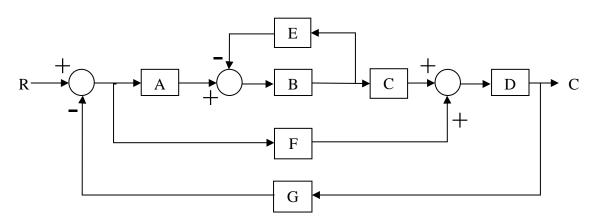


<u>PROGRAM</u>	:	BACHELOR OF ENGINEERING TECHNOLOGY [BEng Tech] IN ELECTRICAL ENGINEERING. B6ELEQ & B6ELXQ
MODULE	:	CONTROL SYSTEMS ENGINEERING 3B
CODE	:	CTLELB3
<u>DATE</u>	:	SUMMER MAIN EXAMINATION NOVEMBER 2019
DURATION	:	3 HOURS
<u>WEIGHT</u>	:	40 : 60
NOF	:	7
TOTAL MARKS	:	100
EXAMINER	:	PROF THOKOZANI C SHONGWE
MODERATOR	:	J. SEBASTIAN
NUMBER OF PAGES	:	6 PAGES, INCLUDING 2 SEMILOG GRAPH PAPERS AND 1 FORMULAE SHEET
INSTRUCTIONS		CALCULATORS ARE PERMITTED (ONLY ONE PER STUDENT) USE ONLY THE ANSWER SHEET PROVIDED WITH THIS PAPER

INSTRUCTIONS TO CANDIDATES:

- 1. 100 MARKS = 100%
- 2. ATTEMPT ALL QUESTIONS.
- 3. THEORY TYPE QUESTIONS MUST BE ANSWERED IN POINT FORM BY CAREFULLY CONSIDERING THE MARK ALLOCATION.
- 4. QUESTIONS MAY BE ANSWERED IN ANY ORDER, BUT ALL PARTS OF QUESTION MUST BE KEPT TOGETHER.
- 5. ALL DIAGRAMS AND SKETCHES MUST BE DRAWN NEATLY AND IN PROPORTION.
- 6. ALL DIAGRAMS AND SKETCHES MUST BE LABELLED CLEARLY.
- 7. ALL WORK DONE IN PENCIL EXCEPT DIAGRAMS AND SKETCHES WILL BE CONSIDERED AS ROUGH WORK.
- 8. NOTE: MARKS WILL BE DEDUCTED FOR WORK WHICH IS POORLY PRESENTED.
- 9. NEGATIVE MARKING APPLIES IF YOUR ANSWER DOES NOT COMPLY WITH THE DETAIL REQUIRED AS REQUESTED IN CERTAIN QUESTIONS.

QUESTION 1



Formulate the transfer function of the diagram above, using:

- (a) **Kirchoff's Method** (the algebraic method).
- (b) Block Diagram Reduction Method.
- (c) Mason's Rule.

[36]

(12)

(12)

(12)

QUESTION 2

Formulate the transient response C(t) of a system with a transfer function:

$$G(p) = \frac{C(p)}{R(p)} = \frac{3}{p^2 + 7p + 3}$$

(a) subjected to a 25 V ramp input. (20)

,

,

(b) subjected to a unit step input.

[40]

(20)

QUESTION 3

The transfer function of the forward path of a closed-loop system is given by

$$G(p) = \frac{300p(p^2+5p+4)}{(p+20)^2(p+70)}$$

and the transfer function of the feedback path is

$$H(p) = \frac{1}{(p+1)} \, .$$

Use the straight line approximation method to draw a Bode plot (phase Vs frequency and magnitude Vs frequency) of the system consisting of G(p) and H(p) described above.

[14]

QUESTION 4

The following transfer function is given by:

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

 $R = 1000 \Omega$, $C = 0.102 \mu F$ and L = 10 mH. Calculate the gain (dB) and phase angle (degrees) for an input of 5000 rad/s

TOTAL MARKS : 100

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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(ωt))	$\frac{\omega}{p^2 + \omega^2}$
Co-sinusoidal $(\cos(\omega t))$	$\frac{p}{p^2 + \omega^2}$
$\frac{1}{(n-1)!}t^{n-1}e^{-at}$	$\frac{1}{\left(p+a\right)^n}$
$e^{-at}sin(\omega t)$	$\frac{\omega}{\left(p+a\right)^2+\omega^2}$
$e^{-at}cos(\omega t)$	$\frac{p+a}{\left(p+a\right)^2+\omega^2}$