PROGRAM	:	NATIONAL DIPLOMA *ELECTRICAL ENGINEERING*
SUBJECT	:	**CONTROL SYSTEMS 2**
CODE	:	**ASY211**
DATE	:	JULY SSA EXAMINATION 18 JULY 2014
DURATION	:	(SESSION 1) 08:00 – 11:00
WEIGHT	:	40 : 60
FULL MARKS	:	100

EXAMINER	:	MR BA KLETTE	
MODERATOR	:	MR DR VAN NIEKERK	2330
NUMBER OF PAGES	:	6 PAGES AND 3 ANNEXURE	

INSTRUCTIONS	:	POCKET CALCULTATORS PERMITTED
REQUIREMENTS	:	NONE

INSTRUCTIONS TO CANDIDATES:

1. DETAILED WAVEFORMS AND CIRCUIT DIAGRAMS ARE REQUIRED FOR ALL MATHEMATICAL DEDUCTIONS, CALCULATIONS AND CIRCUIT-THEORY OR DEVICE-THEORY DESCRIPTIONS.
2. THEORY TYPE QUESTIONS MUST BE ANSWERED IN POINT FORM BY CAREFULLY CONSIDERING THE MARK ALLOCATION.
3. ALL WORK MUST BE WELL PRESENTED IN YOUR EXAMINATION SCRIPT
4. ANY ASSUMPTIONS MADE SHOULD BE STATED CLEARLY.
5. ONLY DRAWINGS MAY BE IN PENCIL
6. POCKET CALCULATORS ARE PERMITTED BUT NO INFORMATION BOOKLETS ARE ALLOWED
7. QUESTIONS THAT ARE NOT CLEARLY NUMBERED WILL NOT BE MARKED
8. KEEP PARTS OF THE QUESTION TOGETHER AND WORK FROM TOP TO BOTTOM AND NOT ALL OVER THE PAGE

QUESTION 1

1.1 The below figure shows a rotating vane type flow meter in two planes. The fluid force on the vanes will cause them to turn the generator connected to it with a shaft. The generator output voltage (DC) is proportional to the speed of rotation and therefore also the flow rate of the fluid.

1.1.1 Draw the block diagram of a closed loop system (feedback employed) with the following components represented as blocks:

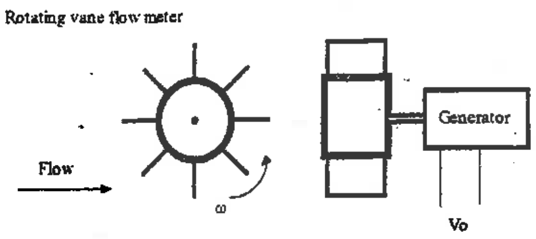
a) DC-power supply of which the output voltage can be adjusted using a voltage signal as an input to the supply.

b) DC operated motor driving a pump.

c) The rotating vane flow meter. (4)

1.1.2 Indicate on the above block diagram the various elements of an automatic industrial controller as well as the signal types of the various points in the block diagram (include units of signals). (5)

1.1.3 What type of input reference is ideal for the above mentioned system? (Show an easy way of generating it) (1)



1.2 Define the following terms as applied to control systems:

1.2.1 Open loop transfer function (2)

1.2.2 Feedback ratio (2)

1.2.3 Disturbance (2)

1.2.4 Characteristic equation (2)

1.2.5 Bode Plot (2)

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QUESTION 2

2.1 The below figure shows a block diagram of a flow control loop. Determine the transfer function C/R for the system using **Masons Rule ONLY.** (8)

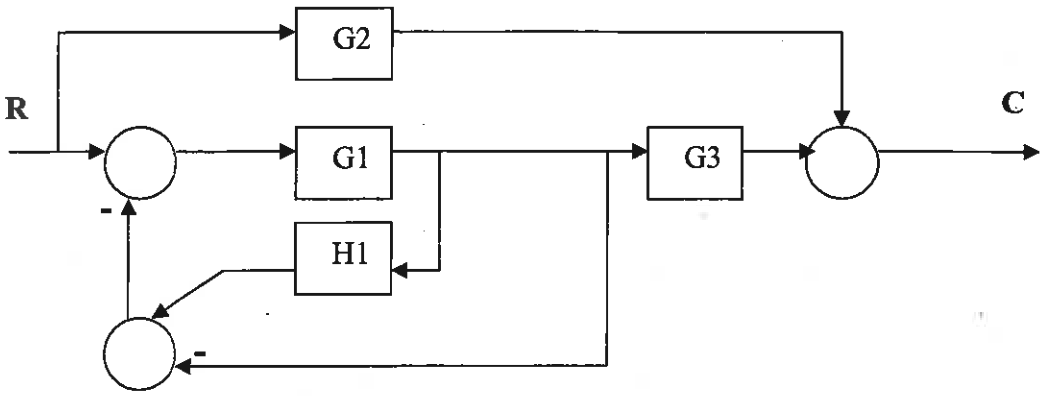

Figure 2

2.2 The below figure shows a block diagram of a flow control loop. Determine the transfer function C/R for the system using **Block Diagram Reduction ONLY.** (9)

