

### DEPARTMENT OF MECHATRONICS III SEMESTER B. TECH MECHATRONICS END SEM EXAM

Subject: Sensors & Instrumentation Time: 45 Min + 3 Min Subject Code: MTE 2155 Date: 31/01/2022

### Part-A Note: All Questions carry equal mark (One mark each).

<b>Q</b> .		Μ	СО	РО	LO	BL
No						
1.	When a relay is not energized,	1	1	1	1	1
	1. There is an electrical path through the NC contacts.					
	2. There is an electrical path through the NO contacts.					
	3. Neither the NO nor the NO contacts have an electrical					
	path.					
	4. Both the NO and the NO contacts have an electrical path.					
2	Statement 1: All Sensors are transducers.	1	3	1	1	4
	Statement 2: All transducers are sensors.					
	Are the statements true or false?					
	1. True, False					
	2. False, True					
	3. False, False					
	4. True, True					
3	Material that cannot be used in manufacturing potentiometer.	1	3	1	1	1
	1. Carbon composition					
	2. Nichrome					
	3. Conductive plastic					
	4. Asbestos					
4	The working sequence of a washing machine is shown in Fig. 1.	1	2	1	1	3
	Which of the register values is incorrect sequence for the "rinse					
	cycle" of the washing machine?					

[						1000	-	-		1.000	-		de la	-					T		1	r –	
	Interval	Soap	Helease	Water in	vaive	Wash Impeller		Ualve	AUNO	Drain	Pump	Drv-heat	Element										
	1			X									199										
	2	Ci Celo		N A		X					- Store		19.51	1									
	3	1						X		X		22											
	4	×		and the						J.	1250												
	5	1 20	100	X	190			105		1.7.1	5.00	1											
	6					×							1										
	7							x		X													
	8			X		200		-															
	9	3/2/2		-191		X	1	1		1		21.53											
	.10					1	-	X		X													
	11											×	5										
	1. 2. 3. 4.	000 001 010 100	110 000 000 000	) ) )																			
5	Resolv	er w	ork	s on	the	prin	cip	al o	of n	nutu	ial	ind	uct	anc	e v	aria	ation	1.	1	3	1	1	1
	It is ma	ainly Pot	use	ed fo moti	r th	e me	east	irer	ner	it of	f _			·									
	1. 2.	Lin	ai y iear	disp	lace	eme	nt																
	3.	Nor	n-lir	near o	disp	lace	me	nt															
	4.	Vel	ocit	y Gli	<u> </u>	0.1		•															-
6	For a 1	6-b1 cond	t B1 litio	t Shi n of	tt L	eft l	Keg Pori	1Ste	erg 	ive	n b	elo	w:						I	2	1	1	3
	1 0	1	1			1			1	1	1	0	1		0	0	1						
	First sh	nift, I	Data	a-in:	Hig	gh.																	
	Second	l shi	ft, E	Data-	in: ]	Low	,																
	What v	vill t	be th	ne co	onte	nt of	the	e re	gis	ter	afte	er tv	WO	shi	fts'	)							
		Α	1	1	0	0 1	0	1	1	1	0	1	0	0	1	1	0	]					
			-	-	U I		Ŭ	1	1	-	Ŭ		Ŭ	Ŭ		-	Ŭ						
		В	1	1	0	1 1	0	0	1	0	1	1	1	0	1	0	0						
		C	0	1	1	0 0	1	0	1	1	1	0	1	0	0	1	1						
		D	1	1	0	1 1	0	0	1	0	1	1	1	0	1	0	0						
								<u> </u>	1	J													
	1.	А																					
	2.	В																					
	3.	С																					



_		1	-			2
7.	For a 16-bit Bit Shift Left Register, the initial bits are shown	1	2	1	1	3
	Delow: Initial condition of the hit register:					
	FIRST SHILL, Data-III: HIgh. Second shift Data in: Low					
	Mention the last hit/s after two shifts					
	ivention the tost bit's area two sints.					
	1 0					
	2 1					
	3 Insufficient data					
	4. 0 & 1 both					
8.	The Boolean representation of the PLC program shown below is	1	2	1	1	3
0.	······································	1	-	1	1	5
	D					
	A) $[A \cdot B + D]C$					
	B) $[A + B \cdot \overline{D}]C$					
	C) $[A, \overline{B} + \overline{D}]C$					
	$\mathbf{D}$ $[\mathbf{A}, \mathbf{D} \in \overline{\mathbf{D}}]_{\mathbf{C}}$					
	$D) [A \cdot B + D]C$					
						-
9.	Identify the OSI model layer for the service given below in	1	4	1	1	3
	networking systems:					
	Time-out of Student Life Cycle Management (slcm)					
	1. Application layer					
	2. Session layer					
	3. Data link layer					
	4. Presentation layer					
10.	Which among the following is not a Sensor level communication	1	4	1	1	1
	protocol?					
	1.Profibus-PA					
	2. MODBUS					
	3.CAN					
	4.AS-I					
11.	Transmission Control Protocol (TCP) and User Datagram	1	4	1	1	3
	Protocol (UDP), these protocols are supported by layer of					
	the ISO-OSI Model.					
	1. Transport					
	2 Session					
	3 Network					
	J. INCLINUIK					
	4. Data link					



