## WINTER- 18 EXAMINATION Model Answer

Subject Name: Mechatronics

Subject Code:

17660

## Important Instructions to examiners:

- 1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
- 2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
- 3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
- 4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
- 5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
- 6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
- 7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q.	Su	Answer	Marking
No	b		Scheme
	Q.		
	N.		
Q	A	Attempt any three of the following:	12
1		i) State and elaborate the importance of mechatronics in various field of engineering.	
	i)	Ans:-	State – 1 mks,
		Mechatronics is the synergistic integration of mechanical engineering with electronics	mks
		and intelligent computer control in designing, manufacturing processes and production.	
		It helps to develop automized, reliable and efficient in manufacturing/production	
		systems to produce high quality products.	
		Importance of Mechatronics in various engineering fields: Mechanical System:	
		These system deal with behaviour of matter under the action of forces. Mechanical	
		system like hydraulic, pneumatic, rotational or translational, thermal, Fluid etc. are	
		used in Mechatronics applications. These systems are interfaced with computer through	
		sensors, actuators and electronic systems.	
		Electrical Systems:	
		It includes transducer, signal conditioning, output device such as analog meters, display	16
		devices recorders and primers.	
		<b>Information Systems:</b> It related with all the aspects regarding information transmission from signal processing to control system and analysis techniques. It is a combinational of communication systems, signal processing, control systems and numerical methods.	
		<b>Computer System:</b> It is combinational of hardware and software. In mechatronic applications hardware	
		<ul> <li>computer specific circuit like flip-flops, computer registers, memories software is nothing but system and application.</li> <li>Electrical components mostly used are electrical motors (ac and dc) generators,</li> </ul>	
		relays, circuit breakers, switches and so forth.	

	Electronic Systems: Analog electronics involves passive and active components such as resistor, capacitor, inductor, diodes and transistors digital circuits contain logic, gates, counters, Flip- flops, memories, microcontroller and process. Instrumentation & control system:	
ii)	ii. Define: a)Sensor	
	b)Transducer with examples of each.	
	<b>a)Sensor:</b> It is device which senses any physical quantity and converts it into electrical variable which may be signal conditioned. It is sophisticated device which is transducer along with signal conditioning , Signal conditioning may include amplification, noise filtering, analog to digital converter etc.	Ans:- Definition with
	e.g. Proximity Sensor, Photo diode, LDR	example-2
	<b>b)Transducer:</b> It is device which converts any physical quantity into other physical quantity.	mks each
	e.g. LVDT, Bourdon tube	
iii)	iii. Draw PI controller using OP-AMP and explain in brief. Ans:-	Diagram- 2 mks, explanation- 2 mks
	$R_2$ $C_1$ $R_2$ $R_1$ $R_2$ $R_1$ $R_2$ $R_2$ $R_1$ $R_2$ $R_2$ $R_1$ $R_2$ $R_2$ $R_2$ $R_1$ $R_2$	
	It is possible to combine the proportional and integral circuit in order to obtain the	

proportional and integral control action by using two resistors and capacitor. In above circuit diagram of PI controller using OP-AMP, A, OP-AMP as a integrator circuit while A2 as a inverter circuit. Output of PI controller is  $Vout = \frac{R^2}{R^2} Ve + \frac{1}{R^2} \int_0^t Ve \, dt$ The output of PI controller in time domain is Vout = KpVe + KpKi  $\int_0^t Ve \, dt$ Where  $Kp = \frac{R^2}{R^1}$  As  $KpKi = \frac{1}{R^1C}$ Therefore  $Ki = \frac{1}{R^2C}$ iv. Explain the basic components of pneumatic system with neat sketch. iv) Ans:--2 mks.



Neat sketch explanation-2 mks

Gas based system is called pneumatic system. A pneumatic system uses compressed air as medium. It consist of element like compressor, reservior, control valve cylinder piston and motor.

