KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY
Department of Mechanical Engineering
B. Sc. Engineering 4th Year Backlog Examination, 2015
ME 4059
(Engineering Tribology)

Time: 3 Hours. Total Marks: 210

N.B. i) Answer any THREE questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.
iii) Assume reasonable data if any missing.

SECTION - A

1(a)	What is meant by tribology? Brief the occurrence of tribology in our daily life.	09
1(b)	Explain the importance of 'Tribology' in designing of different machine elements	08
1(c)	What is tribology surface? Explain with neat sketch the different layers of tribology surface.	10
1(d)	What are the future aspects of tribological research in Bangladesh?	08
2(a)	Explain any two theories of friction.	08
2(b)	Write a note on friction measurement by Pin-on-disk apparatus. Also explain the causes of friction.	09
2(c)	Using deformation theory, derive the equation for coefficient of friction due to deformation with usual notations.	10
2(d)	What is rolling friction? How can you classify the rolling contact?	08
3(a)	Explain different types of additives used to improve the properties of lubricating oils.	09
3(b)	State the importance of recycling of used oils. Explain various method of disposal of used oils.	10
3(c)	What are the methods of studying surface? Describe any one of them.	08
3(d)	Discuss adhesion theory of friction.	08
4(a)	Explain the following terms: (i) Fretting (ii) Delamination and (iii) Pitting	09
4(b)	What is meant by wear? Describe the different types of wear mechanisms with neat sketch.	15
4(c)	What are the methods of measuring wear? Describe the methods of high pressure contact test with necessary figures.	11

SECTION – B

5(a)	What are the purposes of lubrication in industries?	05
5(b)	How lubricant can be classified? State the important properties of lubricant.	10
5(c)	Define viscosity. Describe the effect of temperature on viscosity.	12
5(d)	What are the advantages and disadvantages of synthetic lubricant?	08

6(a)	Derive two dimensional Reynold's equation for hydrodynamic lubrication with usual notations. Also state the assumptions.	08
6(b)	Explain the phenomena of Elasto-hydrodynamic lubrication. How does it differ from hydrodynamic lubrication?	10
6(c)	Write merits, demerits and applications of gas lubrication.	09
6(d)	What is boundary lubrication? Explain it with neat sketch.	08
7(a)	What are the desirable properties of bearing materials. List few suitable materials for bearing.	09
7(b)	Derive the expression for pressure distribution in narrow width tapered pad bearing with neat sketch.	12
7(c)	Write note on "Bearing Construction".	07
7(d)	Explain lubrication requirements in case of forging operation.	07
8(a)	State the merits and demerits of gas lubricated bearing.	07
8(b)	What are the essential elements and requirements of a mechanical seal?	10
8(c)	What are the requirements of lubrication for open gears and enclosed gears?	08
8(d)	Explain the terms 'Nano-tribology' and 'Bio-tribology'.	10

KHULNA UNIVERSITY OF ENGINEERING & TECHNOLOGY

Department of Mechanical Engineering

B. Sc. Engineering 4th Year Backlog Examination, 2015

ME 4085

(Servomechanism & Control Engineering)

Time: 3 Hours. Total Marks: 210

N.B. i) Answer any THREE questions from each section in separate scripts.
ii) Figures in the right margin indicate full marks.
iii) Assume reasonable data if any missing.
iv) Normal and semilog papers may be supplied on request.

