TECHNICAL UNIVERSITY OF MOMBASA

Paper 2

<u>EXAMINATION RUBRIC</u>

FACULTY   ENGINEERING AND TECHNOLOGY

DEPARTMENT   ELECTRICAL & ELECTRONIC

Common ☐   **Not common** ☐

COURSE/CLASS   **Bachelor of Science in Electrical and Electronic Engineering**

UNIT CODE   **EEE 2419**

PAPER   **Microwave**

SERIES   **May 2016**

NO. OF STUDENTS ☐

<u>INSTRUCTION TO CANDIDATES</u>

Answer Question One (Compulsory) and any other Two Questions

Name of setter: Stephen Sande

Name of moderator: Prof. Heywood Ouma

Date submitted to examination centre _____

TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

UNIVERSITY EXAMINATION FOR :

THE DEGREE OF BACHELOR OF SCIENCE IN ELECTRICAL AND ELECTRONIC ENGINEERING

EEE 2419   MICROWAVE

END OF SEMESTER EXAMINATION

SERIES: MAY 2016   **TIME : 2 HOURS**

DATE:

<u>**Instructions to Candidates**</u>

You should have the following for this examination:

- *Answer Booklet, examination pass and student ID*

This paper consists of five questions;

Question ONE is compulsory. In addition attempt any other TWO questions

$$\varepsilon_0 = \frac{1}{36\pi} \times 10^{-9} \, F/m \,; \, \mu_0 = 4\pi \times 10^{-7} \, H/m$$

<u>**Do not write on the question paper**</u>

Question ONE (Compulsory 30 marks)

(a)   Explain why microwave frequencies are suitable for the following applications:

   (i)   Wireless systems   (ii)   Digital transmission systems   (iii)   Radar Systems

   (iv)   Satellite and terrestrial communication links   (v)   Heating   (10 marks)

(b)   Consider an electromagnetic wave which is incident on a boundary. Derive expressions for:

   (i)   reflection coefficient   (ii)   transmission coefficient   (iii)   time- averaging power flow for a dielectric boundary   9 marks)

(d)   (i)   Describe using appropriate sketches the principle of operation of a reflex klystron amplifier.

   (ii)   Distinguish between a reflex klystron and a travelling wave tube (TWT).   (11 marks)

Question TWO

(a)   (i)   State the Poynting theorem

   (ii)   Explain the significance of the terms in a (i) using appropriate sketches.   (7 marks)

(b)   Starting from the three dimensional Helmholtz equation, derive expressions for transverse and longitudinal fields for TE modes in a rectangular waveguide.   (13 marks)

Question THREE

(a)   State the FOUR Maxwell's equations in point form and explain the significance of each   in electromagnetic theory.   (6 marks)

(b)   With the aid of suitable sketches explain the principle of operation of transferable electron device (GUNN diode)   (5 marks)

(b)   Explain the main electrical features of the following microwave devices:

   (i)   IMPATT diode   (ii)   TRAPATT diode   (iii)   BARITT diode   (6 marks)

(C)   Highlight THREE classifications of magnetrons.   (3 marks)

Question FOUR

(a)   (i)   With the aid of a suitable diagram explain the Manley-Rowe equation explaining its significance in parametric amplification.

   (ii)   Distinguish between an up-converter parametric amplifier and a negative resistance parametric amplifier in terms of their principle of operation.   (13 marks)

(b)   (i)   Explain if power measurement techniques used at dc or low frequencies can be applied to microwave frequencies. If not why.

   (ii)   Describe using suitable measurement apparatus the procedure for measuring low microwave power levels.   `   (7 marks)

Question FIVE

(a)   With the aid of a schematic diagram describe the operation of four port microwave circulator.

(6 marks)

(b)   Describe two sources of losses in hollow rectangular waveguides   (4 marks)

(c)   An air-filled rectangular waveguide has cross-sectional dimensions:

$$a = 8cm \qquad b = 4cm$$

(i)   Find the cut-off frequency for the following modes, TE_{10}, TE_{20}, TE_{01} TE_{02}, TE_{11} $TE_{12,}$ and TE_{21} modes.

(ii)   Determine the dominant mode (iii)   Determine the degenerate modes   (10 marks)