- 1. Air in any pneumatic system must be clean and dry to reduce wear and avoid maintenance. Initially the inlet air is filtered by filter to remove dirt and smoke particles otherwise it damages air compressor.
- 2. Function of air compressor is to provide pressursied air. It incresses air pressure by reducing its volume. This compressed air is processed though air treatment unit.

<ul> <li>A pressure sensitive switch is attached to the reservior that activates the compressor through on-off control and motor.</li> <li>The control valve operates the cylinder – piston as per load requirement.</li> <li>Attempt any two of the following:         <ul> <li>State the working principle of cam. List its types. Give any two applications of cam.</li> <li>State the working principle of cam. List its types. Give any two applications of cam.</li> </ul> </li> <li>Interpret of the following:         <ul> <li>Interpret of the following:</li> <li>Interpret of the following:</li></ul></li></ul>		3. The volume of compressed air is stored in reservior .	
<ul> <li>S. The control valve operates the cylinder – piston as per load requirement.</li> <li>Attempt any two of the following:         <ol> <li>State the working principle of cam. List its types. Give any two applications of cam.</li> <li>State the working principle of cam. List its types. Give any two applications of cam.</li> </ol> </li> <li>Following for the following:         <ol> <li>State the working principle of cam. List its types. Give any two applications of cam.</li> </ol> </li> <li>Following for the following:         <ol> <li>State the working principle of cam.</li> <li>For the following:                 <ol> <li>State the working principle of cam.</li> </ol> </li> </ol> </li> <li>For the following:         <ol> <li>Coptional 1</li> </ol> </li> <li>Porting principle of cam:         <ol> <li>Coptional 1</li> <li>Control.</li> <li>A cam is mechanical rotating machine element which is used for converting one motion.</li> <li>It is rotating machine element that gives reciprocating or oscillating motion to another element that gives reciprocating or oscillating motion to another element that gives reciprocating or oscillating motion to another element that gives reciprocating or oscillating motion to follower motion is predetermined according to the shape of cam.</li> <li>Cam rotates and doing so, imports reciprocating motion to follower, with which it is in contact. As the cam rotates, the follower is made to rise dwell and fall the lengths of times spent at each of these positions depending upon shape of the cam.</li> </ol> </li> <li>Plane or dise cam         <ul> <li>Plane or dise cam</li> <li>Contical cam</li> <li>Contical cam</li> </ul> </li></ul>		4. A pressure sensitive switch is attached to the reservior that activates the compressor through on-off control and motor.	
B)     Attempt any two of the following:     8       a)     1. State the working principle of cam. List its types. Give any two applications of cam.     Working Principle M, Types-IM, Any 4 Applications       a)     Image: Constraint of the following:     Image: Constraint of the following is the f		5. The control valve operates the cylinder –piston as per load requirement.	
B)       Attempt any two of the following:       8         i)       i. State the working principle of cam. List its types. Give any two applications of cam.       (Working Principle 11M, Types-11M, Any 4 Applications.         ii)       iiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiiii			
<ul> <li>i. State the working principle of cam. List its types. Give any two applications of cam.</li> <li>(Working Principle III, Types-III, A, Applications - 2M)</li> <li>(Working Principle III, Types-IIII, A, any 4</li> <li>(optional)</li> <li>Working principle of cam:</li> <li>A cam is mechanical rotating machine element which is used for converting one motion.</li> <li>In to another. It is rotating machine element that gives reciprocating or oscillating motion to another element known as follower. Usually cams are rotated at uniform speed by shaft. The follower motion is predetermined according to the shape of cam.</li> <li>Types of CAM:         <ul> <li>Wedge/filat cam</li> <li>Plane or disc cam</li> <li>Cylindrical cam</li> <li>Conical cam</li> </ul> </li> </ul>	B)	Attempt any two of the following:	8
can.       (Working Principle IM, Types-IIM, Any 4 Applications         interface       interface         interface       interface         interface       interface         into an other       interface         into another       into another dement known as follower. Usually cans are rotated at uniform speed by shaft. The follower motion is predetermined according to the shape of cana .         into another element known as follower is made to rise dwell and fall the lengths of times spent at each of these positions depending upon shape of the cam.         Expess of CAME         • Wedge/flat cam         • Plane or disc cam         • Cylindrical cam         • Conical cam	i)	i. State the working principle of cam. List its types. Give any two applications of	
<ul> <li>Fail Grant Rise</li> <li>coptional J</li> <li>Morting principle of cam:</li> <li>A carn is mechanical rotating machine element which is used for converting one motion.</li> <li>In to another I the is rotating machine element that gives reciprocating or oscillating motion to another element known as follower. Usually cams are rotated at uniform speed by shaft. The follower motion is predetermined according to the shape of cam.</li> <li>Cam rotates and doing so , imports reciprocating motion to follower, with which it is in contact. As the cam rotates, the follower is made to rise dwell and fall, the lengths of times spent at each of these positions depending upon shape of the cam.</li> <li>Medge/flat cam</li> <li>Plane or dise cam</li> <li>Cylindrical cam</li> <li>Conical cam</li> </ul>		cam.	(Working Principle 1M, Types- 1M, Any 4 Applications - 2M)
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- Helical cam
  - Radial
  - 3-dimentional