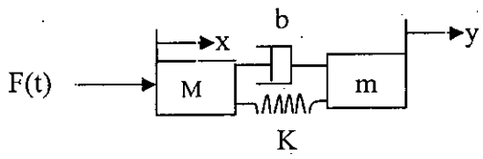
SECTION - A

1(a) Draw the functional block diagram of a closed loop control system and define each term of the block diagram. 09

1(b) Explain the operation of a rotating power amplifier. Draw the schematic diagram of a single-stage rotary power amplifier and deduce the input-output relationship. 15

1(c) Draw the schematic diagram and deduce the systems of equation of a dc servomotor with armature control. 11

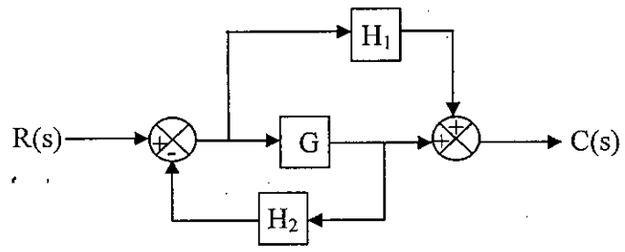
2(a) A two-mass model of a robot is shown below. Find the transfer function, $\frac{Y(s)}{F(s)}$. 12



2(b) The response of a dc motor is given by the following differential equation, 11

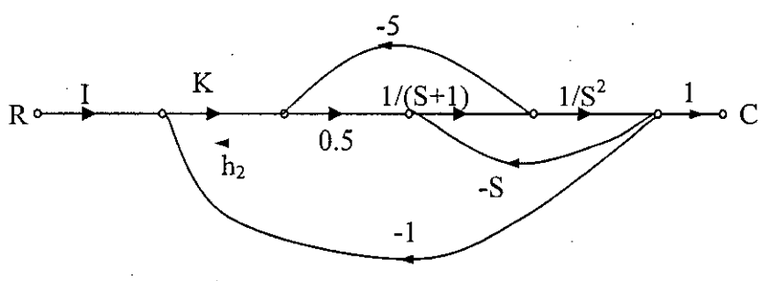
$A_2\frac{d^2x}{dt^2} + A_1\frac{dx}{dt}A_o x = r$, where x is position and r is input. Find the steady state position of the motor for ramp input given by the expression, r =(a_o+a_1t)ult.

2(c) Simplify the block diagram as shown. Obtain the transfer function , $\frac{C(s)}{R(s)}$. 12



3(a) Define poles and zeros. Explain how the stability of a system may be ascertained by the regional location of poles. 10

3(b) Using Mason's gain rule, obtain the overall TF of a control system represented by the signal flow graph of the figure. 13



3(c) Define poles and zeros of a system. A system has 3 poles, 2 zeros. The values of the poles are $P_{1,2}$ =-1±j2, P_3 =-3 and the values of the zeros are z_1 = -5, z_2 = -6. If the gain factor, k=3, determine the differential equation for the system. 12

4(a) State Routh's stability criterion. A unity feedback system has, 11

$$G(s) = \frac{20(S+2)}{S(S+3)(S+4)}.$$

Apply Rauth's stability criterion to determine the closed loop stability of the system.

4(b) Draw the signal flow graph for the state and output equations. 14

$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\\ \dot{x}_3\end{bmatrix} = \begin{bmatrix}-2 & 1 & 0\\ 0 & -3 & 1\\ -3 & -4 & -5\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix} + \begin{bmatrix}0\\ 0\\ 1\end{bmatrix}u; \quad y = \begin{bmatrix}0 & 1 & 0\end{bmatrix}\begin{bmatrix}x_1\\ x_2\\ x_3\end{bmatrix}$$

4(c) Drive the transfer function of a lag-lead compensator using passive elements. 10

SECTION - B

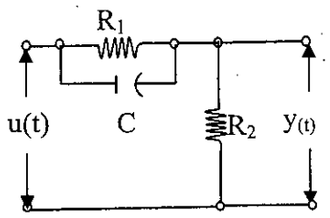
5(a) Define break-in and break-away points, angle –of-departure and angle-of-arrival. 10

5(b) A unity feedback control system has the following transfer function, 25

$$G(s) = \frac{k(S+3)}{S(S^2+4S+10)}.$$

Draw the root locus of the system for positive gain. Comment on the stability of the system.

