

BOX OF THE

Please **DARKEN** the answer you believe most correctly answers the question. Each question is worth 1 point ...

1. The definition of IMPEDANCE is:

- “the characteristic of a circuit element to limit the flow of voltage”
- “the characteristic of a voltage that causes a battery to lose its power”
- “the characteristic of a circuit element to limit the flow of current”

2. What are the three fundamental elements of mechatronics?

*37/40**93*

- Sensors, computers, motors
- Sensors, controllers, actuators
- Switches, microcontrollers, motors

3. Which expression gives the force developed in a ^{extension} tension spring for a given displacement:

- $F = F_i + kx$
- $F = kx$
- $F = ma$
- $F = M / d$

4. For power transmission, under the conditions of LOW torque and HIGH speed, which would you recommend in your design:

- Belt drive
- Chain drive
- Friction drive

5. The function of SENSORS in mechatronic systems is to:

- Provide programs to the microcontroller
- Provide measurements of system parameters and conditions
- Provide electricity to the control system
- Control the actuators

6. Which statement is NOT true in comparing mechatronic designs to traditional mechanical designs:

- Mechatronic designs are more functional
- Mechatronics designs overcome limitations of mechanical designs
- Mechatronic designs are difficult to modify once implemented
- Mechatronic designs enhance “smartness” of traditional mechanical designs

7. What is the term used in Lego RCX programming that describes the “connecting” of function icons together (hint: what “tool” do you use to connect the icons together)?

- Wiring
- Pasting
- Welding
- Matrimony

8. Which statement is FALSE when comparing “potentiometers” to “strain gages”.

- They are both resistive sensors
- They both measure displacement
- They both work with output ports on microcontrollers
- They both utilize circuits based on voltage dividers to operate

9. DARKEN ALL OF THE POINTS about “mechatronics”, that you believe are CORRECT (1 point each correct answer, - 2 points for each incorrect answer!!):

- Mechatronics is relevant to the future of mechanical engineering
- Mechatronics overcomes design limitations of traditional mechanical designs
- Mechatronics is being embraced by major manufacturers of goods such as automobiles and appliances
- Mechatronics design does not require in-depth education in electrical engineering
- Industry and consumers demand products that feature functionality and “smartness”
- Mechatronics designs answers the demand of industry and consumers
- I sure am glad I got some mechatronics education at Kettering University!

Short Problems (5 pts each)

10. A motor spinning at 60 revolutions per second has a 1/4-inch diameter wheel attached to its shaft. This is used, via a belt drive system under no-slip conditions, to turn a 4-inch diameter wheel. **MAKE A DIAGRAM OF THIS SYSTEM.** Determine the speed in **RPM** of the driven wheel.



$$60 \text{ R/s} \left(\frac{60 \text{ s}}{1 \text{ min}} \right) = 3600 \text{ RPM}$$

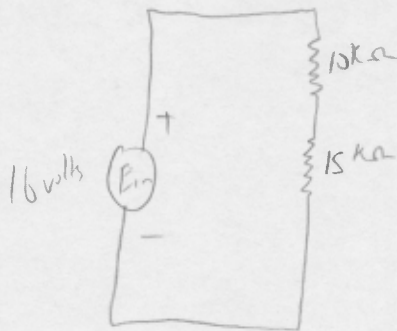
$$\frac{3600}{16} = 225 \text{ RPM} \quad \checkmark$$

11. For the system of problem 11, the motor turns with a torque of 8 inch-pounds. What is the torque developed on the shaft of the driven wheel?

$$T_s = 8 \text{ in-lbs}$$

$$T_{aw} = 8 \times 16 = 128 \text{ in-lbs} \quad \checkmark$$

12. **Draw** a voltage divider circuit with the following parameters: $E_{in} = 16$ volts, $R_1 = 10$ kilo-ohm and $R_2 = 15$ kilo-ohm. What is the voltage measured across R_2 ?



$$V_{R_2} = E_{in} \left(\frac{R_2}{R_1 + R_2} \right) = 16 \left(\frac{15}{25} \right) = 9.6 \text{ volts} \quad \checkmark$$

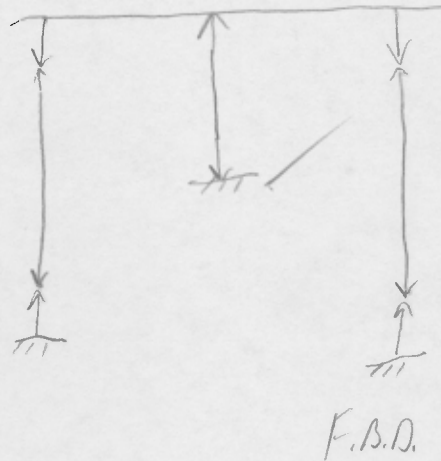
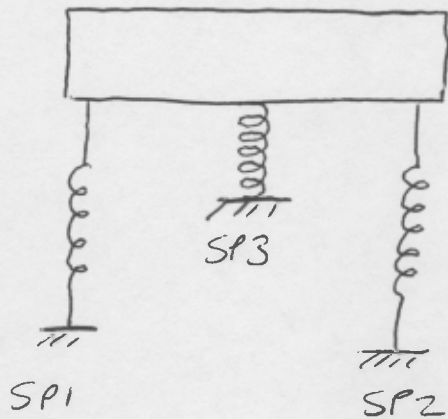
13. For the circuit of problem 12, what is the current flowing in the circuit?

$$V = IR$$

$$\frac{16}{25} = I = .64 A$$

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14. Consider the spring and block set-up shown. SP1 and SP2 are extension springs and SP3 is a compression spring. The spring constant for all springs is $k = 0.33 \text{ lb/in.}$ The initial force (F_i) of the extension springs is 0.5 lb. The system is in equilibrium with the DEFLECTION of the extension springs being measured as 0.75 inches. What is the deflection of the compression spring? **YOU MUST INCLUDE A FREE BODY DIAGRAM FOR ANY CREDIT!!**



$$\sum F_{ex} = [0.5 + (.33)(0.75)] 2 = 1.495 \text{ lbs}$$

$$1.495 \text{ lbs} = .33 \text{ lb/in} \times X$$

$$\Delta X = 4.5303 \text{ in.}$$

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