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Enrolment No:	

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2018

Programme Name: B.Tech Mechatronics Course Name : Mechatronics System Design Course Code : MEEL404 Nos. of page(s) : 3 Instructions:	Semester : VII Time : 03 hrs Max. Marks : 100
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SECTION A

S. No.		Marks	CO
Q 1	A hospital is interested in developing an instrument to measure the force exerted by the humans finger. This instrument will be useful in the rehabilitation department. How will you approach the design of such an instrument. Identify the type of sensor, explain its principle with a possible sketch.	4	CO3
Q 2	The automatic control system for the temperature of a bath of liquid consists of a reference voltage fed into a differential amplifier. This is connected to a relay, which then switches on or off the electrical power to a heater in the liquid. Negative feedback is provided by a measurement system, which feeds a voltage into the differential amplifier. sketch a block diagram of the system and explain how the error signal is produced.	4	CO3

Q 3	A steel mill has production set up where metal sheets are rolled for desired thickness as they emerge from the production sequence. It is a continuous, real time production and measurement have to be made on line. Suggest a sensor that can do the job. The final output should be electrical	4	CO3
Q 4	Strain is mounted in a cantilever beam using strain gauge of resistance $1\text{ K}\Omega$, $GF=2$ and temperature coefficient = $10^{-5}/^{\circ}\text{C}$ at room temperature. It is mounted on beam and connected to the bridge circuit. (a) Calculate the change in resistance of the gauge if the gauge is strained 0.1%(use strain 5.0011) (b) Calculate the change in effective strain indicated when the room temperature increased by 10°C	4	CO4
Q 5	Describe the features of interactive modeling	4	CO1

SECTION B

Q 6	A machine table driven by a closed loop positioning system consists of a servo motor, lead screw, and optical encoder. The lead screw has a pitch of 0.500 cm and is coupled to the motor shaft with a gear ratio of 4:1(4 turns of motor for 1 turn of lead screw). The optical encoder generates 150 pulses/rev of the lead screw. The table has been programmed to move a distance of 15 cm at a feed rate of 45	10	CO3
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	<p>cm/min. determine</p> <p>(a) How many pulses are received by the control system to verify that table has moved exactly 15 cm?</p> <p>(b) What is the pulse rate?</p> <p>(c) What is the motor speed that corresponds to the specified feed rate?</p>		
Q 7	Describe the process of rapid prototyping of a mechatronic product.	10	CO3

Q 8	<p>A 1.8° stepper motor is directly connected to a machine table driven by a lead screw with three threads per cm.</p> <p>(a) Determine the axial distance traveled by the lead screw when an external input of 4355 pulses are sent to motor</p> <p>(b) A separate encoder is connected to the other end of the lead screw. The encoder generates 180 pulses/rev. What will be the number of pulses in the part(a)</p>	10	CO4
Q 9	<p>Describe the mechatronics system design. How is it different from the traditional approach of designing. State the advantage and disadvantage of using the mechatronics design methodology.</p> <p style="text-align: center;">OR</p> <p>Understand the purpose of the following mechatronics system and recommend appropriate sensor and actuator to carry out the specified task.</p> <p>a. Temperature control system Purpose: To maintain the temperature of a confined space at the specified temperature.</p> <p>b. Anti-Lock braking system Purpose: To prevent wheels from locking up by automatically modulating the brake pressure during an emergency stop.</p>	10	CO2

SECTION-C

Q 10	<p>A computer numerically controlled PCB drilling machine uses a stepper motor for the positioning purposes. The lead screw which drives the table of the machine tool has a pitch of 10 mm. the work table traverse 40 mm at a linear speed of 400 mm per minute. If the stepper motor has 180 step angles, calculate the speed of the stepper and the number of pulses needed to move the machine table to a desired location.</p>	20	CO1
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Q 11	<p>Piezoelectric crystals of 1cm^2, 0.1cm thick has been subjected to a force. two metal electrodes measure the change in the crystal. Young's modulus of the material $=9 \times 10^{10}$ Pa, Charge sensitivity $2\text{pF}/\text{Relative permittivity}$ is 5; the applied force is 0.01N</p> <ol style="list-style-type: none"> Find the voltage across the electrodes Find the change in the crystal thickness <p>Output Voltage $= gF/A$; $g=d/\epsilon_r \epsilon_0 V_m/N$</p> <p style="text-align: center;">OR</p> <p>A CNC machine tool table is powered by a servo motor, lead screw, and optical encoder. The lead screw has a pitch of 5 mm and is connected to the motor shaft with a gear ratio of $16:1$ (16 turns of the motor for one turn of the lead screw). The optical encoder is connected directly to the lead screw and generates 200 pulses per revolutions of the lead screw/ The table must move a distance of 100 mm at the feed rate of $= 500\text{mm}/\text{min}$. Determine</p> <ol style="list-style-type: none"> pulse count received by the control system to verify that the table has moved exactly 100 mm pulse rate motor speed that corresponds to the feed rate of $500\text{mm}/\text{min}$ <p>If the range of the work table axis is 500 mm and there are 12 bits in the binary register used by the digital controller to store the position, determine the control resolution</p>	20	CO4