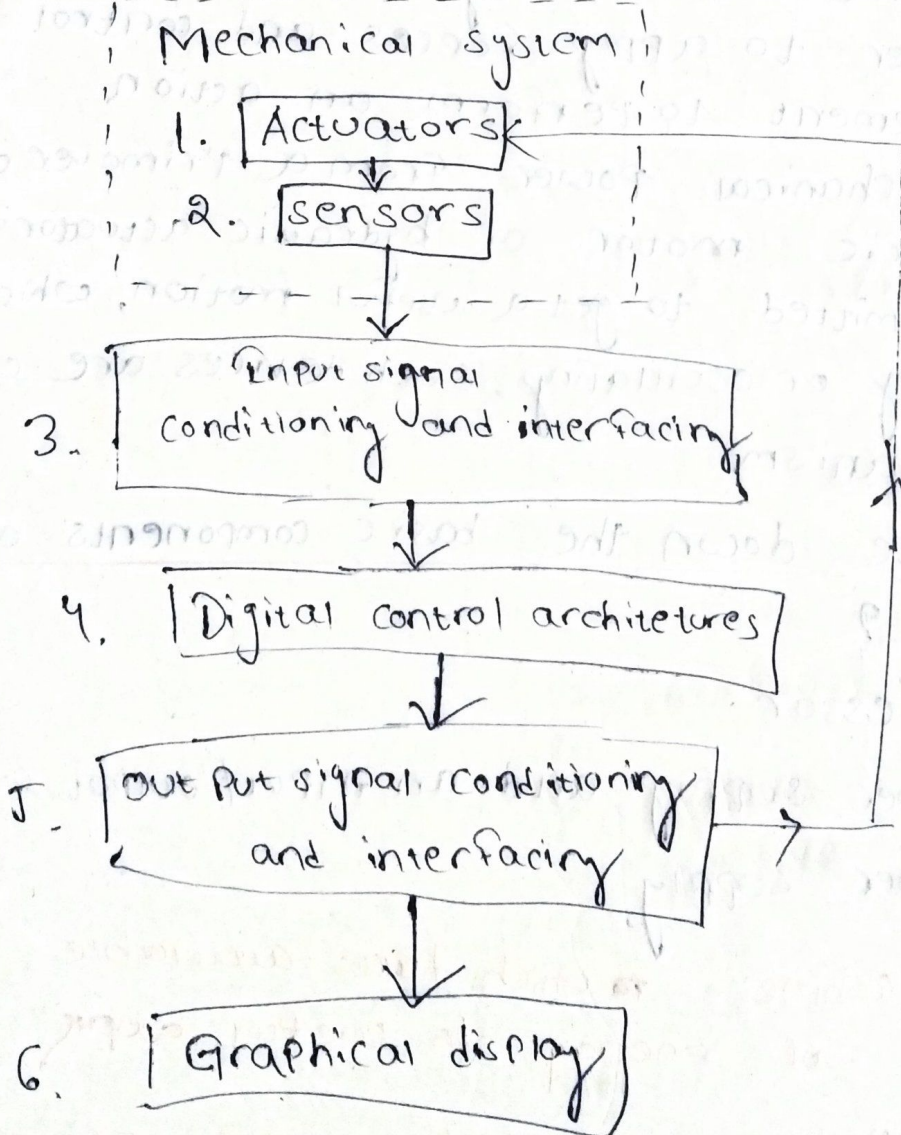
Application of NC machine

i) It is expected engineering design changes in future

~~Good surface finish~~ like CNC machine.

ii) High metal removal is required

iii) The workpart required 100% inspection

f) State the function of robotics!

→ ~~material handling, inspection, operate machines.~~

→ The function of robotics is design machines that can help and assist humans.

g) List the component of Mechatronics system?

Mechanical system

1. Actuators
2. Sensors
3. Input signal conditioning and interfacing
4. Digital control architetures
5. Out put signal conditioning and interfacing
6. Graphical display

h) what is displacement sensor and where it is used? Gy- ultrasonic sensor, potentio moter

7) i) A displacement sensor is used to measure travel range between where an object is and a reference position.

ii) Displacement sensors can be used for dimension measurement to determine an object's height, thickness, and width in addition to travel range

I) Define machine and mechanism

7) i) A machine is a physical system using power to apply forces and control movement to perform an action

ii) Mechanical power from a primover or an electric motor or hydraulic actuators is to be transmitted to get a useful motion, which may be rotary or oscillating, such devices are called mechanism.

