Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2015/2016

COURSE NAME	:	MOTION CONTROL
COURSE CODE	:	BEH41202
PROGRAMME	:	BACHELOR OF ELECTRONIC ENGINEERING WITH HONOURS
EXAMINATION DATE	:	DECEMBER 2015 / JANUARY 2016
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

Q1 (a) In the motion control application in **Figure Q1(a)**, the nip rolls feed long wood boards which are cut to equal length pieces. **Figure Q1(b)** shows the velocity profile for one cycle of the linear axis that carries the shear. The shear waits at a hover position over the conveyor. When it gets a signal from the controller, it accelerates and matches the speed of the conveyor (constant velocity segment). During this time, the shear is lowered and retracted to make the cut. After that the axis slows down to zero speed and returns to the hover position. Calculate the return velocity, V_{ret} that need to be programmed to the controller.

(11 marks)

(b) Direct-current (DC) motors have been used in industrial applications for years. Motor selection for the DC brushed motor, brushless servo motor and stepper motor with mechanical element is a crucial part in designing a motion control system. Differentiate these motor design technologies in terms of its advantages, disadvantages and potential applications.

(9 marks)

Q2 (a) Motor amplifier or drive is one of the main components in motion control system. With the aid of a block diagram, show clearly the function of the motor amplifier or drive.

(5 marks)

(b) Consider a motion controller for a stepper motor with encoder feedback as shown in **Figure Q2**. The stepper motor will start at a position count of 10 and end the motion at a count of 40. The motion is to have a maximum angular velocity of 5 counts/s and acceleration/deceleration time of 1 s.

(i) Design a smooth trapezoidal motion profile that satisfies these constraints.

(11 marks)

(ii) Determine the motion time at 25 m.

(4 marks)

Q3 (a) 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.

(6 marks)

(b) **Figure Q3** shows the robotic arm used in manufacturing process. Paths are to be planned for a three axis motion controller. Each of the joints has a maximum velocity of 25 degree/s, and a maximum acceleration of 10 degree/s^2. Assuming all of the joints start at an angle of 90 degree. Joints 1, 2 and 3 moves to 10 degree, 0 degree and 170 degree respectively. Design the motion profiles by assuming:

(i) Slew motion.

(6 marks)

(ii) Interpolated motion.

(8 marks)

Q4 (a) 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.

(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. Table Q5** 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) The proposed motor may be driven beyond the base speed. Justify your answer by including the method to be used and the Volt vs Speed graph characteristics in your explanations.

(7 marks)

(iii) Determine the maximum torque at base speed and the speed of an unloaded motor at 125 VDC.

(5 marks)

END OF QUESTION

FINAL EXAMINATION

SEMESTER/SESSION: SEM I/2015/2016 PROGRAMME : 4 BEJ
COURSE : MOTION CONTROL COURSE CODE: BEH41202

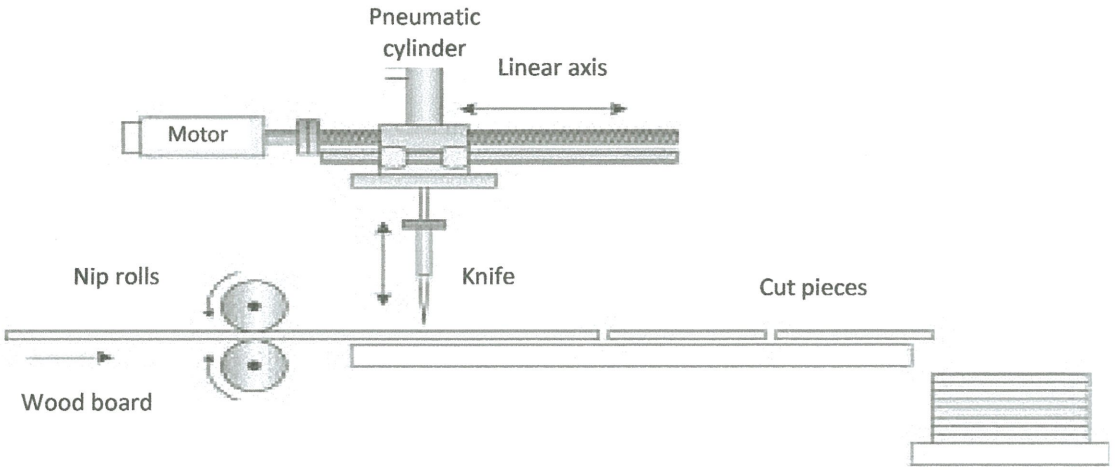

FIGURE Q1(a)

