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Universiti Tun Hussein Onn Malaysia

**UNIVERSITI TUN HUSSEIN ONN MALAYSIA**

**FINAL EXAMINATION  
SEMESTER I  
SESSION 2017/2018**

COURSE NAME : MOTION CONTROL  
COURSE CODE : BEH 41202  
PROGRAMME CODE : BEJ  
EXAMINATION DATE : DECEMBER 2017 / JANUARY 2018  
DURATION : 3 HOURS  
INSTRUCTION : ANSWER ALL QUESTIONS

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THIS QUESTION PAPER CONSISTS OF SIX (6) PAGES

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**Q1** (a) Draw the block diagram of motion control components. (3 marks)

(b) **Figure Q1(b)** shows the robotic arm used in manufacturing process that have three axis of motion and joints. Each of the joints has a maximum velocity of 25 degree/s and the maximum accelerations are (10, 12.5, 12.5) degree/s<sup>2</sup>. Assuming all of the joints start at an angle of 90 degree and joints 1, 2 and 3 are moved to (10, 10, 160) degree respectively. Design the motion profiles by using:

(i) Slew motion. (7 marks)

(ii) Interpolation motion. (10 marks)

**Q2** (a) An axis has a maximum velocity of 5m/sec and an acceleration/deceleration time of 2sec. The axis start at 20m and travel until 60m.

(i) Design a smooth trapezoidal motion profile. (10 marks)

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(ii) Determine the motion time at 30m. (4 marks)

(b) Given the velocity and position profile as in Figure Q2(b), where all the segments have equal time.

(i) Calculate the time,  $t$  if the position of  $S_B$  is 6 meter and the velocity,  $V_m$  is given as 5m/sec. (5 marks)

(ii) Determine the deceleration time of the motion. (1 mark)

**Q3** (a) Radio Control (RC) servomotor is a small device that has an output shaft that can be positioned to specific angular positions by sending the servo a coded signal usually a Pulse Width Modulation (PWM) signal. With the help of related graphs, explain how the position varies in RC servomotor with different pulse.

(7 marks)

(b) RC hobby servos are small actuators designed for remotely operating model vehicles such as cars, airplanes, and boats. Moreover, its ability to rotate and maintain at certain position or angle according to control pulses from a single signal wire also make servo motor popular in robot building.

(i) Construct a block diagram of RC servo motor with the major components.

(7 marks)

(ii) Produce a flow chart with explanation that demonstrate the motor operation.

(6 marks)

**Q4** (a) Direct Current (DC) brushless motor operation is known to have same working principle with a stepper motor. Differentiate between the DC brushless motor and the stepper motor by considering the control system configuration, and speed/torque characteristics.

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(8 marks)

(b) Programmable Motion Controller (PMC) is defined as the application of programmable hardware and software in conjunction with input sensory devices, actuator, data acquisition and microprocessor. Produce a comprehensive chart which represents the PMC development process with consideration of motion control components.

(12 marks)

- Q5** (a) As a production engineer in Perwaja Steel Sdn Bhd, you are assigned to an expansion project for metal sheet winding machine. Supplier A has given you the specification of the SIEMENS motor as in the nameplate in **Figure Q5(a)**. **Table Q5(a)** indicates the information on the proposed expansion project.
- (i) Justify the suitability of the proposed motor in terms of the category of the motor for the requested application, classification of the motor and its insulation class.  
(8 marks)
- (ii) Determine the maximum torque at base speed and the speed of an unloaded motor at 100 VDC.  
(3 marks)
- (b) Direct Current (DC) motors have been used in industrial applications for years. DC motor can be classified into permanent magnet, series and shunt motor connection. Differentiate these motor classification in terms of its advantages, disadvantages and circuit connection.  
(9 marks)

**-END OF QUESTIONS –**

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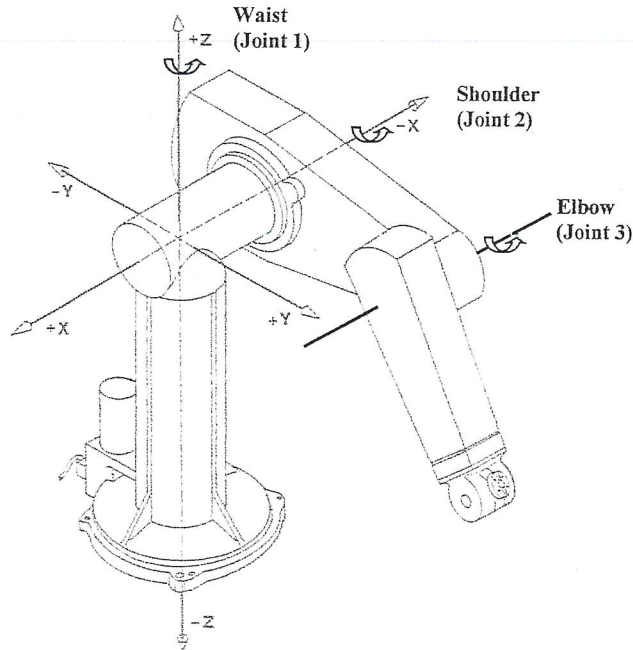


Figure Q1 (b)

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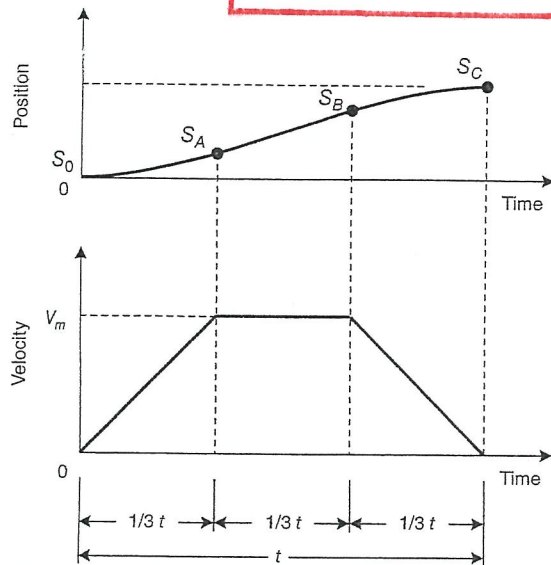


Figure Q2 (b)

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<b>SIEMENS</b>			
HP	10	RPM	1180
VOLTS		500	
ARM AMPS	17.0	WOUND	SHUNT
FLD AMPS	1.4/2.8	FLD OHMS 25C	156
INSUL CLASS	F	DUTY	CONT
MAX AMBIENT		40° C	
PWR SUP CODE	C	FLD VOLTS	300/150
TYPE	E	ENCL	DP
INSTR			
MOD	SER		
NP36A424835AP		DIRECT CURRENT MOTOR	
		MADE IN U.S.A.	

**Figure Q5 (a)**

**Table Q5 (a)**

Application	Metal Sheet Winding with forward and reverse
Working Environment Temperature	40° C

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