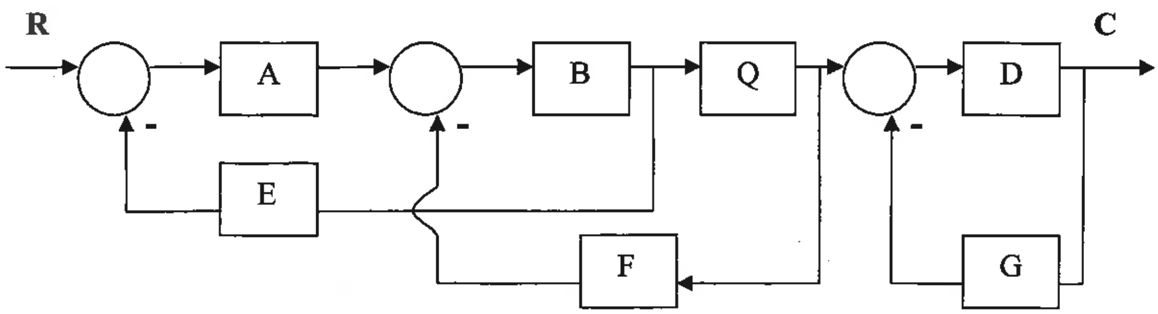

Figure 3

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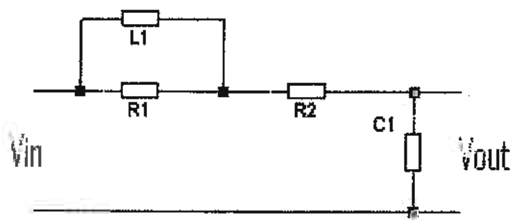
QUESTION 3

3.1 Determine the transfer function for the passive network in the below figure. (7)



3.2 Draw a transient response of an under damped system and indicate the rise time, peak time, settling time, steady state error and maximum overshoot on the diagram. (4)

3.3 With reference to 3.2 above define the following terms:
3.3.1 Peak time
3.3.2 Maximum overshoot
3.3.3 Rise time
3.3.4 Error band (6)

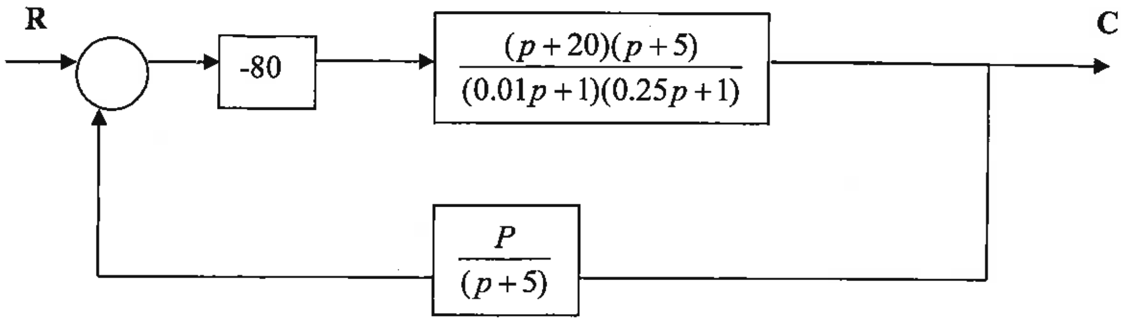
3.4 The following transfer function is given by:

$$\frac{Vo(p)}{Vi(p)} = \frac{\frac{1}{LC}}{p^2 + p\frac{R}{L} + \frac{1}{LC}}$$

R = 1500 Ohm C = 0.672μF L = 20mH

Calculate the gain (dB's) and phase angle (degrees) for an input of 4000 radians per second (6)

3.5 Use the straight line approximation method to draw a Bode plot of the system described by the block diagram. (14)



3.6 A second-order system has an overshoot of 10% and a peak time of 0.4 seconds when subjected to a step input. Determine:

3.6.1 The damping coefficient (3)

3.6.2 The natural frequency of oscillation (3)

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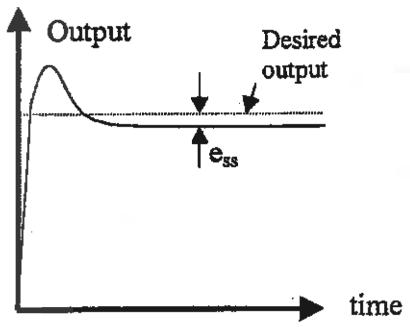
QUESTION 4

4.1 List six processes that are carried out after the END instruction (of a Klockner Moeller PLC) has been executed. (6)

4.2 Consider the following transient response of a system:



Which control mode should be used in order to reduce or compensate for the steady state? Give reasons for your answer by making reference to the definition of the particular control mode.

