PP2

TECHNICAL UNIVERSITY OF MOMBASA

School of Applied and Health Sciences

Department of Mathematics and Physics

UNIVERSITY EXAMINATION FOR:

BACHELOR OF TECHNOLOGY (APPLIED PHYSICS)

EEE 4351: CONTROL ENGINEERING II.

END OF SEMESTER EXAMINATION

SERIES: JULY 2025

TIME: 2 HOURS

DATE: JULY 2025

Instructions to Candidates

You should have the following for this examination
-Answer Booklet, examination pass and student ID
This paper consists of **five** Questions; Question ONE is compulsory. In addition attempt any Other TWO Questions.
Do not write on the question paper.

Question ONE (Compulsory 30 marks)

a) Define the following
   i) State variable
   ii) State of a system
   iii) State space

[6 marks]

b) Derive the transfer function of the lead-lag network of Figure Q1b

[12 marks]

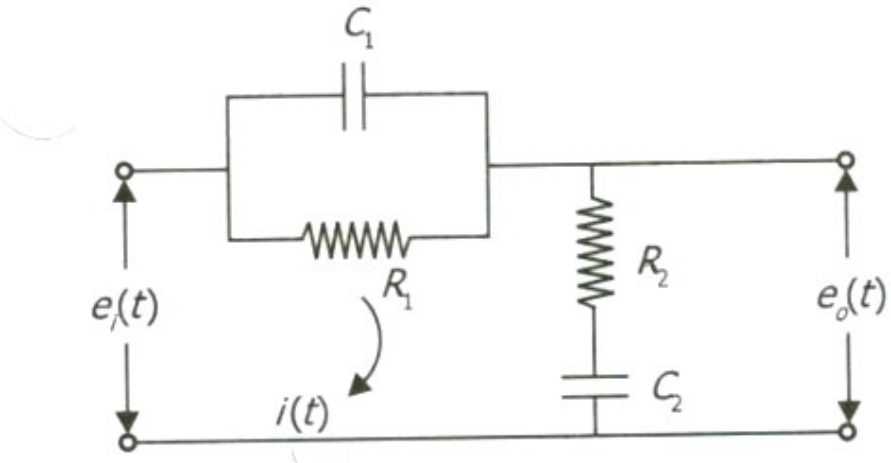

Figure Q1b

c) Find the state space model for the electrical circuit of Figure Q1c using the current *i* and the voltage across the capacitor, vc, as state variables.

[8 marks]

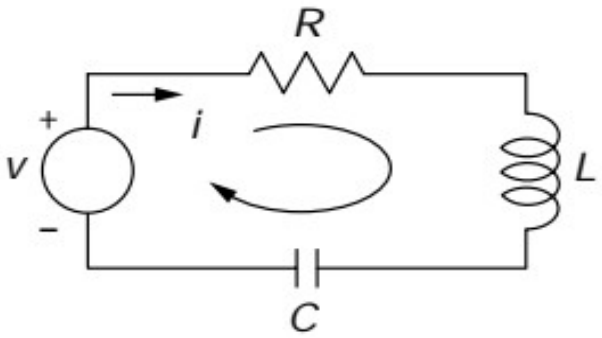

Figure Q1c

d) State any four effects of a **lag** compensator

[4 marks]

Question TWO

a) For the electrical phase lag network of figure Q1a,

i) Derive the transfer function $E_o(s)/E_i(s)$

ii) Show that the phase lag angle is a maximum at a frequency given by $\omega_m=\sqrt{\left(\frac{1}{\tau}\right)\left(\frac{1}{\beta\tau}\right)}$ where $\omega_{c1} = 1/\beta$ and $\omega_{c2} = 1/\beta\tau$ are the corner frequencies of the phase lag compensator.

