Strathmore UNIVERSITY

SCHOOL OF COMPUTING AND ENGINEERING SCIENCES
BACHELOR OF ELECTRICAL AND ELECTRONICS ENGINEERING
END OF SEMESTER EXAMINATION

BEE 2203: NETWORK THEORY

DATE: 11th March 2024 **Time: 13:00-16:00 Hours**

Instructions

1. This examination consists of **FIVE** questions.
2. Answer **Question ONE (COMPULSORY)** and any other **TWO** questions.
3. Do not write on the question paper.

QUESTION ONE **(Total:30 Marks)**

a) Illustrate (*using a diagram*) and discuss the difference between network analysis and synthesis. (3 Marks)

b) Showing all the subplots and workings, construct the magnitude and phase Bode plots for function below (7 Marks)

$$H(s) = \frac{s+10}{s(s+5)^2}$$

c) Determine the z parameters for the circuit in figure 1. (6 Marks)

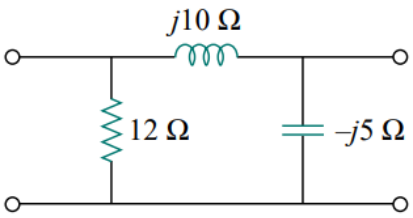

Figure 1

d) Test whether $s^5 + 8s^4 + 24s^3 + 28s^2 + 23s + 6$ is Hurwitz or not using Routh array method. *Show all the steps* (4 Marks)

e) List three properties of Butterworth filters. (3 Marks)

f) Highlight two main limitations **each** of passive and active filters. (2 Marks)

g) What is the meaning of decade as used in Network Theory? (1 Mark)

h) Determine the type of the filter shown in figure 2 and derive it's transfer function. (4 Marks)

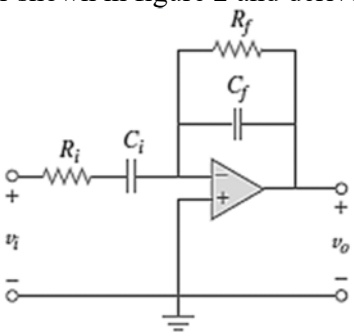

Figure 2

QUESTION TWO **(Total: 15 Marks)**

a) Test whether the following polynomials are Hurwitz. *Show all the steps*

i. $s^4 + s^3 + 5s^2 + 3s + 4$ (3 Marks)

ii. $s^5 + s^3 + s$ (4 Marks)

b) Synthesize the following driving point impedance function of a one-port reactive network using **EITHER** the 1st **OR** 2nd Foster synthesis method and draw the resulting circuit. (8 Marks)

$$H(s) = \frac{5(s^2 + 4)(s^2 + 25)}{s(s^2 + 16)}$$

QUESTION THREE **(Total: 15 Marks)**

a) Check the positive realness of the following function (4 Marks)

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

b) Synthesize the impedance function $Z(s) = \frac{6s^3+3s^2+3s+1}{3s(2s^2+1)}$ of an RLC network using Cauer realization method. (7 Marks)

c) The op amp circuit in figure 3 is to be magnitude-scaled by 100 and frequency-scaled by 10^5. Find the resulting element values. (4 Marks)

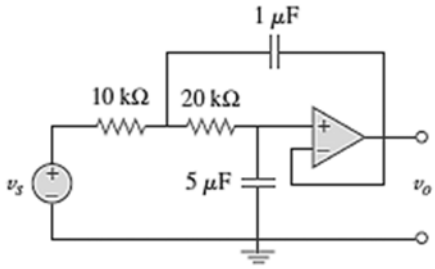

Figure 3

QUESTION FOUR **(Total: 15 Marks)**

a) Design a highpass active filter with a high frequency gain of 5 and a corner frequency of $2kHz$. Use a $0.1\ \mu F$ capacitor in your design (3 Marks)

b) A series-connected circuit has R = 2 Ω, L = 1 mH, and C = 0.4 μF.

i. Find the resonant frequency,ω_0, and the half-power frequencies, ω_1 and ω_2. (4½ Marks)

ii. Calculate the quality factor and bandwidth. (3 Marks)

iii. Determine the amplitude of the current at ω_0, ω_1 and ω_2.. (4½ Marks)

QUESTION FIVE **(Total: 15 Marks)**

a) Sketch Chebyshev Type 1 filter magnitude response for n = 7 (2 Marks)

b) Sketch Chebyshev Type 1 filter attenuation responses for n = 3 and 6 on the same plot. (3 Marks)

c) Design a Butterworth lowpass filter that meets the following specifications; (10 Marks)

- Maximum attenuation $\alpha_{max} = 0.55\ dB$
- Maximum attenuation $\alpha_{min} = 22\ dB$
- Passband edge frequency $\omega_p = 1000\ rad/s$
- Stopband edge frequency $\omega_s = 3500\ rad/s$