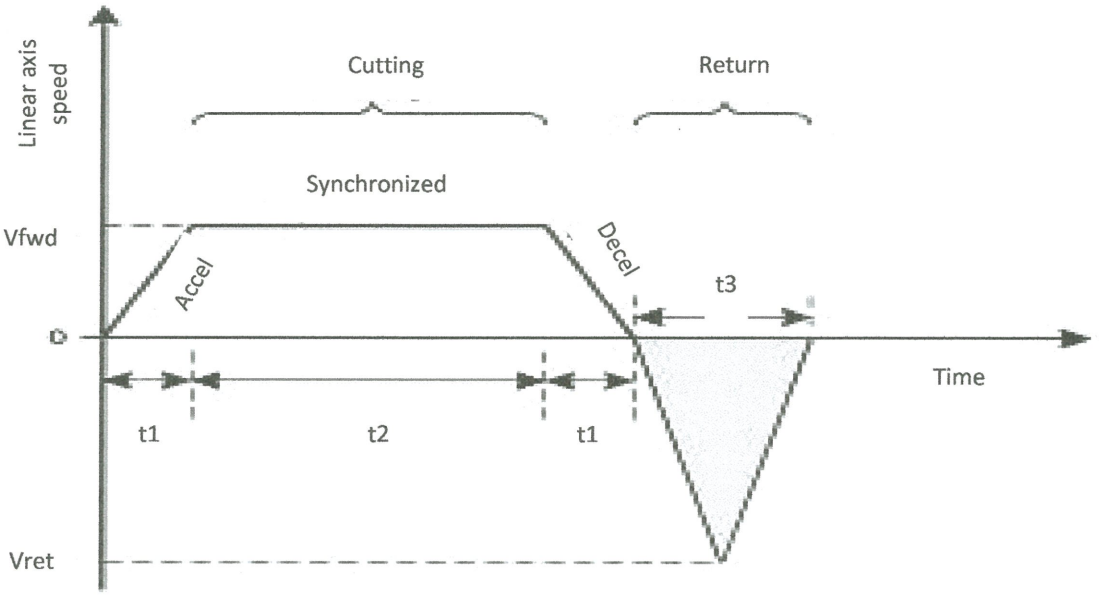

FIGURE Q1(b)

FINAL EXAMINATION

SEMESTER/SESSION: SEM I/2015/2016 PROGRAMME : 4 BEJ
COURSE : MOTION CONTROL COURSE CODE: BEH41202

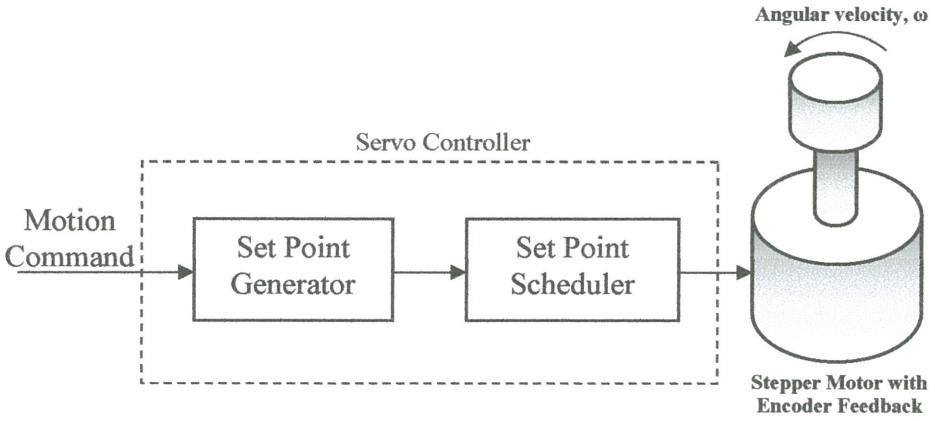

FIGURE Q2

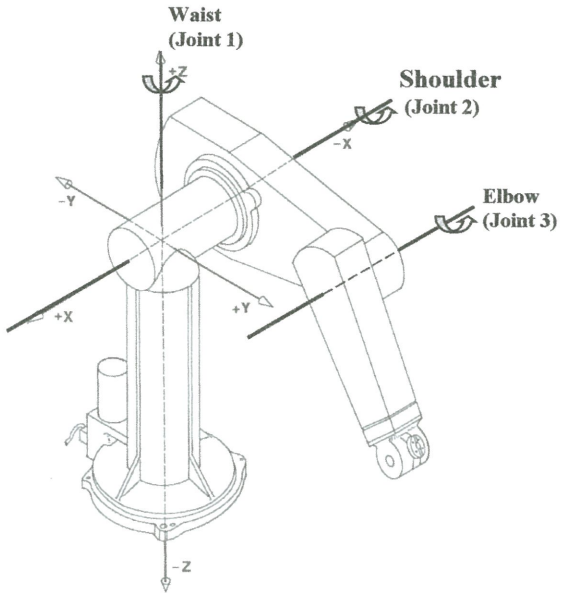

FIGURE Q3

FINAL EXAMINATION

SEMESTER/SESSION: SEM I/2015/2016 PROGRAMME : 4 BEJ
COURSE : MOTION CONTROL COURSE CODE: BEH41202

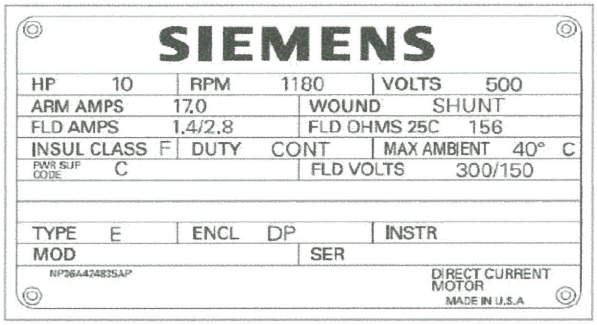

FIGURE Q5

TABLE Q5

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