# MURANG'A UNIVERSITY OF TECHNOLOGY

## SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS

UNIVERSITY ORDINARY EXAMINATION

2023/2024 ACADEMIC YEAR

**THIRD** YEAR **SECOND** SEMESTER EXAMINATION FOR EEE, BSc. EEE

EES 301 – ELECTRICAL CIRCUIT THEORY III

DURATION: 2 HOURS

**INSTRUCTIONS TO CANDIDATES:**

1. Answer question one and any other two questions.
2. Mobile phones are not allowed in the examination room.
3. You are not allowed to write on this examination question paper.

**SECTION A: ANSWER ALL QUESTIONS IN THIS SECTION**

**QUESTION ONE (30 MARKS)**

a. Differentiate between the following terms as used in electrical circuit theory.
   i. Driving point functions and transfer function.
   ii. Magnitude and phase frequency response.
   iii. Impedance and frequency scaling (6marks)

b. ..
   i. List two properties of Brune's positive real functions.
   ii. Check whether the following functions are positive real or not. (6marks)

$$y1_{(s)} = \frac{5(S^2 + 2s + 1)}{S^3 + 2S^2 + 2s + 40}$$

$$y2_{(s)} = \frac{S^3 + 5s}{s^4 + 2S^2 + 1}$$

c. A series RL low pass filter with R – 100S2 and cut off frequency of 1000 rad/sec. It is required to scale the cut off frequency to 5000 rad/sec.
   i. Sketch the unscaled circuit and obtain the value of L.
   ii. Determine the scaling constant and use the value to calculate the new values of R and L. (4marks)

d. From the circuit shown in figure 1 below, draw the magnitude response of the transfer function and deduce the type of filter represented. (6marks)

   Insert diagram……..

e. …
   i. Define the term bode plot and give two advantages of them.
   ii. You are hired as a Research and Design Engineer with Huawei International Limited to design and optimize filters for Safaricom Limited. Your first task is to design a filter corresponding to the following bode magnitude plot. Determine $T_{(S)}$ and sketch the corresponding Bode phase response. (8marks)

   Insert diagram……..

**SECTION B – ANSWER ANY TWO QUESTIONS IN THIS SECTION**

**QUESTION TWO (20 MARKS)**

a. ..
   i. Define the sensitivity function and explain the importance of the sensitivity function in an electrical network. (3marks)
   ii. Derive …….. (4marks)
   iii. Given that … insert……. (7marks)

b. Determine if $P_{(s)} = S^u + 3S^3 + Ss^2 + 2$ is a Hurwitz polynomial. (6marks)

**QUESTION THREE (20 MARKS)**

**a. ..**
   i. Define the term electrical filter citing two applications of filters.
   ii. List two limitations of passive filters. (5marks)
   iii. For the active filter shown in Figure 3.

b. Insert diagram…….
   i. Derive the filter transfer function and determine the type of filter represented.
   ii. In terms of $R_1$, $R_2$ $C_1$ and $C_2$ derive the expression for Q, $W_o$ and $H_o$.
   iii. Given the transfer function below, locate the poles and zeros on S-plane and comment on its stability.

$$T_{(s)} = \frac{S^2 - 4S + 8}{(S^2 + 42 + 8\,(S^2 + 9S + 18)}$$

**QUESTION FOUR (20 MARKS)**

a. Using suitable sketches, discuss the characteristics of a Chebysher filter. (4marks)

b. Find:
   i. The order … of the Butterworth filter needed to satisfy the following low pass filter specifications …… 2min = 3S dB, $W_p$ = 1000rad/sec and $W_s$= 3500 rad/sec.
   ii. For the filter in (i) above, locate the poles on the S-plane
   iii. Evaluate Q for each pole. (8marks)

c. ..
   i. Derive the transfer function of network shown in figure .. and show that it is a bilinear network.

   Insert diagram….

ii. Further given that $L_i$ = 0.5H, $L_2$ = 1H, $R_i$ = 1052, and $R_2$ = 1250 and using the transfer function obtained in $C_{(i)}$. Sketch the bode magnitude and phase plots.
(8marks)