THE OPEN UNIVERSITY OF SRI LANKA
FACULTY OF ENGINEERING TECHNOLOGY
BACHELOR OF TECHNOLOGY – LEVEL 06
FINAL EXAMINATION 2005/2006
MEX6333 – MECHATRONICS
DATE : 03rd April 2006
TIME : 1330 TO 1630 HOURS
DURATION : THREE HOURS

READ THE FOLLOWING INSTRUCTIONS CAREFULY BEFORE ANSWERING THE QUESTION PAPER

- This question paper has two parts, **Part A** and **Part B.**
- Answer **four** questions only. Question one from Part A is **compulsory.** Answer three others from Part B.

Part – A

Question 1 *Spend approximately one and quarter hours* **[40 Marks]**

Any automobile engine has a specific idle speed. If the engine speed falls below this specified value, the engine starve of lubricant and may shorten the engine life. When the engine runs at this specified idle speed, imposition of a load such as switching an air conditioner or head lights the engine speed falls. Therefore, the engines have mechanism to restore the speed to the specified valve. If you are given an engine, of which this mechanism is faulty, design a suitable system which monitor and control the idle speed. Assume you have any sensors and actuators to be used at your discretion. Identify the inputs and outputs to this newly designed system.

Part –B

Question 2 **[20 Marks]**

(a) Consider the following mechanisms and state the number of degree of freedom in each case

i. a windscreen wiper
ii. your knee
iii. your ankle
iv. a car hood hinge

(b) For the mechanism shown in Fig Q2 (b), the arm AB rotates at a constant rate. B and F are sliders moving along CD and AF. Describe the behavior of this mechanism.

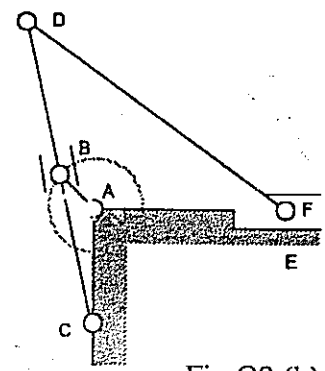


Fig Q2 (b)

(c) State the sequence of operations that occur for cylinders A and B in Fig Q2 (c) when the start button is pressed. a^- , a^+ b^- and b^+ are limit switches to detect the position of the cylinders when they are fully retracted and fully extended.

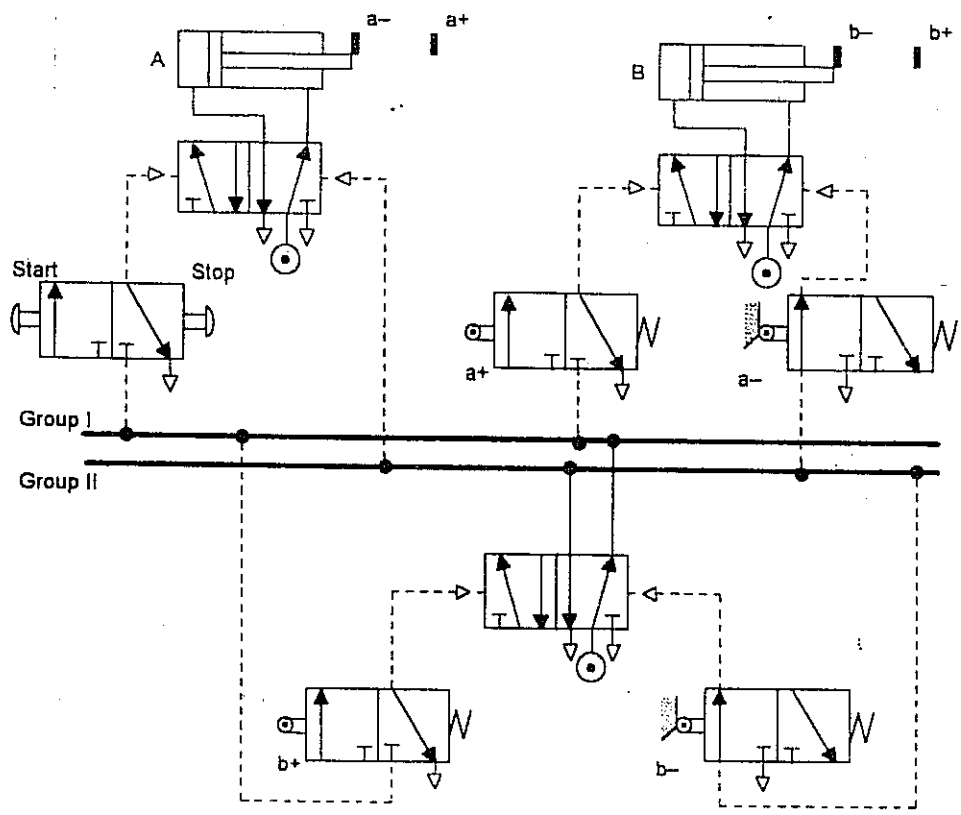


Fig Q2 (c)