[12 marks]

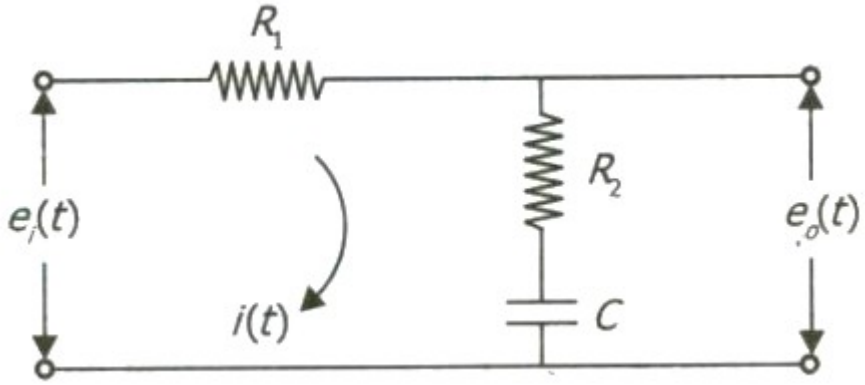

Figure Q2b

b) Outline Four effects of lead compensation on a system

[8 marks]

Question THREE

a) Given the transfer function of the system as

$$\frac{Y(s)}{U(s)}=\frac{b_o s^3+b_1 s^2+b_2 s+b_3}{s^3+a_1 s^2+a_2 s+a_3}$$

i) Derive the state model in observable canonical form

ii) Draw the block diagram

[15 marks]

b) Explain the effects of a proportional controller connected in cascade with a process

[5marks]

Question FOUR

a) Derive the state space equation for the armature controlled DC motor of Figure Q4a

[13 marks]

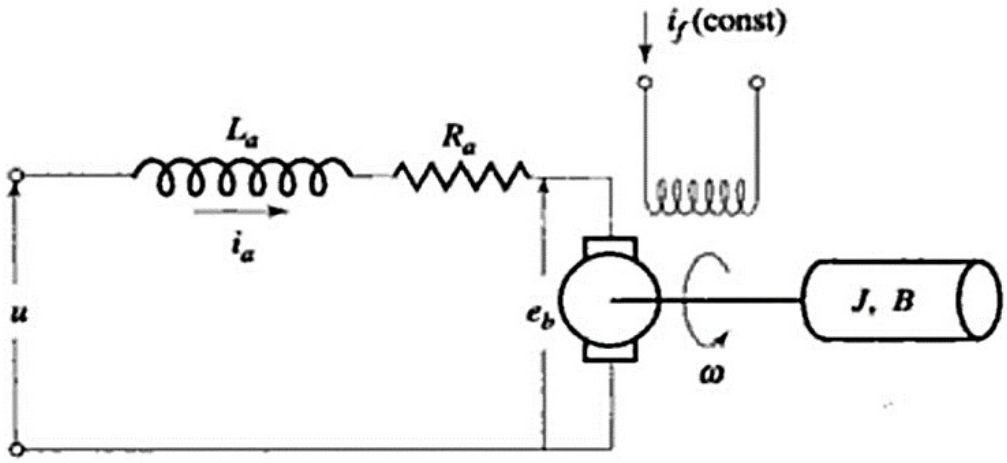

Figure 4a

b) Obtain the time response of the following system:

$$\begin{bmatrix} \dot{x}_1 \\ \dot{x}_2 \end{bmatrix} = \begin{bmatrix} 0 & 1 \\ -2 & -3 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \end{bmatrix} + \begin{bmatrix} 0 \\ 1 \end{bmatrix} u$$

where $u(t)$ is the unit-step function occurring at $t = 0$, or $u(t) = 1(t)$

[7 marks]

Question FIVE

a) (i) Define the term compensation as used in control engineering

(ii) Briefly explain any two types of compensating networks

[6 marks]

b) (**i**)Figure Q5a is a proportional integral controller. Determine the expression for k_i and k_d

[14 marks]

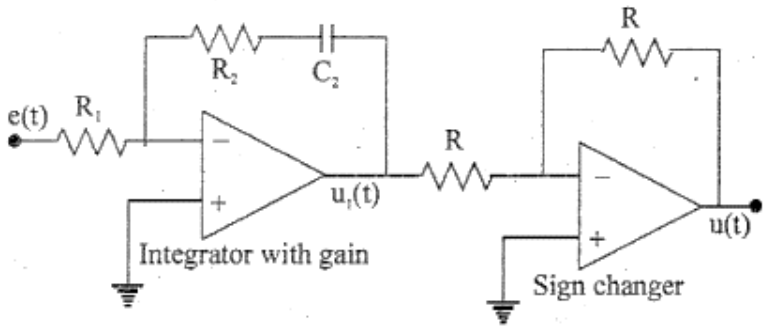

Figure Q5a

(ii) State four effects of a pi controller