J) write down the basic components of a PLC?

7) i) processor

ii) Power supply, and an input/output section

iii) power supply.

machine:- which takes available form of energy to cesefay aropue

mechanism:- which convert one motion to another motion by the help of gears & sinas.

2) a) Explain in brief the advantages and disadvantages of Mechatronics: → produce cost effectives
good quality
→ High degree flexibility.
→ greater machine utilization.

Advantages:

i) High level of integration
ii) Increased functionality and better design
iii) Multisensory and program environment.
iv) High reliability and safety.
v) Improved and less expensive controls.
vi) operation with little interference of operators. → greater productivity

dis advantage:

(i) The initial cost is very high.
(ii) The complicated design and system
(iii) The repair and maintenance is complex.
(iv) It is expensive to change old system to new system.

b) what is temperature sensor and classify it? Discuss the different types of temperature sensor!

→ A temperature sensor in which some change occurs with a change in temperature; and some means of converting this change into a numerical value.

Types of sensors:

i) There are 4 types of sensors :- Thermocouples, RTD, Thermistors, semiconductor based integrated circuits (IIC).

i) **Thermocouples:-** Thermocouples are the most commonly used type of temperature sensor. They are used in industrial, automotive, and consumer applications. Thermocouples are self-powered, require no excitation, can operate over a wide temperature range.

ii) **RTD (Resistance Temperature Detector):** This difference in resistance is what RTD temperature sensors are based on. An RTD is a resistor with well-defined resistance vs. temperature characteristics. Platinum is the most common and accurate material used to make RTDs.

iii) **Thermistors:-** Thermistors are similar to RTDs in that Temperature changes cause measurable resistance changes. Thermistors are cheaper but are also less accurate than RTDs. Most thermistors are available in two wire configurations.

iv) **Semiconductor based ICs :-** This is 2 different type: local temperature sensor and remote digital temperature sensor. Some micro-processors and FPGAs include a bipolar sensing transistor to measure die temperature of the target IIC.

c) Explain the working of solenoid.

→ A "solenoid" consists of a coil and a movable iron core called the armature. When the current is passed through the coil it gets energized and consequently the core moves to increase the flux linkage by closing the air gap between the cores. The movable core is usually spring-loaded to allow the core to retract when the current is switched off. The force generated is approximately proportional to the square of the current and inversely proportional to the square of the width of the air gap.

• Solenoids are inexpensive
• Solenoids can be used to provide electrically operated actuators. Solenoid valves are examples of such devices, being used to control fluid flow in hydraulic or pneumatic system

<u>Solenoid are used</u>

- Home appliances (washing machine)
- Automobiles (door latches and starter solenoid)
- Pinball machines (plungers and bumpers)
- Factory automation (s∮m)
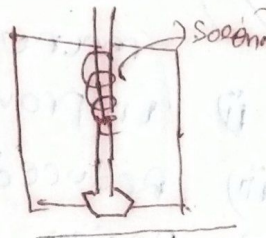
d) Explain briefly : (i) Mnemonics
                    (ii) Jump controller

i) **Mnemonics:-** Mnemonics are used to specify an opcode that represents a complete and operational machine language instruction. This is later translated by the assembler to generate the object code. mnemonic Move is used in assembly language for copying and moving data between registers and memory locations.

ii) **Jump controller:-** Jump controller to interrupt the linear execution of the program. that is mean that you jump to the desired part of your program which do have defined by a label erlear.

Q) List the various features and applications of CAD / CAM]

- i) Improved accuracy of design and product manufacturing.
- ii) Improved quality assurance
- iii) Reduced requirements of skilled personel
- iv) Design and modifications in product easily made.
- v) Errors are minised in Part Programming.
- vi) Reduced material handling costs.
- vii) Increased capacity.
- viii) Flexible production schedule.
- ix) Reduced lead time and in-process inventory.
- x) Avoidance of sub-contracting to meet schedules.

f) Explain the different types of between switches and relays.

