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(*University of Choice*)

MASINDE MULIRO UNIVERSITY OF SCIENCE AND TECHNOLOGY (MMUST)

MAIN CAMPUS

SUPPLIMENTARY/SPECIAL EXAMINATIONS
2021/2022 ACADEMIC YEAR

SECOND YEAR SECOND SEMESTER EXAMINATIONS

FOR THE DEGREE
OF
BACHELOR OF SCIENCE IN ELECTRICAL AND COMMUNICATION ENGINEERING

COURSE CODE: ECE 524E
COURSE TITLE: MICROWAVE ENGINEERING

DATE: Friday, 7th October,2022 **TIME:** 3-5PM

INSTRUCTIONS TO CANDIDATES

Question ONE (1) is compulsory
Answer Any Other TWO (2) questions

TIME: 3 Hours

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 2 Printed Pages. Please Turn Over.

QUESTION 1 (30 MARKS)

(a) Define following terms with respect to rectangular waveguide and derive expression for both of them.

(i) cut-off frequency

(ii) Group velocity.

(iii) Velocity factor

(6 marks)

(b)(i) Name four applications of microwaves.

(i) Describe briefly the features of microwaves make them more suited to the applications in (b)(i).

(8 marks)

(c)(i) The cut-off frequency of an air-filed rectangular waveguide is 2.4 GHz for the TE10 mode. What would be the cut-off frequency if the same guide were filled with a lossless nonmagnetic material whose dielectric permittivity is four times that of air?

(ii) A strip-line is constructed from a metal strip 1 mm wide (W= 1 mm) separated from a ground plane by an oxide layer whose thickness, D, is 20 m. The relative dielectric constant of the oxide layer is εr= 8.00, and its relative permeability is μr= 1.00. What is the velocity of an electromagnetic wave on this line?

(8 marks)

(d)(i) What are ferrites and give their properties?

(ii) Give two examples of ferrite devices in microwave engineering?

(iii) Explain the construction and principle of operation of a TRAPATT diode.

(8 marks)

QUESTION 2 (20 MARKS)

(a) Name five passive Waveguide Components and their functions.

(5 marks)

(b)(i) With the aid of an illustration, define a microstrip and describe its operation.

(ii) Describe the operation of a reflex klystron with the aid of a block diagram.

(iii) Name three applications of a reflex klystron?

(9 marks)

(c)(i) Draw and explain the working of directional coupler.

(ii) Obtain the S matrix of a three-port directional coupler.

(6 marks)

QUESTION 3 (20 MARKS)

(a)(i) With the aid of a diagram, describe three types of microwave cavities.

(ii) Name and describe two microwave devices using faraday rotation principles

(iii) What are power dividers used for in a microwave engineering?

(9 marks)

(b)(i) Why is the frequency range between 1GHz – 10 GHz more suitable for use by most commercial microwave systems?

(ii) With the aid of a block diagram, describe the operation of a microwave oven.

(iii) What do you think are the reasons why the 2.45GHz was chosen for use in microwave ovens?

(11 marks)

QUESTION 4 (20 MARKS)

(a) (i) With the aid of illustrations, discuss two methods of coupling a co-axial transmission line to a waveguide.

(ii) State the properties of s-matrix?

(iii) Why is s-matrix used in microwave analysis?

(9 marks)

(b). State the advantages and disadvantages of waveguides compared with Transmission lines.

(4 marks)

(c)(i) (c)(i) Describe the principle of operation of an IMPATT diode.

(ii) An IMPATT diode has the following parameters:

Carrier drift velocity, $V_d = 2 \times 10^7$ cm/s

Drift-region length, $L = 6$ μm

Maximum operating voltage, $V_{max} = 100$ V

Maximum operating current, I_{max} = 200 mA

Efficiency, η = 15%

Breakdown voltage, V_{bd} = 90 V

Calculate **(I)** the maximum CW output power in watts; **(II)** the resonant frequency in gigahertz.

(7 marks)