## Applications of cam:

- Automatic machines.
- IC engines.
- Machine tools.
- Printing control mechanisms.
- Spinning and weaving machineries.
- Textile machineries.
- Paper cutting machines.

# ii) ii. What is 'Part Programming'? Enlist basic requirements for part programming with suitable example

## **Ans: Part programming:**

The part program is a sequence of instructions, which describe the work, which has to be done on a part, in the form required by a computer under the control of a numerical control computer program. It is the task of preparing a program sheet from a drawing sheet. All data is fed into the numerical control system using a standardized format. Programming is where all the machining data are compiled and where the data are translated into a language which can be understood by the control system of the machine tool.

The part programming contains the list of coordinate values along the X, Y and Z directions of the entire tool
path to finish the component. The program should also contain information, such as feed and speed. Each of the
necessary instructions for a particular operation given in the part program is known as an NC word. A group of

such NC words constitutes a complete NC instruction, known as block. The commonly used words are N, G, F, S, T, and M.

- Hence the methods of part programming can be of two types depending upon the two techniques as below:
- Manual part programming
- Computer aided part programming
  - 1. It is series of coded instructions required to produce a part.
  - 2. It controls the movement of the machine tool and on/off control of auxiliary

(Explanation of part programmin g 2M, Basic requirement 2M)

	functions such as spindle rotation and coolant.	
	3. The coded instructions are composed of letters, numbers and symbols	
Basic	requirements for part programming with suitable example	
•	Knowledge about various manufacturing processes and machine	
•	Sequence of operations to be performed for a given component.	
•	Knowledge of the selection of cutting parameters.	
٠	Editing the part program according to the design changes.	
	Knowledge about the codes and functions used in part programs.	
	Requirement Computer aided part programming	
	The programme has to do only following things:	
	(a) Defining the work part geometry.	
	(b) Defining the repetition work.	
	(c) Specifying the operation sequence	
) Ar	Draw and explain strain guage accelerometer. ns: Diagram:	
1	and the second sector of research the discrepting sector is possible	
		(Diagram
	Strain gauges Casing	2M, Explanation
	Beam Seismic mass	2M)
	Work piece	
Ex	planation	
Th ho pla	e seismic mass is placed on the cantilever beam placed inside the housing . The using is filled with fluid to create damping force. The strain gauges of same type are used on both the top and bottom surface of cantilever beam as shown in fig.	

