PROGRAM	: NATIONAL DIPLOMA *ELECTRICAL ENGINEERING*
SUBJECT	: **CONTROL SYSTEMS III**
CODE	: **ASY331**
DATE	: END-YEAR EXAMINATION 13 NONVEMBER 2017
DURATION	: 12:30 to 15:30
WEIGHT	: 40:60
TOTAL MARKS	: 100

UNIVERSITY OF JOHANNESBURG

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NUMBER OF PAGES	: 5 PAGES AND 1 ANNEXURE	

INSTRUCTIONS

1. 100 MARKS = 100%. TOTAL MARKS AVAILABLE = 100
2. ATTEMPT ALL QUESTIONS.
3. ALL DIAGRAMS AND SKETCHES MUST BE DRAWN NEATLY AND IN PROPORTION.
4. ALL DIAGRAMS AND SKETCHES MUST BE LABELLED CLEARLY.
5. ALL WORK DONE IN PENCIL, EXCEPT DIAGRAMS AND SKETCHES, WILL BE CONSIDERED AS ROUGH WORK AND WILL NOT BE MARKED.
6. MARKS WILL BE DEDUCTED FOR WORK THAT IS POORLY PRESENTED.
7. QUESTIONS MAY BE ANSWERED IN ANY ORDER, BUT ALL PARTS OF A QUESTION, MUST BE KEPT TOGETHER.
8. ONLY ONE POCKET CALCULATOR PER CANDIDATE MAY BE USED.

QUESTION 1

1.1 Determine the transfer function for the following system shown in figure 1, by using simple block reduction algebra. (Do not use Mason's or Kirchoff's method)

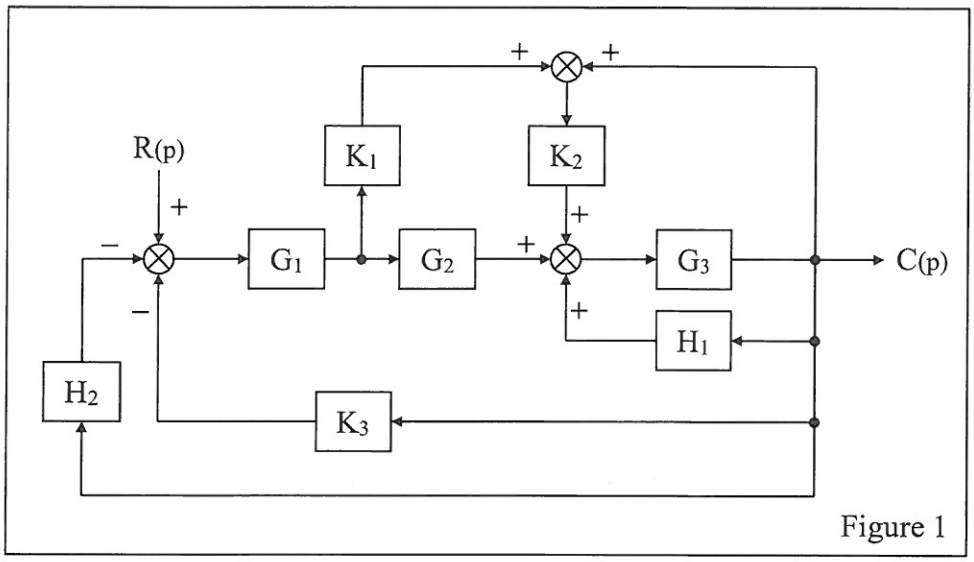

Figure 1

(9)

1.2 Find the transfer function: Vo(p)/Vi(p), of the electrical circuit shown in figure 2.

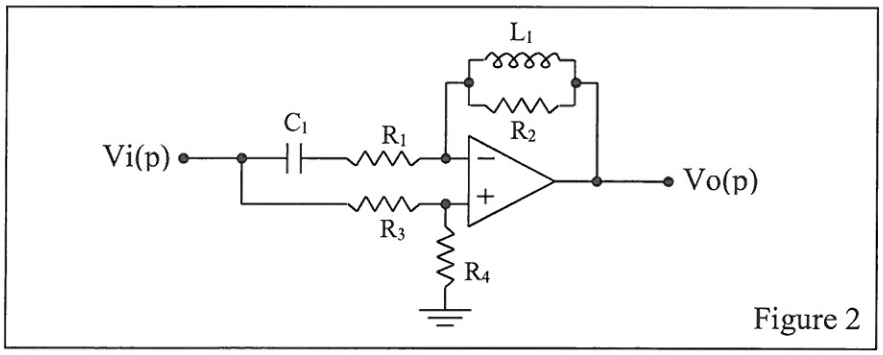

Figure 2

(7)

1.3 What is the difference between continuous process and batch process control?

(4)

1.4 Sketch a block diagram of a direct digital control production system and then explain the advantage and disadvantage of this control system.