-) Switches: i) In electrical engineering, a switch is an electrical component that can "make" or "break" an electrical circuit, interrupting the current or diverting it from one conductor to another.

ii) The mechanism of a switch removes or restores the conducting path in a circuit when it is operated.

iii) These are usually more complicated than simple electromechanical toggles or pushbutton devices, and operate without direct human interaction.

-) relays:

i) A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays.

ii) A type of relay that can handle the high power required to directly control an electric motor or other loads is called a contactor.

iii) It was used in long distance telegraph circuits, repeating the signal coming in from one circuit and transmitting it to another.

q) Define robotics. Explain the laws of robotics.

→ Robotics means a science which enables us to design and manufacture Robots. These robots may be meant for real-Life applications in automated manufacturing processes or non-manufacturing activities.

Laws of Robotics:-

First law :- A robot must not harm a human being or, through inaction, allow one to come to harm.

Second law:- A robot must always obey human beings unless it is in conflict with a higher order law.

Third law:- A robot must protect itself from harm unless that is in conflict with a higher order law.

4) a) Explain briefly the Ac motor & Dc motor

i) **D.c Motors**
   * permanent magnet
   * series wound
   * shunt wound
   * compound wound

A.C Motors

2. /(a) **Single Phase**
   • squirrel cage:
   - split phase
   - capacitor start
   - permanent split capacitor
   - shaded pole
   - Two-value capacitor
   • wound rotor:
   - Repulsion
   - Repulsion start
   - Repulsion induction

(b) **Synchronous**:
   • shaded pole
   • Hystersis
   • Reluctance
   • permanent magnet

Polyphase
   a) induction
   • wound rotor
   • squirrel cage
   (b) synchronous

iii) universal motors.

4)(b) Write the advantages and disadvantages of robots.

) Advantages:

i) In many situations robots can increase productivity, efficiency, quality and consistency of products.

ii) Unlike humans, robots don't get bored.

iii) Until they wear out, they can do the same thing again and again

iv) They can be very accurate - to fractions of an inch (as is needed: for example in manufacturing of microelectronics).

disadvantages

i) The use of robots can create economic problems if they replace human jobs.

ii) Although robots can be superior to humans in some ways, they are less dextrous than humans, they don't have such powerful brains, and cannot compete with a human's ability to understand what they can see.

iii) In the terms of the initial cost, maintenance the need for extra components, and the need to be programmed to be programmed to do the task.

3)(a) Discuss the different types of sensors.

i) **Internal state sensors:-** There are used to measure position, velocity. or acceleration of robot joints and the end it effector.

- * Potentiometers
- * Synchros
- * Resolvers
- * Linear inductive scales
- * Differential Transformers (LVDT and RVDT)
- * optical interrupters
- * Tachometer
- * Accelerometers.

ii) **External state sensors:-** These are used to monitor the robot's geometric and dynamic relation it its task, environment, or the objects that it is handling. Such devices can be of either the visual on non-visual variety. Following devices are include this class. (i) strain gauges (ii) pressure Transducers

(iii) ultrasonic sensors:-

Tactile sensors:- These are contact sensors that must be brought in contact with the object to obtain signals to measure the necessary quantities.

Typical contact type robotic sensors

(i) force sensors,   (ii) Torque sensors

(iii) Touch sensors,   (iv) Position sensors.

(b) with neat diagram explain slider crank mechanism


connecting rod

crank   Piston   cylinder.
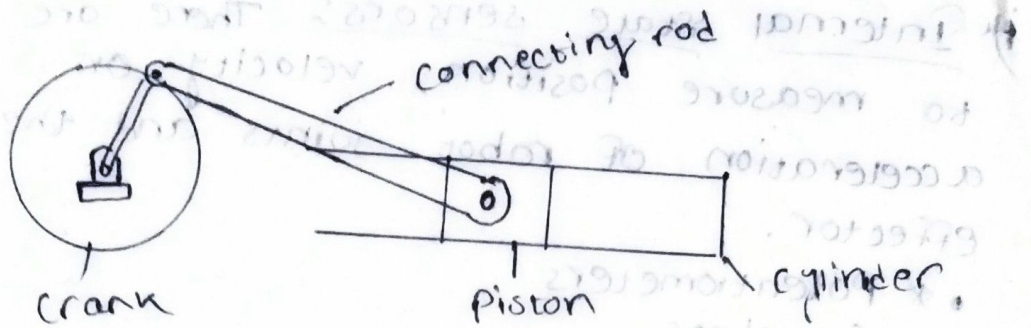
i) Slider crank mechanism, arrangement of mechanical parts designed to convert straight-line motion to, rotary motion, as in a reciprocating piston engine, or to convert rotary motion to straight-line motion, as in a reciprocating piston pump.

