CONFIDENTIAL

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2017/2018

COURSE NAME	:	CONTROL ENGINEERING
COURSE CODE	:	BDA30703
PROGRAMME	:	BDD
EXAMINATION DATE	:	DECEMBER 2017/ JANUARY 2018
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **FIVE(5)** QUESTIONS **ONLY** OUT OF **SIX(6)** QUESTIONS

TERBUKA

THIS QUESTION PAPER CONSISTS OF **FIVE (5)** PAGES

CONFIDENTIAL

Q1 (a) Explain the terms accuracy, sensitivity and linearity of an instrument. (6 marks)

(b) Propose a sensor that can be used to measure angular position of a shaft. Explain on the working principle with the help of suitable figure. (4 marks)

(c) **Figure Q1(c)** shows a circuit for differential amplifier.

(i) Explain two basic functions of the differential amplifier (2 marks)

(ii) Calculate output (V_0) of the circuit given the input $V_A = Vs$ and $V_B = 0$. Note that V_n is the noise voltage. (8 marks)

Q2 (a) Use block diagram reduction techniques to obtain a single transfer function for the system shown below in **Figure Q2**. (9 marks)

(b) Referring to **Figure Q2**, obtain the transfer function, T(s) using Mason's rule technique. (10 marks)

(c) Compare the results obtained in (a) and (b). (1mark)

Q3 (a) In modern control system describe what is a mathematical model. Give one example mathematical model for a mechanical system. (4 marks)

(b) **Figure Q3(b)** shows mechanical control systems which consists of two masses and two springs. A force F_a acts on the mass m, which causes the movement of X_1 and X_2.The indication b_1 and b_2 is damping viscous between mass and floor.

(i) Draw free body diagram for both masses. (6 marks)

(ii) Derive the equation of motion for X_2 as a function of F_a. (10 marks)

Q4 Consider the system with closed loop transfer function as:

$$G(s)=\frac{K}{s(s+0.5)(s^2+0.6s+10)},\ H(s)=1$$

(i) Sketch the root locus for the system. (15 marks)

(ii) Observe that for small or large values of K the system is under damped and for medium values of K it is over damped. (5 marks)

Q5 (a) Provide a sketch that shows how to measure both gain and phase margins using Bode diagram. (3 marks)

(b) The transfer function of an electric shredding machine system is given by;

$$G(s)=\frac{8000}{s(2s+20)(s+40)}$$

(i) Sketch the Bode diagram for the system

(ii) Determine the gain and phase margins from the Bode diagram sketched in section (b)(i). (17 marks)

Q6 Consider the feedback control system shown below in which a proportional compensator is employed. A specification on the control system is that the steady-state error must be less than two per cent for constant inputs.

$$G(s)=\frac{2}{(s^3+4s^2+5s+2)};D(s)=K_p$$

(i) Use a proportional controller K_p that satisfies this specification (10marks)

(ii) If the steady-state criterion cannot be met with a proportional compensator, use a dynamic compensator D(s) = 3+ K_I/s. Find the range of K_I that satisfies the requirement of steady-state error. (10 marks)

- END OF QUESTION –

FINAL EXAMINATION

SEMESTER/SESSION : I/2017/2018 PROGRAMME : BDD

COURSE : CONTROL ENGINEERING COURSE CODE : BDA 30703

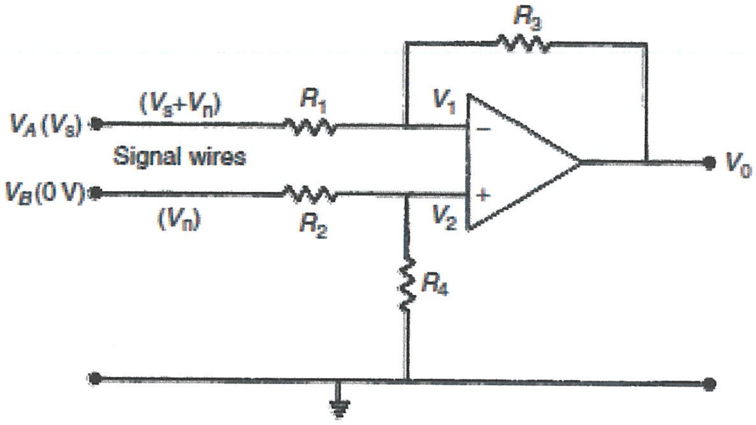


Figure Q1(c)