12.	is used to transmit torque over long distance without the use of rigid mechanical connection.	1	3	1	1	1
	a) Potentiometer					
	b) Synchros					
	c)LVDT					
	d)Hall-effect phenomenon					
13.	Identify the contact-based transducer from the following.	1	3	1	1	1
	a) LVDT					
	b) Synchros					
	c) Potentiometer					
14	d) Potentiometer & Synchros both	1		1	1	•
14.	A thermistor cannot be used for the following application	1	3	1	I	2
	a) Measurement of flow					
	b) Measurement of temperature					
	<ul> <li>C) Measurement of strain</li> <li>d) Protection from current surges</li> </ul>					
15	d) Protection from current surges	1	2	1	1	2
15.	A tootned rotor variable reluctance tachometer, with 20 teeth, is	1	3	1	1	3
	used to measure the speed of a motor. The sensor records 100					
	a) 5 rpm					
	b) $60 \text{ rpm}$					
	c) 300 rpm					
	d) 100 rpm					
16.	The working of a thermocouple is not affected by soldering lead	1	3	1	1	2
10.	wires due to which of the following thermoelectric laws?	1	5	1	1	2
	a) Law of intermediate temperatures					
	b) Law of intermediate metals					
	c) Law of homogenous circuits					
	d) Law of homogenous metals					
17.	In a steel production industry, precise angular position of a motor	1	3	1	1	4
	is required to be continuously monitored. The motor is placed					
	close to a furnace and thus is subjected to high temperature and					
	rough environmental conditions. The most suitable sensor for the					
	purpose would be:					
	a) Absolute encoder					
	b) Incremental Encoder					
	c) Potentiometer					
10	d) Resolver	1	-	1	1	-
18.	what is the angular resolution of an absolute encoder having 8		3	1	1	3
	tracks in the encoder disc?					
	(a) 1.4 b) $45^{\circ}$					
	a) 0.25°					
	d) 2.8°					
10	Consider the following transducers:	1	3	1	1	2
		1 I	5	1	1	-



	a. LVDT b. Piezoelectric c. Thermocouple d. Toothed					
	wheel tachometer e. Strain gauge					
	Which of these are active transducers?					
	a) a,c,e					
	b) b,c,d					
	c) b,c,e					
	d) a,c,d					
		1	2	1	1	
20.	With reference to a robotic system, which of the following	1	3	1	1	2
	statement about sensors is incorrect:					
	a) The encoder provides feedback about motor shaft					
	position, speed and acceleration					
	b) The gyroscope provides information about the orientation					
	of the robot					
	c) Grippers comprise force and factile sensors which can be					
	force sensitive resistors or piezo resistors.					
	d) LIDAR sensor maps the space around the robot					
	facilitating collision free navigation					
21.	In order to measure strain in a cantilever beam, two strain gauges	1	3	1	1	3
	of resistances 1 k $\Omega$ and gauge factor of 2 are mounted on the					
	beam (in a configuration to achieve maximum sensitivity) and					
	connected to a bridge circuit. The other two fixed resistances are					
	1 k\Omega each. Calculate the bridge output voltage for $0.1\%$ strain.					
	a) $10 \text{ mV}$					
	b) SmV					
	c) 2.5mV					
	d) 15mV					
22.	Which of the following resistive sensor configurations offers the	1	3	1	1	1
	least noise immunity to lead wire resistance fluctuations?					
	a) Two wire bridge configuration					
	b) Three wire bridge configuration					
	c) Four wire configuration					
	d) Voltage divider configuration					
23.	For a piezoelectric crystal of dimension 5mm x 5mm x 5mm and	1	3	1	1	3
	voltage sensitivity 50 x $10^{-3}$ Vm/N, what is voltage generated for					
	a pressure of 50N?					
	a) $2.5 \text{ V}$					
	b) 2.5 mV					
	c) 12.5 V					
	d) 12.5 mV					
24.	If a 3N force acts on a quartz crystal along XY plane at an angle	1	3	1	1	3
	of $30^{\circ}$ to X, then what is the charge developed in the X axis					
	$(Q_{xx})?$					
	Given, $d_{11} = 2.3 \times 10^{-12} \text{ C/N}$ , $d14 = -0.67 \times 10 - 12 \text{ C/N}$					
	a) 2.52 pC					
	b) 6.9 pC					
	c) 9.42 pC					
	d) 12.3 pC					

