MACHAKOS UNIVERSITY

University Examinations for 2019/2020Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

THIRD YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONICS ENGINEERING

EEE 307: NETWORK ANALYSIS & SYNTHESIS

DATE: 25/11/2020 **TIME: 2.00-4.00 PM**

INSTRUCTIONS

Answer Question One and Any Other Two Questions
Show calculations where applicable

QUESTION ONE (30 MARKS)

a) Given that the desired specifications of a Butterworth lowpass filter are as follows: $\alpha_{\max} = 3\,dB$, $\alpha_{\min} = 50\,dB$, $\omega_p = 1000\,rad/s$, and $\omega_s = 2500\,rad/s$, design the filter the meet the specifications given. (10 marks)

b) Synthesis the following RC function in Cauer form I:

$$Z(s) = \frac{(s+1)(s+4)}{s(s+2)(s+5)}$$ (6 marks)

c) Test whether the following function is a positive real function or not

$$G(s) = \frac{4s(s^2+4)(s^2+16)}{(s^2+1)(s^2+9)}$$ (6 marks)

d) For the circuit shown in Fig. Q1 d), determine

i. the voltage ratio of $V_2(s)/V_1(s)$,

ii. the current ratio $I_2(s)/I_1(s)$,

iii. the transfer impedance $V_2(s)/I_1(s)$, and

iv. the driving point impedance $V_1(s)/I_1(s)$ (8 marks)

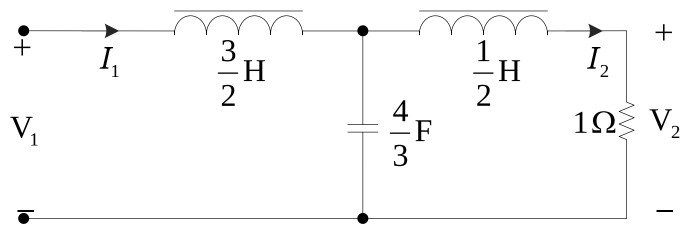

Fig. Q1 d)

QUESTION TWO (20 MARKS)

a) Determine if the following function satisfies the analogue filter theorem design and plot the poles and zeros of the function on an s-plane. (6 marks)

$$X(\omega) = \frac{\omega^3 + 9\omega^2 + 26\omega + 24}{\omega^4 + 5\omega^2 + 4}$$

b) Design an inverse Chebyshev low pass filter to satisfy the following specifications: $\omega_p = 750\, rad/s, \omega_s = 2500\ rad/s, \alpha_{\max} = 0.2\,\text{dB}$ and $\alpha_{\min} = 55\,\text{dB}$. (14 marks)

QUESTION THREE (20 MARKS)

a) Given that the desired specifications of a Chebyshev Type I lowpass filter are as follows: $\alpha_{\max} = 0.85\, dB, \alpha_{\min} = 35\, dB$, $\omega_p = 3{,}500$ rad/s, and $\omega_s = 7{,}500$ rad/s, design the filter the meet the specifications given. (9 marks)

b) Realize the following LC function in Foster form I. (6 marks)

$$Z(s) = \frac{s\left(s^2+4\right)}{2\left(s^2+1\right)\left(s^2+9\right)}$$

c) Test whether the following transfer function is positive real. (5 marks)

$$F(\text{s}) = \frac{s^2+1}{s^3+4s}$$

QUESTION FOUR (20 MARKS)

a) Synthesize a network which has the impedance function:

$$Z(s) = \frac{5s^3 + 2s^2 + 3s + 1}{5s^3 + 3s}$$ (8 marks)

b) State the properties of R-C driving point impedance. (3 marks)

c) Using the properties in b) above, test whether the following function is an R-C driving point impedance. (4 marks)

$$Z(s) = \frac{(s+1.5)(s+3.5)(s+7)}{s(s+2.5)(s+5.5)}$$

d) Synthesize the following function using Foster form II. (5 marks)

$$Z(s) = \frac{\left(s^2+1\right)\left(s^2+3\right)}{s\left(s^2+2\right)\left(s^2+4\right)}$$

QUESTION FIVE (20 MARKS)

a) Test whether the following function is a Hurwitz polynomial. (5 marks)

$$P(s) = s^7 + 2s^6 + 2s^5 + s^4 + 4s^3 + 8s^2 + 8s + 4$$

b) Synthesize the following RC admittance function using Cauer form II $Y(s) = \dfrac{4s^2 + 6s}{s+1}$.

(5 marks)

c) State three applications of analogue filters. (3 marks)

c) Sketch the Chebyshev type I magnitude response for $n = 6$ (2 marks)

d) Briefly explain five advantages of active filters as compared to the passive filters? (5 marks)