ii) The basic nature of the mechanism and the relative motion of the parts can best be described with the aid of the accompanying in which the moving parts are lightly shaded.

iii) The slider-crank mechanism is a particular far-bar linkage configuration that converts linear motion to rotational, or vice versa

iv) Internal combustion engines are a common example of this mechanism.

v) where combustion in a cylinder creates pressure which drives a piston

5) with a neat diagram, explain the architecture of PLC.

Programmable Logic Controller, (PLC) is defined as a digital electronic device that uses programmable memory to store instruction and to implement function such as logic, sequencing, timing, counting and arithmatic in order to control machines and processes.

i) They are rugged in design to withstand vibrations, temperature, humidity and noise.

ii) Interfacing for inputs and outputs are inside the controller.

iii) They can be easily programmed in an easily understood language. Basic structure of PLC is
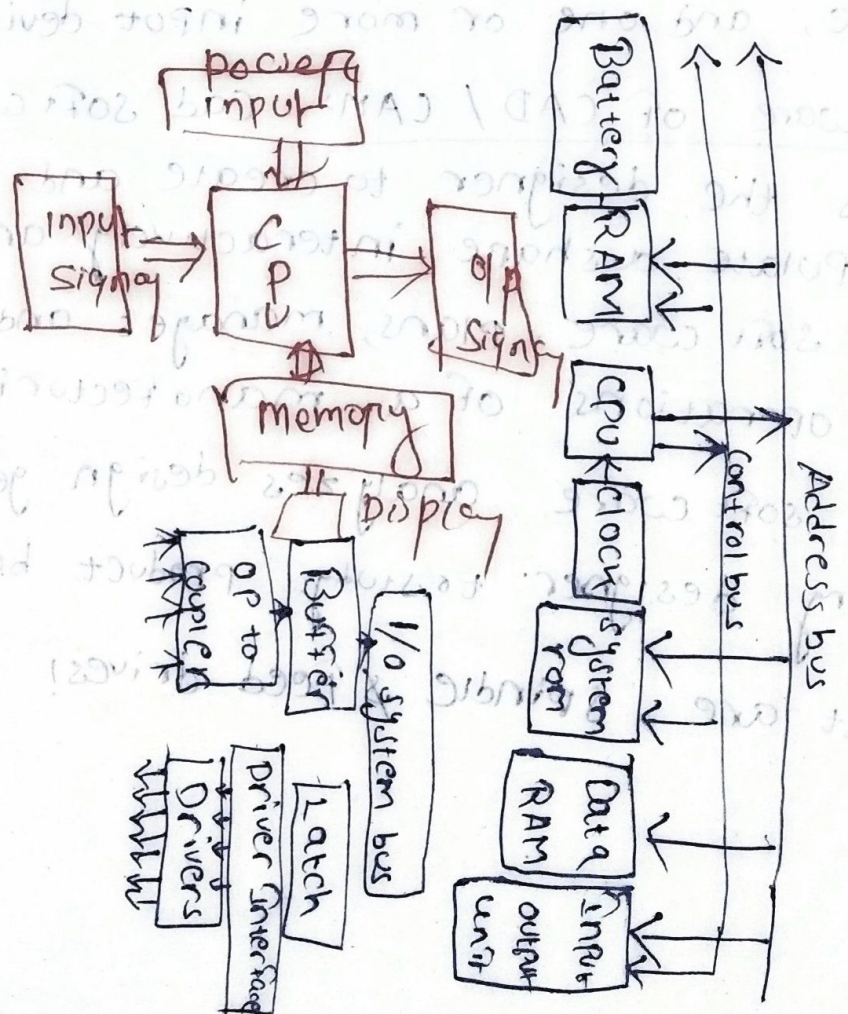
This consists of CPU unit, clock, RAM, ROM, Input/output, opto-isolator and other interfacing devices. Invariably, inputs and outputs are connected by opto couplers, so as to protect PLC. It also provide with battery power house.

