

MIDDLETECHNICAL UNIVERSITY  
BAGHDAD TECHNICAL ENG. COLLEGE  
DEPARTMENT OF MCHATRONICS



SUBJECT: MECHATRONICS  
STAGE: FOURTH  
TIME: 3 HOURS  
Date: 30/5/2018

**THE FINAL EXAM SAMPLE-1 / 2017-2018**  
**ANSWER ALL OF THE FOLLOWING QUESTIONS**

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**(Q1: A)-** What is stepper motor? Enumerate the types of stepper motors with each application. Show that how To use an **HCS12** microcontroller to drive the **PM** stepper motor (10 Marks)

**(Q1: B)-** In a bidirectional control of motors, draw the **H-bridge – 4 transistors** arranged in two “push – pull” Pairs. (10 Marks)

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**(Q2: A)-** What are the various criteria to choose the microcontroller? (10 Marks)

**(Q2: B)-** Complete the following statements; Answer five only:

- 1- A lumped parameter control system is one which can be represented by .....
  - 2- A distributed parameter control system is one which can be represented by .....
  - 3- In adaptive control system the system parameters are ..... to keep the system at a .....
  - 4- A process control system is an ..... System in which the output is .....
  - 5- A deterministic control system is one in which the response to input is .....and .....
  - 6- A stochastic control system is one in which the response to input is ..... and .....
- (10 Marks)

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**(Q3: A)-** What is important when designing a controller? Four microcontrollers (**A, B, C, & D**) have maximum Clock speeds (**3.2 MHz, 4.1 MHz, 6.4 MHz, and 9.8 MHz**) respectively. Microcontrollers (**A&C**) Divide their clocks by **4** to give one machine cycle. Microcontroller (**B**) by **8** and microcontroller (**D**) By **3**. Microcontrollers (**A&B**) take **10** machine cycles to perform an instruction, while microcontroller (**C&D**) takes **12** cycles. Place the microcontrollers in order of the speed in which they can perform Those instructions. (10 Marks)

**(Q3: B)-** Draw the block-diagram of a typical full-featured microcontroller. Enumerate the essential features that Enable the microcontroller to operate properly. (10 Marks)

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**(Q4: A)-** Derive the transfer function below for a mass on a torsion bar fitted with a damper and show it is Another example of the second order transfer function.  $T$  is torque and  $J$  is moment of inertia. The Derivation should yield to:

$$G(S) = \frac{\theta}{T}(\dot{S}) = \frac{1/k}{(J/k)s^2 + (Jk_d/k)s + 1} = \frac{1/k}{T^2 s^2 + 2\delta Ts + 1} \quad (10 \text{ Marks})$$

**(Q4: B)-** A hydraulic cylinder has a bore of **(10mm)** and is controlled with a valve with a constant  $(k_v = 0.1 \text{ m}^2/\text{s})$ . Calculate the following:

- 1- The time constant  $T$ , if  $x_i$  and  $x_o$  are zero when  $t = 0$ .
- 2- The velocity of the piston and the output position after **2 seconds** when the input is changed Suddenly to **25 mm**.

(10 Marks)

**(Q4: C)-** A piezoelectric crystal measuring  $(1.5\text{mm} \times 1.5\text{mm} \times 0.75\text{mm})$  is used to measure a force. Its Voltage sensitivity is  $0.05 \text{ Vm/N}$ . Calculate the force if voltage developed is **50V**. (10 Marks)

**(Q4: D)-** The following data related to a practical armature & field dc-motor controlled operation. Given that:-

- 1- Gain of potentiometric error detector.  $(18 \text{ V}/\pi \rightarrow \text{V}/\text{rad})$ .
- 2- Amplifier gain.  $(12 \text{ volts/volt})$ .
- 3- Armature winding resistance.  $(0.1 \Omega)$ .
- 4- Back  $e.m.f$  constant.  $(5 \text{ mV sec/rad})$ .
- 5- Motor torque constant.  $(2.2 \mu \text{ ib ft/amp})$ .
- 6- Motor moment of inertia.  $(0.75 \mu \text{ ib ft/sec})$ .
- 7- Load moment of inertia  $(1.4 \text{ m ib.ft sec}^2)$ .
- 8- Load damping coefficient.  $(2.5 \text{ m ib.ft/rad/sec})$ .
- 9- Gear ratio.  $N_1/N_2 = 1/20$

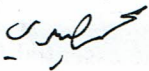
**Needed:**

- 1- Draw and design the above control system.
- 2- Find the closed loop transfer function (CLTF).

(10 Marks)

BEST WISHES

رئيس القسم



مدرس المادة: أ.م.د. علاء خميس خضير