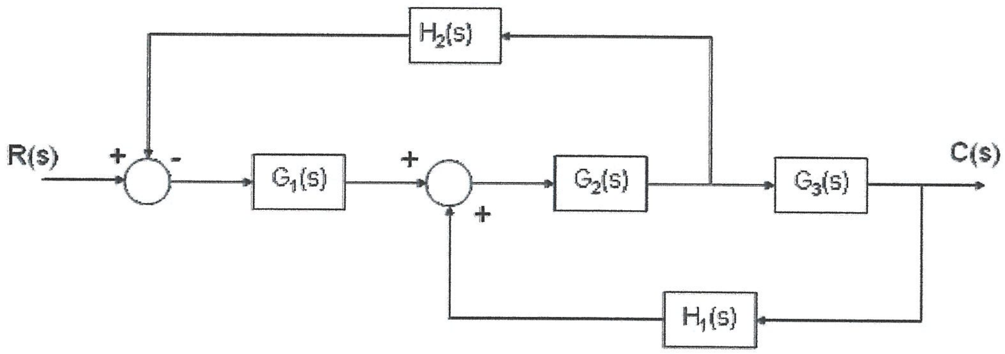


Figure Q2

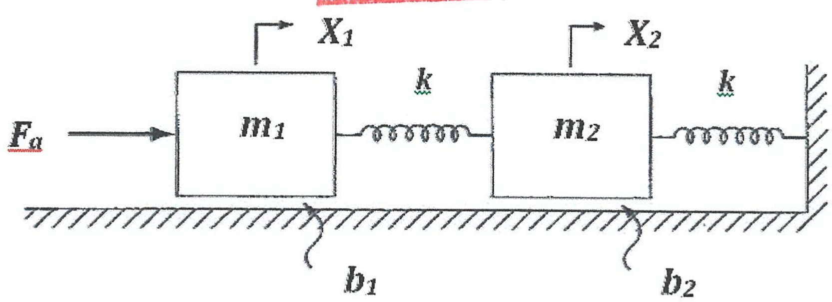


Figure Q3 (b)