2

	If any force acting on housing frame, the corresponding displacement by the mass will take place inside the housing . Owing to this, the mass is displaced from original place, which is sensed by strain gauges placed over the cantilever beam. Therefore, the change in resistance occur in strain gauges due to mass displacement according to Wheatstone bride circuit. At the same time, a damping force of the fluid by mass displacement. Owing to both mass displacement and damping force of the fluid, the beam bends, which produces strain on the beam. This strain is directly proportional to the acceleration.	
a)	Attempt any four of the following:	16
	a)With diagram, explain working hall effect sensor.	
	Ans: Diagram:	(Diagram 2M, Explanation 2M)
	<b>Working:</b> Working principle of a Hall effect sensor is that if strip of conducting material carries a current in presence of transverse magnetic field as shown fig . The difference of potential is produced between the opposite edges of the conductor. The magnitude of the voltage depends upon the current and magnetic field. The current is passed through leads 1 and 2 of the strip and output leads 3 and 4 are connected with Hall strip . When a transverse magnetic field passes through the strip, the voltage difference occurs in output leads.	
	b. Explain in brief spherical robot. Why it is called as spherical robot?	
b)	Ans:-	
	OR	













These cylinders produce work in one direction of motion hence they are named as single acting cylinders. The compressed fluid pushes the piston located in the cylindrical barrel causing the desired motion. The return stroke takes place by the action of a spring .generally the spring is provided on the rod side of the cylinder.

	Explain in brief, how antilo	ock barking syste	em works.	Diagram – 2 mks,
	Ans: An ABS is a sys	tem on motor	vehicles which prevents the wheels from locking	explanation-2
	while braking stopping	safely is one o	of the most important functions a motor vehicle can	mks
	perform			
	Diagram:			
	2014		The second second	
	Batteny Isnitten		Retay szotos	
	Overning post-tion			
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## Explanation: 04M

Failure of the brake system will almost invariably results in property damage, personal injury or even death. An ABS allow the driver to maintain steering control under heavy braking by preventing a skid and allowing the wheel to continue to roll forward and create lateral control, as directed by driver steering inputs.

A typical ABS is composed of a central electronic unit, four speed sensors (one for each wheel)

The electronic unit constantly monitors the rotation speed of each wheel. The pulsed output

from the wheel speed sensors goes to an electronic controller which monitors each wheels speed relative to the speed of the other wheels.

As long as the brakes are not being applied and all of the monitored wheels are rotating at roughly the same speed, the system takes no action.

If however the brakes are being applied and one or more monitored wheels suddenly beings to reduce speed indicating a loss of traction with load the controller then activates the antilock system.

When it senses that any one of the wheels is rotating slower than the others, it moves the valves to decrease the pressure on the braking circuit, effectively reducing the braking force on that wheel.



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Survey bernest and	Storage	effectors
	1- 1-0	

Functions Of An End Effector : (diagram is optional)

1. End effector is the device at the end of a robotic arm designed to interact with the environment.

2. End effectors originates from robotic manipulators (robotic arm) It is the last link of the robot.

3. It is a last link of the robot. It is similar to human hand with or without finger. It incorporates various sensors



## Fig. End effectors

e) Explain how the piezoelectric effect is used to measure acceleration. List the features of Diagram:- (2 mks)

Ans :