Name one disadvantage of this particular control mode. (4)

4.3 Explain Proportional and Integral control modes (4)

4.4 Why can differential control not be used on its own (1)

4.5 Draw a block diagram of a three-term controller incorporated in a plant, label all the blocks. (5)

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TOTAL = 100

Annexure A

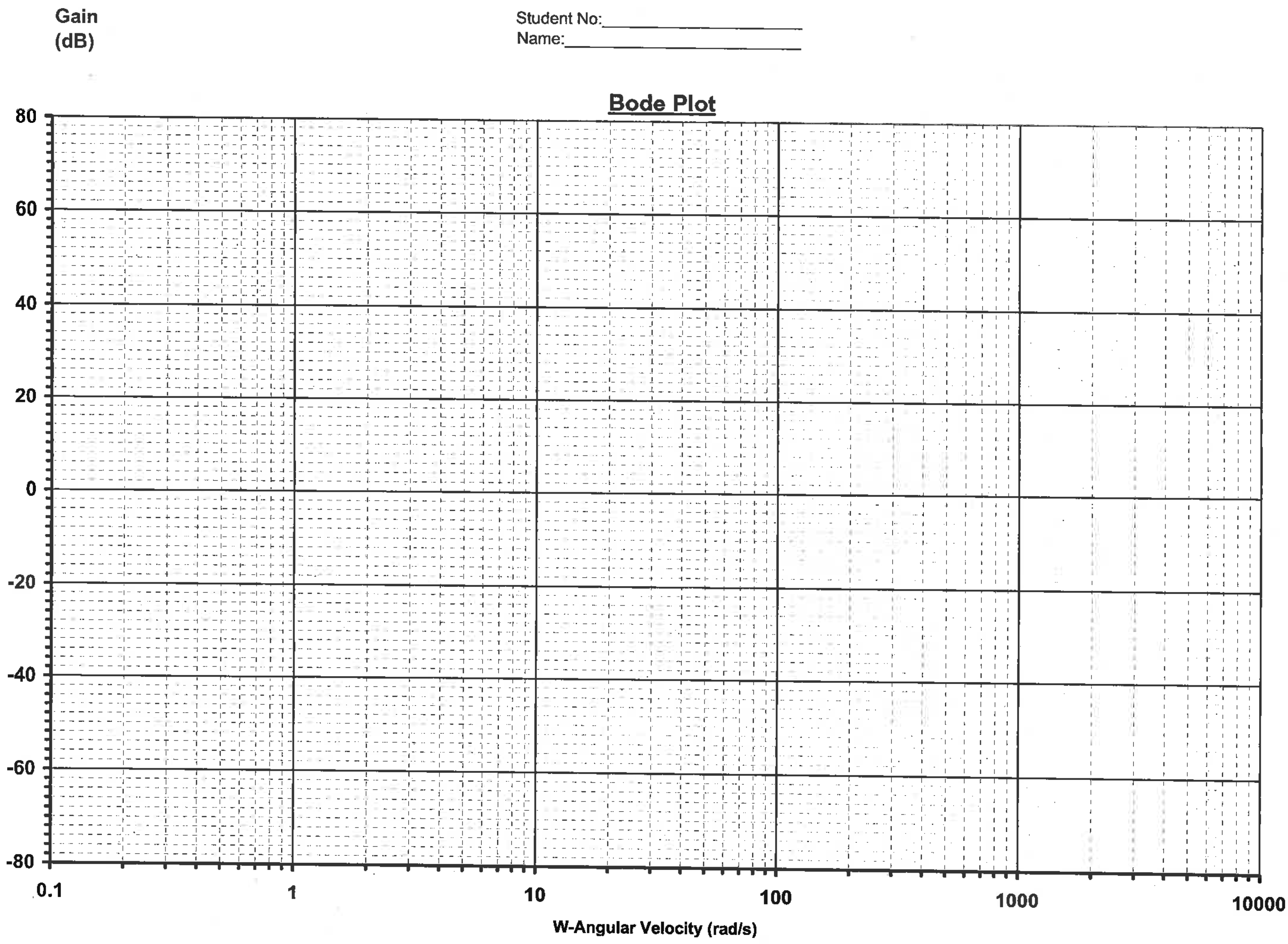
Laplace Transforms

TIME FUNCTION f(t)	LAPLACE FUNCTION F(p)
Unit impulse	1
Unit step	$\frac{1}{p}$
Unit ramp	$\frac{1}{p^2}$
Unit parabolic	$\frac{1}{p^3}$
Exponential (e^{-at})	$\frac{1}{p+a}$
Sinusoidal ($\sin(\omega t)$)	$\frac{\omega}{p^2+\omega^2}$
Co-sinusoidal ($\cos(\omega t)$)	$\frac{p}{p^2+\omega^2}$
$\frac{1}{(n-1)!}t^{n-1}e^{-at}$	$\frac{1}{(p+a)^n}$
$e^{-at}\sin(\omega t)$	$\frac{\omega}{(p+a)^2+\omega^2}$
$e^{-at}\cos(\omega t)$	$\frac{p+a}{(p+a)^2+\omega^2}$

Student No:____________________

Name:________________________

Bode Plot



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Bode Plot