FINAL EXAMINATION
SEMESTER/SESSION : I/2017/2018 PROGRAMME : BDD
COURSE : CONTROL ENGINEERING COURSE CODE : BDA 30703

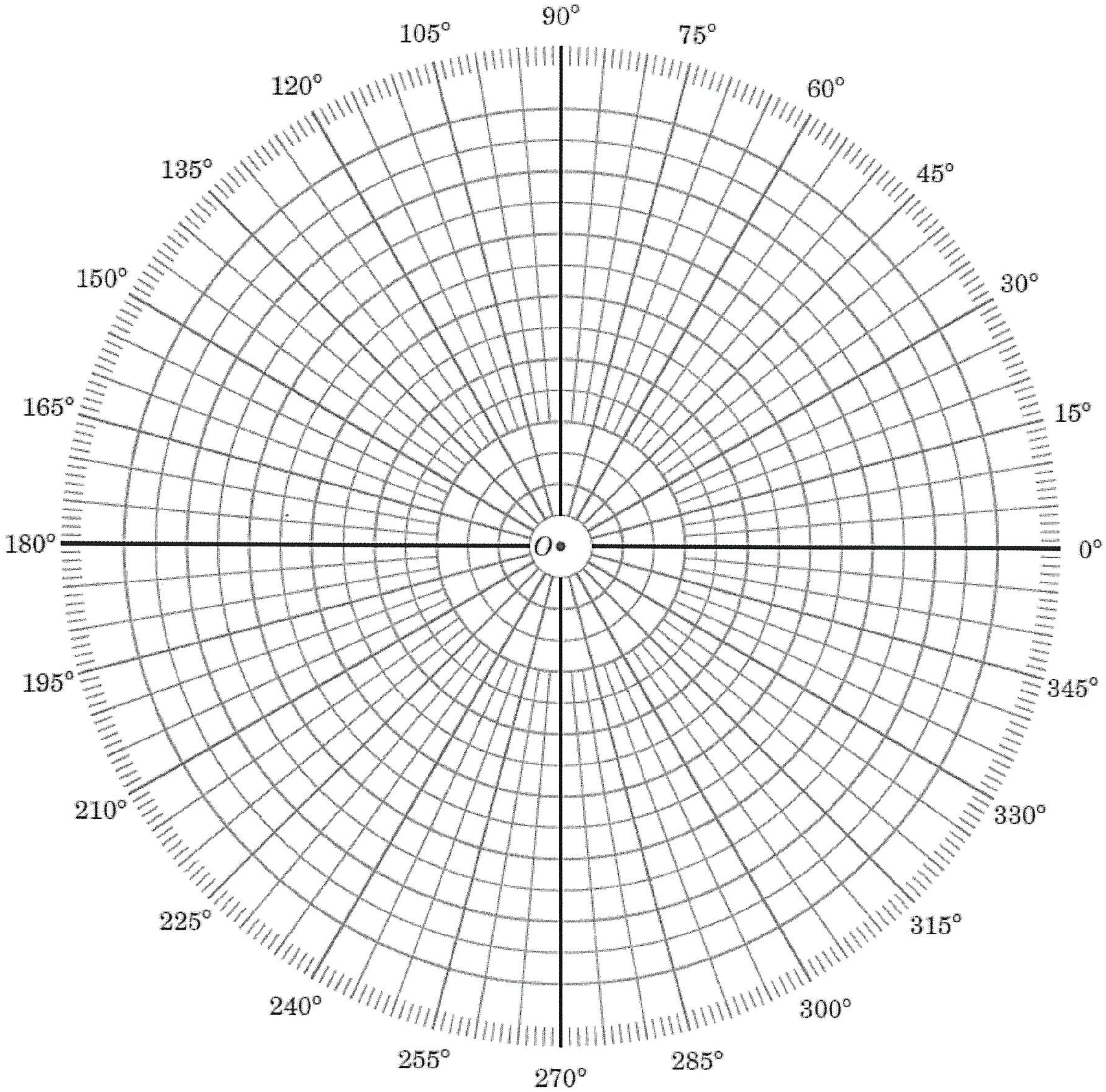
REFERENCE

f	$\mathcal{L}_t\,[f(t)]\,(s)$	conditions
1	$\frac{1}{s}$	
t	$\frac{1}{s^2}$	
t^n	$\frac{n!}{s^{n+1}}$	$n \in \mathbb{Z} \geq 0$
t^a	$\frac{\Gamma(a+1)}{s^{a+1}}$	$\mathbb{R}\,[a] > -1$
e^{at}	$\frac{1}{s-a}$	
$\cos(\omega t)$	$\frac{s}{s^2+\omega^2}$	$\omega \in \mathbb{R}$
$\sin(\omega t)$	$\frac{\omega}{s^2+\omega^2}$	$s > \lvert \mathbb{I}\,[\omega] \rvert$
$\cosh(\omega t)$	$\frac{s}{s^2-\omega^2}$	$s > \lvert \mathbb{R}\,[\omega] \rvert$
$\sinh(\omega t)$	$\frac{\omega}{s^2-\omega^2}$	$s > \lvert \mathbb{I}\,[\omega] \rvert$
$e^{at}\sin(b\,t)$	$\frac{b}{(s-a)^2+b^2}$	$s > a + \lvert \mathbb{I}\,[b] \rvert$
$e^{at}\cos(b\,t)$	$\frac{s-a}{(s-a)^2+b^2}$	$b \in \mathbb{R}$
$\delta(t-c)$	e^{-cs}	
$H_c(t)$	$\begin{cases} \frac{1}{s} & \text{for } c \leq 0 \\ \frac{e^{-cs}}{s} & \text{for } c > 0 \end{cases}$	
$J_0(t)$	$\frac{1}{\sqrt{s^2+1}}$	
$J_n(a\,t)$	$\frac{\left(\sqrt{s^2+a^2}-s\right)^n}{a^n\sqrt{s^2+a^2}}$	$n \in \mathbb{Z} \geq 0$

$$C(s) = R(s)\cdot\frac{\omega_n^2}{s^2+2\zeta\omega_n s+\omega_n^2}, \quad T = \frac{1}{\left(\zeta-\sqrt{\zeta^2-1}\right)\omega_n},$$

TERBUKA

TERBUKA


90°
105°
75°
120°
60°
135°
45°
150°
30°
165°
15°
180°
O
0°
195°
345°
210°
330°
225°
315°
240°
300°
255°
285°
270°