OR



<b>Graphical Displays:</b> Various variable, outputs, voltages etc.	types of graphical displays are used for display waveforms can be displayed for various analy	ving measured ses by CRT.	
<b>Controllers:</b> It takes input f equal to the required set points is given to actuators and sense	rom output signal conditioning and interface s then it is adjusted based on generated error an ors.	and if is not d again signal	
b) Explain the classification of r Robot. Ans	robots on the basis of work place ? Give one ex	ample of each	:- classificatio – 2 mks, one example of each – 2 mks
Classification of rol	oot:		
• M	aterial Processing robot		
• 101			
• •	seembly robot		
• A • In	ssembly robot spection robot		
• A • In	ssembly robot spection robot	-	
<ul> <li>A</li> <li>In</li> <li>Type of Robot</li> </ul>	ssembly robot spection robot Example		
A     In     Type of Robot     Material processing robot	Example  1. Spot welding 2. Continuous arc welding 3. Spray painting 4. Machining operations		
A     In     Type of Robot     Material processing robot     Material handling robot	ssembly robot spection robot Example 1. Spot welding 2. Continuous arc welding 3. Spray painting 4. Machining operations 1. Movement of parts, tools, materials and equipment.		
A     In     Type of Robot     Material processing robot     Material handling robot     Assembly robot	statemat mandring robot         ssembly robot         spection robot         Example         1. Spot welding         2. Continuous arc welding         3. Spray painting         4. Machining operations         1. Movement of parts, tools, materials and equipment.         1. Select and assemble components.         2. Part linking and part joining.         3. Pick and Place robot.		
A     A     In     Type of Robot     Material processing robot     Material handling robot     Assembly robot     Inspection robot	ssembly robot spection robot Example 1. Spot welding 2. Continuous arc welding 3. Spray painting 4. Machining operations 1. Movement of parts, tools, materials and equipment. 1. Select and assemble components. 2. Part linking and part joining. 3. Pick and Place robot. 1. Detect the presence or absence of a component in an assembly line using touch or an optical sensor.		
A     In     Type of Robot     Material processing robot     Material handling robot     Assembly robot     Inspection robot     c) Draw the schematic and ladded	seembly robot         spection robot         Example         1. Spot welding         2. Continuous arc welding         3. Spray painting         4. Machining operations         1. Movement of parts, tools, materials and equipment.         1. Select and assemble components.         2. Part linking and part joining.         3. Pick and Place robot.         1. Detect the presence or absence of a component in an assembly line using touch or an optical sensor.	system.	









		additions with the membership function of the respective variables .These in additions with the membership function curve are utilized to come to a solution .	
5	a)	5. Attempt <b>any four</b> of the following :	16
		Ans: Block diagram –Diagram:	2 mks, explanation
		Gripper Arm 14 Base (b) Gripper (c) Pick 2 Place	of requirement – 2 mks
		has three axes about which motion can occur. Rotation in a clockwise or anti-clock wise direction of the unit on its base. Arm extension or contraction and arm up or down. Gripper can open or close. These movements can be actuated by the use of pneumatic cylinders operated by solenoid controlled valves with limit switches to indicate when a motion is completed. Thus clock wise rotation of the unit might result from the piston in a cylinder being extended and the anticlockwise direction by its retraction.	
		Likewise the upward movement of the arm might result from the piston in a linear cylinder being extended and the downward motion from it retracting. The extension of the arm by the piston in another cylinder extending and its return movement by the piston retracting. The gripper can be opened or closed by the piston in a	
	b)	<ul> <li>b) Explain MEMS accelerometer used as air bag sensors for car safety.</li> <li>Ans: MEMS Accelerometer is used as airbag sensor:</li> </ul>	

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film	n Sioz	
1. Marsh.		<b>ID</b> !
		[Diagram Mark,
	- sinn	Explana 2 Marki
Explanation	- Mechanical ignition airbags fit inside the steering wheel pad. When a	
collision		
occurs, the in	ertial sensor moves, setting off a mechanical igniter and inflator to deploy the e sensor and igniter were in the same unit, the compact airbag unit easily fit	
most steerin	g wheels, allowing broad application of the airbag unit. With electrical	
ignition		
airbags, a co	mputer monitors signals from the impact sensor. When it detects a collision,	
computer set	s off the airbag's igniter electrically. Therefore, the sensor need not be close	
to		
the airbag, bu	It can be placed anywhere on the vehicle and connected to the airbag with	
wiring. This	is especially effective when fitting both driver- and passenger-side and ags.	
c) Draw and e	xplain LVDT accelerometer.	
Ans:		
Diagram:		



## Working:

A type of accelerometer takes advantage of the natural linear displacement measurement of the LVDT to measure mass displacement. LVDT is Linear Variable differential transducer which works on magnetic principle. In these instruments, the LVDT core itself is the seismic mass.

