



# MURANG'A UNIVERSITY OF TECHNOLOGY

## SCHOOL OF ENGINEERING TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONICS  
ENGINEERING

UNIVERSITY ORDINARY EXAMINATION

2023/2024 ACADEMIC YEAR

..... YEAR **SECOND** SEMESTER EXAMINATION FOR, BACHELOR OF  
SCIENCE IN .....

**EET 633**– MICROWAVE ENGINEERING

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 (25 MARKS)

- a)
  - i. Define a signal flow graph and explain any one of its benefits ( 4marks)
  - ii. Use sketches and expressions to explain the third SFG rule ( 4marks)
- b)
  - i. Explain any two reasons for impedance matching ( 2marks)
  - ii. Design a single section quarter- wave matching transformer to match 50 $\Omega$  load to a 100 $\Omega$  transmission line at  $f_0=2\text{GHz}$ . Determine the percentage bandwidth for which  $\text{SWR} = 1.5$
- c)
  - i. Define the term 'isolation' as a characteristic of directional couplers.
  - ii. A lossless T-junction power divider has a source impedance of 100 $\Omega$ . Determine the output characteristic impedances of  $Z_1$  and  $Z_2$  so that the output powers are in a 2: 1 ratio ( 5marks)

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

### QUESTION TWO (25 MARKS)

- a) using sketches, explain the role of the distance,  $d$ , selected during the matching process in the following cases;
  - i) Shuntg-stub
  - ii) Series-stub ( 8marks)
- b) A four- port directional coupler has an input power  $P_1=25\text{MW}$ ,  $P_3 = 8\text{mw}$  and  $P_4 = 0.2\text{mw}$ . Determine the following;
  - i) Coupling coefficient
  - ii) Directionary
  - iii) Isolation ( 6marks)
- c) Design a band- pass filter having a 0.5dB equal-ripple response, with  $N=3$  centre frequency at 2GHZ, with 10% bandwidth and an impedance of 50 ( 11marks)

### QUESTION THREE (25 MARKS)

- a) State any three characteristics of dielectric resonators compared to metallic cavities ( 3marks)
- b) A two-port T-network is represented by two series impedances ( $Z_A$  and  $Z_B$ ) and a parallel impedance,  $Z_C$  between the input and output ports. Determine the Z- parameters of this network and show its Z-matrix. ( 9marks)
- c) A low-pass composite filter with a cut-off frequency of 1MHZ and impedance of 75 is required. Design such a filter by placing the infinite attenuation pole at 2MH ( 13marks)

### QUESTION FOUR (25 MARKS)

- a) Explain any two applications of isolators ( 4marks)

- b) A directional coupler has the following 5 parameters -----
- i) Supporting your answers, comment on port matching and reciprocity of this coupler ( 4marks)
  - ii) Identify any three through paths for this coupler, if any ( 3marks)
  - iii) Calculate the coupling factor of the coupler ( 2marks)
- c) Design a three – section binomial transformer to match a 100 load to a 50 line ( 12marks)
- i) Calculate the bandwidth for ( $\epsilon = 0.05$ )
  - ii) Determine required characteristics for impedances  $Z_1, Z_2, Z_3$  for  $n=0, n=1$  and  $n=2$

## QUESTION FIVE (25 MARKS)

- a) Define the following terms used in signal flow graphs .
- i) Source node ( 2marks)
  - ii) Self-loop ( 2marks)
  - iii) Branch ( 2marks)
- b) A signal flow graph for a given system contains three nodes ( $X_1, X_2$  and  $X_3$ ) and six branches. Table 1 shows connections of nodes and branches.-----  
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- i) Draw the signal flow graph for this system ( 3marks)
  - ii) Use SFG rules, sketches and expressions to reduce this signal flow graph to its simplest form ( 6marks)
- c) Consider a two-port 11-network device with two parallel admittances,  $Y_1=0.05, Y_2 =0.02$  and a series admittance  $Y_3 = 0.1$
- i) Sketch the two port 11-network device ( 3marks)
  - ii) Determine the ABCD matrix of this device ( 7marks)