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25.	Which type of orificemeter can be used for the measurement of flow of water with suspended solid particles?	1	3	1	1	2
	(a) (b) (c) (d) (d)					
	a) (a) b) (b) c) (c)					
	d) (d)					
26.	Refer the datasheet of Platinum RTD sensor as attached.	1	3	1	1	3
	Considering linear approximation of the RTD resistance-					
	temperature characteristics, calculate the resistance of the sensor					
	at 25 degree C					
	a) 110.43 ohms					
	b) 109.37 ohms					
	c) 109.75 ohms					
	d) 125.02 ohms					
27.	Refer the datasheet of the Platinum RTD sensor as attached.	1	3	1	1	3
	Calculate the accuracy of the sensor at a temperature of 60 degree					
	C.					
	a) ±0.3°C					
	b) ±0.36°C					
	c) ±0.48°C					
	d) ±0.5°C					
28.	What is the sensitivity of a J-type thermocouple with a	1	3	1	1	3
	temperature range of -100 to +1350 and an output range of 0 to $10 \text{ V}$ ?					
	a) 6.4 mV/°C					
	b) 8 mV/°C					
	c) $7.4 \text{ mV}/^{\circ}\text{C}$					
	d) 6.9 mV/°C					
29.	You need to measure the temperature of a hot air oven, whose	1	3	1	1	2
	temperature varies from 37 to 200 degree C. You require an					
	accuracy of $\pm 0.2$ but are a little low on budget. What kind of					
	temperature sensor would you prefer?					
	a) RTD					
	b) K-type thermocouple					
	c) J-type thermocouple					
	d) Metal oxide thermistor					
30.	A thermopile is:	1	3	1	1	1
	a) Used to average out readings of thermocouples connected					
	in parallel					
	b) Used to add the readings of thermocouples connected in					
	series					
	c) Another name for thermocouple					



d)	Used to add the readings of thermocouples connected in			
	parallel			

### DEPARTMENT OF MECHATRONICS ENGINEERING III SEMESTER B. TECH MECHATRONICS ENGINEERING

### END SEM EXAM PART B

MANIPAL INSTITUTE OF TECHNOLOGY

### Subject: Sensors & Instrumentation

MANIPAL (A constituent unit of MAHE, Manipal)

Subject Code: MTE 2155

Time: 2.20 to 3.45 pm

### Date: 31/1/2022

Q. No.		Μ	CO	РО	LO	B L
1A	Develop a ladder logic program that will give output 'B', 20 seconds after 'A' has been turned ON. After 'A' is pushed, there will be a 20-second delay, and the timer will reset. After 'A' has been pushed 3 times, 'B' should go OFF. Also, draw the Timing diagram: T-off Timer.	5	2	3	5	6, 3
18	A well-known chemical manufacturer was experiencing repeated product (thermistor) failure and the key problems that were causing the failure was the high- pressure environment and the high temperature of a vessel containing the reaction of partial oxidization of natural gas to carbon monoxide (POX). The products had to last for a two-year plant rebuild cycle. The customer needed to be supplied with full material, process control, testing, and safety documentation. Mention the steps to guide the customer to avoid such sensor failure risks.	3	3	6,1	18	3
1C	Strain gauges are used for health monitoring of the pillars of a bridge as shown in Fig.Q1c. Demonstrate a configuration in which the strain gauges should be placed on a pillar for maximum sensitivity: elucidate the number of strain gauges to be used for each measurement, the placement/ arrangement of the sensors and the electrical connections for measurement of resistance change.	2	3	2	2	4



r						
	Fig.Q1c					
2A	IEC 61508 has become a foundation for international standards of the safety-related systems such as airborne systems, railway, nuclear power plants, medical equipment, energy and process systems, machinery, aces, and automobiles emphasizing the complete safety installation from sensor to actuator with its technical as well as management issues. The failure of such a system could have a significant impact on the safety of humans and/or the environment. Mention the three major steps which are involved in such a safety risk assessment procedure and give an automatic of a risk assessment procedure and give an	4	5	6	9	4
2B	The modern vehicles as shown in Fig. Q2b are embedded with many functionalities including steering and braking data which are communicated electronically from the driver to the actuators. The implementation strongly depends on the choice of braking mechanics (e.g., hydraulics, pneumatics, electro-hydraulics, or even electro-mechanics), the	4	4	2	2	4
	availability of a transmission ECU, and the interface to the engine ECU. Therefore, in order to have a smooth and bumpless transfer of data within all the ECUs of such vehicles, a standardized protocol is required for proper communication within the control system. Suggest and elucidate the most suitable communication protocol for this purpose.					



	<image/>					
• •	1 ig. Q20		2	1	1	2
2C	A thermocouple is used to measure the temperature of a gas turbine exhaust. The reference junction temperature of the thermocouple is measured by a RTD. At some time instant, the RTD registers a temperature of 25°C and the thermocouple gives a voltage output of 5.97 mV. Calculate the temperature of the gas turbine at the instant from Appendix 1.	2	3	1	1	3