Displacements of the core are converted directly into a linearly proportional ac voltage. These accelerometers generally have a natural frequency less than 80 Hz and are commonly used for steady-state and low-frequency vibration. Fig. shows the basic structure of such an accelerometer.

## d)

d) Draw and explain PLC ladder diagram of ON-OFF control of lamp.

## Ans : Diagram



## Explanation:- (2 mks)

Figure above shows simple ladder diagram for ON- OFF control of lamp. I: 0/0 is start button, as soon as it is pressed the contact gets closed and output binary bits B3 : 0/0 goes high (logic 1). As soon as B3 : 0/0 is high, lamp O: 0/0 turns ON as shown in rung 2. When I:0/1 stop button is pressed, contact gets open and B3:0/0 goes low(Logic 0). When B3:0/0 goes logic 0, lamp named O: 0/0 turns off.

e) Explain how torque is calculated using Torsion-bar torque transducer.

(Any correct ladder logic) - (2 mks) , Explanation: - (2 mks)



Sr. No.	Pneumatic System	Hydraulic System	
1.	Pneumatic system uses gas for power transmission, after compression and it is used as medium for carrying out mechanical work.	In hydraulic systems, a liquid-based solution such as oil is used under pressure to carry out work.	
2.	The components of these systems are compressor, air receiver, directional control valve, and pneumatic cylinder.	The components of these systems are pump, pressure regulation/relief valve, control valve, filter and hydraulic cylinder.	four relevant points – 4 mks)
3.	The excess air is vent out to atmosphere.	The excess fluid is return back to the tank.	
4.	Motor driven compressor is used to pull air from atmosphere.	Pump and motor combination is used to pull liquid from tank or reservoir.	
5.	External lubricator is required during mechanical motion of cylinder.	External lubricator is not require as oil acts as a lubricator.	
6.	The system is more costly	The system is less costly.	
7.	Applications: In industrial applications, air conditioners	Applications: In petrochemical industries, oil refineries.	

## 6. Attempt **any four** of the following :

a) Describe poppet valve with neat sketch.

**Ans:-** A poppet valve (also called mushroom valve) is a valve typically used to control the timing and quantity of gas or vapors flow into an engine. It consists of a hole, usually round or oval, and a tapered plug, usually a disk shape on the end of a shaft also called a valve stem. The portion of the hole where the plug meets with it is referred to as the 'seat' or 'valve seat'. The shaft guides the plug portion by sliding through a valve guide. In exhaust applications, a pressure differential helps to seal the valve and in intake valves a pressure differential helps open it. Poppet valves date from at least the 1770s, when James Watt used them on his steam engines.

Poppet valves are used in many industrial processes, from controlling the flow of milk to isolating sterile air in the semiconductor industry. However, they are most well known for their use in internal combustion and steam engines, as described below

16

a)







d) d) Explain the concept of degree of freedom of Robot with sketch. Ans:-DOF: Degree of freedom is a term used to describe a robot's freedom of motion in 3 dimensional spaces specifically the ability to move forward and backward, up and down, left and right. For each DOF a joint is required. Retational traverse Redial traver Vertical traverse Pilch Sketch – 2 mks. explanation-2 mks Fig. Degree of freedom (DOF) End effectors: · End effector is the device at the end of a robotic arm designed to interact with the environment. · End effectors originates from robotic manipulators (robotic arm) It is the last link of the robot. End effectors. · It is a device at the end of robotic arm , designated to interact with the work environment It is a last link of the robot. It is similar to human hand with or without finger. It incorporates various sensors e) e) Enlist the advantages of Microcontroller (any four). Ans:-