6(a) Derive the transfer function of the system given in the figure shown below. If R_1=10kΩ, R_2= 5kΩ and C = 0.1μf, draw the bode plot. 20



6(b) The transfer function of an AC servomotor is obtained as; 15

$$\frac{w(s)}{V(s)} = \frac{4.2}{1+20s}$$

(i) Obtain the bode plot
(ii) Obtain the band width

7(a) Define eigen values of a system. Show that the eigen values of a system are invariant under linear transformation. 10

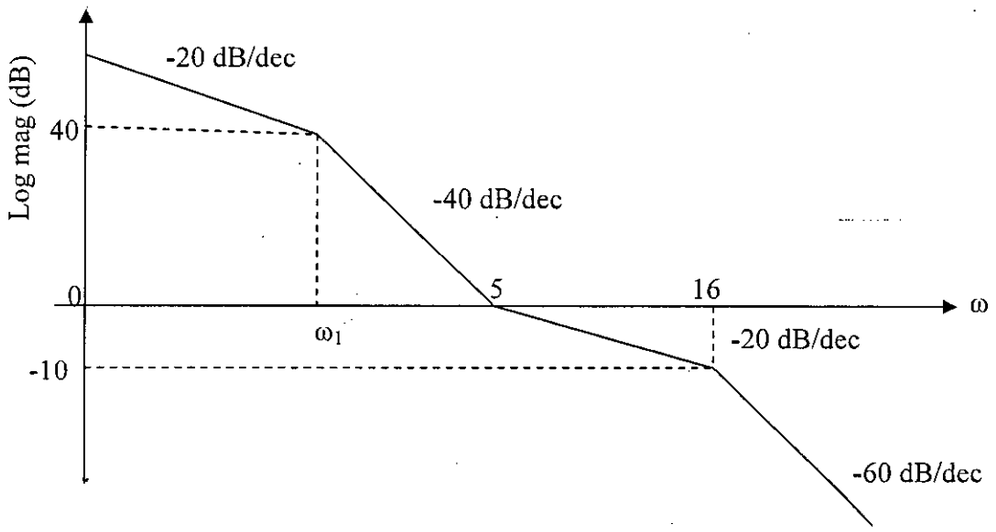
7(b) Briefly explain ON-OFF, P, PI, PD and PID controllers. 12

7(c) Define controllability and observability. State whether the following system is controllable and observable. 13

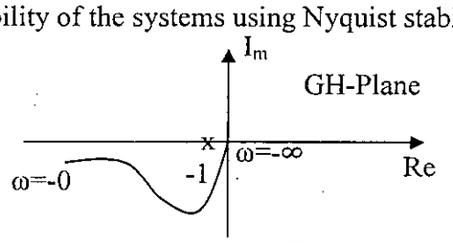
$$\begin{bmatrix}\dot{x}_1\\ \dot{x}_2\end{bmatrix} = \begin{bmatrix}-3 & 1\\ -2 & 1.5\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix} + \begin{bmatrix}1\\ 4\end{bmatrix}u$$

$$y = \begin{bmatrix}0.8 & 1\end{bmatrix}\begin{bmatrix}x_1\\ x_2\end{bmatrix}$$

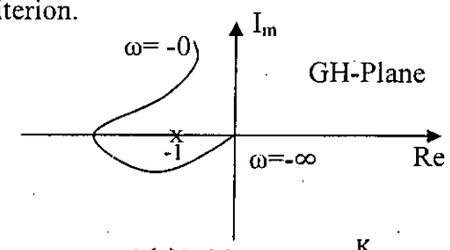
8(a) Explain the procedure of determining transfer function of a physical system using Bode diagram in laboratory. Determine the transfer function of the system presented below; 14



8(b) State Nyquist stability criterion. Complete the following polar plots and comment on the stability of the systems using Nyquist stability criterion. 12



$$G(s)H(s) = \frac{K}{S^2(Ts+1)}$$



$$G(s)H(s) = \frac{K}{S(T_1S+1)(T_2S+1)}$$

8(c) Explain Nichol's chart, M-loci and N-loci. 09