(5)

1.5 Sketch a block diagram of a distributed control system and explain the operational advantages of this system.

(5)

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QUESTION 2

2.1 Explain how a bias signal is used in a proportional controlled system to eliminate the steady-state error? (3)

2.2 Describe the type of corrective restoring force produced by a derivative controller. (2)

2.3 Explain how derivative control causes the control system to respond more rapidly to a sudden set-point change and how it reduces potential system overshoot. (4)

2.4 What problems can occur when too much derivative control action is introduced by increasing derivative gain? (2)

2.5 In practice how fast must a digital controller sample to control a system and what limits the maximum possible sampling rate? (2)

2.6 A control system samples a position signal 30-times per second. If the position signal is cycling back and forth, what is the highest frequency the controller can follow? Give both theoretical and practical values. (2)

2.7 What is a digital controller called that implements auto-tuning and what is auto-tuning? (3)

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QUESTION 3

3.1 What is the aim in using a controller and what must the controller have capacity to do? (4)

3.2 In point form, list the Zieler and Nichols continuous-cycle PID controller tuning approach. (8)

3.3 A control system is to be tuned using the continuous-cycle method. It was found that the system went into oscillation when K_P' was 0.3 V/deg. Determine K_P, K_I and K_D by using the system recorded response shown in figure 3. (3)

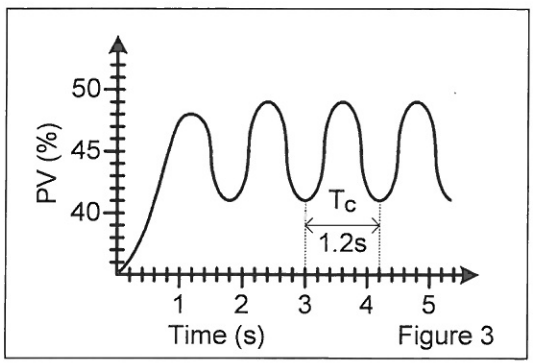

Figure 3

[15]

QUESTION 4

4.1 The electrical circuit in figure 4, has the following component values: L= 40mH, C= 1uF and R=180Ω. A unit step input is then applied.

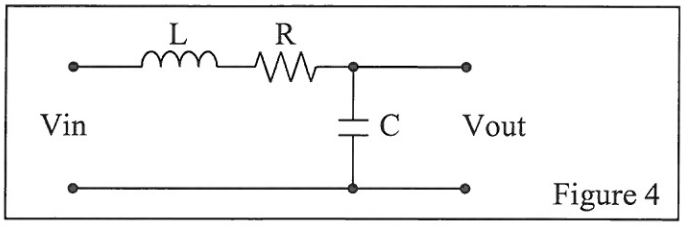

Figure 4

4.1.1 Determine the transfer function in terms of L, R and C symbols (2)
4.1.2 What is the un-damped natural frequency of oscillation? (2)
4.1.3 What is the damped natural frequency of oscillation? (4)
4.1.4 What is the percentage overshoot? (2)
4.1.5 What must C be changed to, so that the system becomes critically damped? (2)

4.2 For an aircraft position tracking control system shown in figure 5,

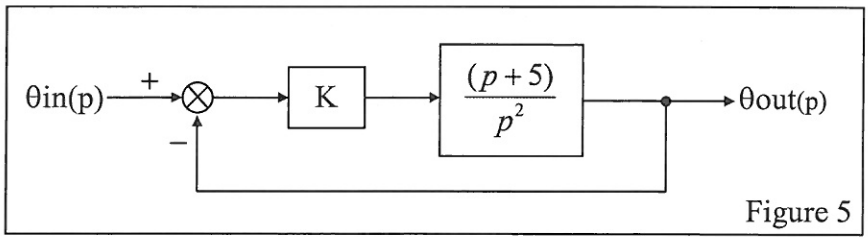

Figure 5

4.2.1 Determine the value of gain "K" that will ensure a constant steady state error of 5%. (4)

4.2.2 For the calculated gain "K" value, determine how long the tracking system will initially take to reach the required steady state error of 5%. (4)