Question 3 **[20 Marks]**

An horizontal transfer system employs a servo motor with a speed reducer. It carries a payload of 200 kg over a travel distance of 600 mm through a steel ballscrew. The required velocity profile is trapezoidal, as shown in Fig Q3.

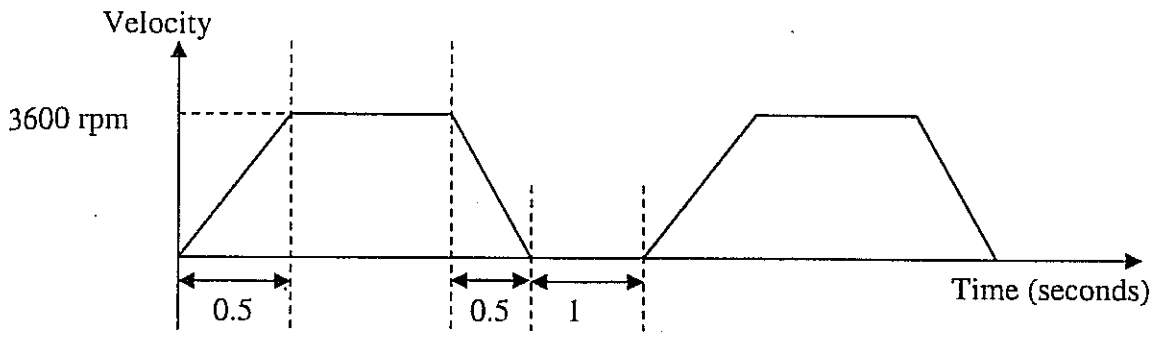


Fig Q3 Trapezoidal velocity profile

Parameters of the motor and mechanical components are:

Motor inertia :	$J_{motor}=1.5 \times 10^{-4}$ Kg.m^2
Reducer ratio :	N = 2
Reducer efficiency:	$\eta = 90\%$
Reducer inertia:	$J_r = 2 \times 10^{-4}$ Kg.m^2
Reducer friction torque:	$T_r = 0.15$ N.m
Ballscrew diameter	D = 20mm
Ballscrew pitch:	P = 10 mm/rev
Ballscrew length:	L = 1,500 mm
Ballscrew transmission efficiency :	e = 80%
Density of steel:	$\rho = 7{,}900$ Kg.m^3
Friction coefficient for steel-to-steel lubricant contact:	$\mu = 0.15$

Analyze the motion, inertia and torque characteristics.

Question 4 **[20 Marks]**

(a) What are the criteria that need to be considered when selecting the size and type of PLC required for a particular task or tasks?

(b) Devise a circuit that could be used with a domestic washing machine to switch on a pump, to pumps water for 100 s into the machine, then switches off and switches on a heater for 50 s to heat the water. The heater is then switched off and a second pump is switched on to empty the water from the machine for 80s.

Question 5 **[20 Marks]**

(a) What is the principle of microstepping? Briefly explain the advantages of two-phases on full stepping over one-phase on full stepping.

(b) Compare and contrast the control system for a domestic central heating system involving a bimetallic thermostat and that involving a microprocessor.

Question 6 **[20 Marks]**

(a) Design a mechanical system which can be used to:

(i) Operate a sequence of micro switches in a timed sequence.
(ii) Transform a rotary motion into a linear back-and-forth movement with simple harmonic motion.
(iii) Transform an angular displacement into a linear displacement.
(iv) Rotate a second shaft situated some distance away from the first shaft , when both shafts are parallel.

(b) Discuss the advantages of "soft" computing methodologies as compared to "hard" computing and explain how they are more appropriate for handling real-word problems. Explain the operating principle of a fuzzy logic washing machine which is an example in the application of soft computing methodology.