6) a) Explain briefly the hardware and the software components of CAD/CAM.

) Hardware ~~software~~ of CAD: These includes the computer with its memory and CPU, means of storing programs on disk or magnetic tape, the display screens, various devices for inputting instructions to the computer. Graphic device is composed of a display processing unit, a display device, and one or more input devices.

Software of CAD/CAM: Cad software allows the designer to create and manipulate a shape interactively and store. Cam software plans, manages and control the operations of a manufacturing site. CAE software analyzes design geometry, allowing designer to study product behavior.

B) What are spindle & feed drives!
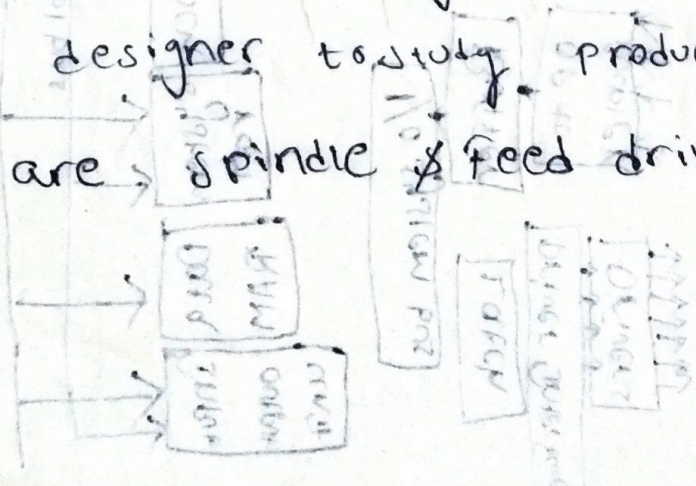
7) i) spindle drives convert the power, generated by the motor into feed velocity and feed force. The integrated axial bearing can take extremely high axial loads; maxon spindle drives are available with metric, ball screw, and trapezoidal screw spindles.

ii) feed drives are used to position the machine tool components carrying the cutting tool and workpiece to the desired location, their positioning accuracy and speed determine the quality and productivity of machine tool.

7) a) Discuss the various types of Industrial robots.

- Cartesian co-ordinate configuration
- cylindrical configuration
- spherical configuration
- jointed-arm configuration

i) <u>Cartesian co-ordinate configuration</u>

The cartesian robot also termed as gantry robot, has three mutually perpendicular axes which define as rectangular, work volume. Axes of a robotic device that behave in this way are referred to as "prismatic."

ii) cylindrical configuration:

cylindrical configured use a vertical column with the robot arm attached to a side which can move up and down the column usually, a full 360° rotation ino is not permitted, due to restriction imposed by hydraulic, electrical, or pneumatic connection

iii) spherical configuration:

The configuration has a telescope arm which pivots about a horizontal axis and also rotates about a vertical axis. Owing to mechanical and actuator connection limitations, the work envelope of such a robot is a portion of sphere

iv) Jointed arm configuration:

The jointed-arm robot mat resembles as human arm and consists of a series of links connected by rotary joints which when referenced from base are referred to as shoulder, arm and wrist joints.

There are different type's of joint's:

(a) pure spherical

(b) parallelogram spherical

(c) cylindrical

7) b) write the difference between stepper motor & servomotor.

Stepper Motor	Servo motor
i) High torque in low speed.	i) High torque in high speed.
ii) Faster positioning time during short strokes.	ii) Faster positioning time during long strokes.
iii) No hunting during stop position	iii) hunting during stop position
iv) High tolerance movement of inertia	iv) Low Tolerance movement of inertia
v) Suitable for fluctuating loads.	v) Not suitable for fluctuating loads
vi) Tuning adjustment not required.	vi) Turning adjustment required