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QUESTION 5

5.1 A house alarm system has three passive infrared sensors, two laser beam sensors, a siren, an alarm light and a key switch to arm or disarm the alarm system as shown in figure 6. The house alarm system must operate as follows:

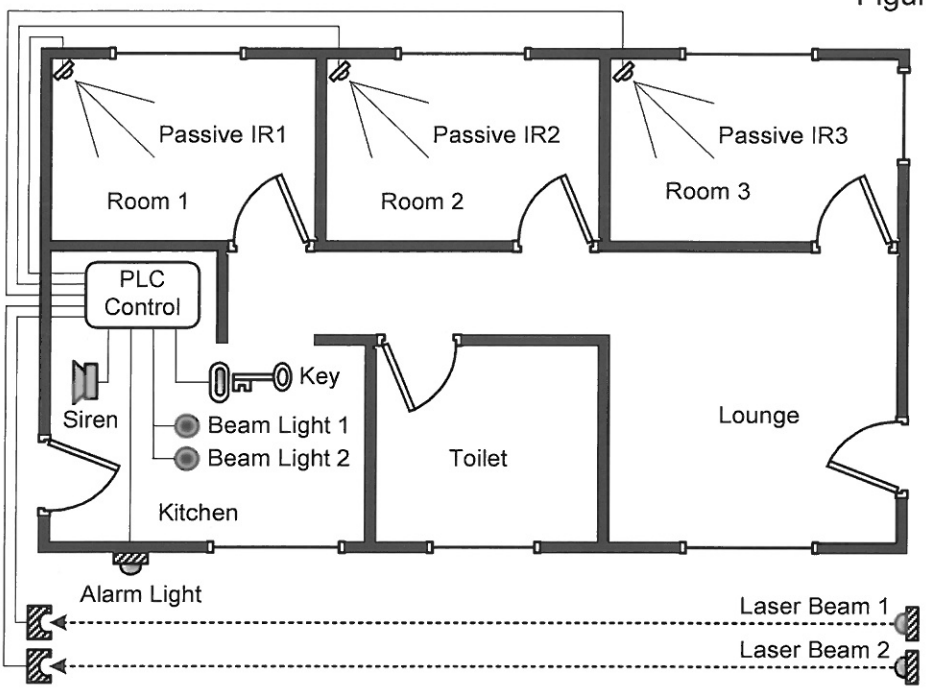
a) The alarm system must be functional only when the key switch is activated or armed. When the siren and alarm light is triggered on and retained, only the key switch can deactivate or disarm both the siren and alarm light.

b) The siren and the alarm light must go on, if anyone of the infrared sensors in the three rooms detects movement. The siren and alarm light must be retained on after anyone of the infrared sensors is trigged.

c) When both laser beam sensors are triggered the siren and alarm light must go on and be retained. Also the two beam light indicators for both laser beams, must light up whenever either of the laser beams are triggered, when the key switch is on. This will indicate functionality and assist in fault finding.

d) When the siren is triggered, it must only be retained on for 30 seconds, so that it doesn't stay on for the whole day if you are not there to reset the alarm system by switching the key off and then on again. However the when triggered the alarm light must be retained on until the alarm system is reset.

Figure 6



Design and sketch a PLC ladder program to control the alarm system. Use the PLC input and output names shown in the table. Only N/O or N/C contacts, internal relays, output relays and on-delay timers may be used. Set and reset relays must not be used.

Names	PLC I/O's	Description
ixIR1	%IX0.0	N/C when triggered and N/O when not triggered
ixIR2	%IX0.1	N/C when triggered and N/O when not triggered
ixIR3	%IX0.2	N/C when triggered and N/O when not triggered
ixKEY	%IX0.3	N/C when switched on and N/O when switched off
ixBEAM1	%IX0.4	N/O when triggered and N/C when not triggered
ixBEAM2	%IX0.5	N/O when triggered and N/C when not triggered
qxALARM-LIGHT	%QX0.0	Active = light on and deactivated = light off
qxSIREN	%QX0.1	Active = siren on and deactivated = siren off
qxBEAM-LIGHT1	%QX0.2	Active = light on and deactivated = light off
qxBEAM-LIGHT2	%QX0.3	Active = light on and deactivated = light off

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TOTAL [100]

Pneumatic Components and PLC function blocks