THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

(A Constituent College of JKUAT)

(A Centre of Excellence)

Faculty of Engineering & Technology

DEPARTMENT OF ELECTRICAL & ELECTRONIC ENGINEERING

UNIVERSITY EXAMINATION FOR:
BACHELOR OF SCIENCE IN ELECTRICAL & ELECTRONIC ENGINEERING

EEE 2419: MICROWAVES

END OF SEMESTER EXAMINATION
SERIES: DECEMBER 2012
TIME: 2 HOURS

Instructions to Candidates:
You should have the following for this examination
- *Answer Booklet*

This paper consists of **FIVE** questions. Answer any other **THREE** questions
Maximum marks for each part of a question are as shown
This paper consists of **THREE** printed pages

Question One (Compulsory)

a) State and explain **FOUR** major characteristics that distinguish microwave engineering from its lower engineering counterpart. **(4 marks)**

b) Explain why microwave engineering is applicable to the following:
- **(i)** Antennas
- **(ii)** Satellite communications
- **(iii)** Radar systems
- **(iv)** Remote sensing, medical diagnostics, treatment and heating method **(6 marks)**

c) A plane wave propagating in a lossless dielectric has an electric field given by:

$\overline{E} = EoC\Omega\left(1.45\times10^{10}t - 62.5z\right)\hat{a}_2$

. Determine its:

(i) Phase velocity
(ii) Wave impedance **(5 marks)**

d) Write down Maxwell's equations and the constitutive parameters in differential form. **(4 marks)**

e) For a dielectric material, show that the Maxwell equation for H can be expressed as:

$$\nabla\times H = jw\left(\varepsilon' - j\varepsilon'' - j\frac{\delta}{\omega}\right)\overline{E}$$

(4 marks)

f) Show that for a rectangular wave guide:

$$xg = \frac{\lambda_o}{\sqrt{\left[1-\left(\frac{\lambda_o}{\lambda_c}\right)^2\right]}}$$

$$\beta = \pm\sqrt{k^2 - k_c^2}$$

Take: and the symbols have their usual meaning. **(7 marks)**

Question Two

a) State giving reasons why conventional vacuum tubes are less useful signal sources at microwave frequencies above IGH2. **(4 marks)**

b) Describe using suitable diagrams the principle of operations of Reflex Klystron **(6 marks)**

c) State **FOUR** major applications of Reflex Klystron Oscillator **(2 marks)**

d) A Reflex Klystron is to be operated at frequency of 10GHz with dc beam voltage 300V, repeller space 0.1cm for 1 ¾ mode. Calculate:
(i) The maximum RF power output
(ii) Repeller voltage for a beam current of 20mA **(4 marks)**

e) State, giving frequency ranges, performance and applications of a multi-cavity Klystron. **(4 marks)**

Question Three

a) Explain the following modes stand for:
(i) TEM
(ii) TE
(iii) TM

b) By separation of variable method express $H_z(x, y, z)$, $E_x(x, y, z)$ $E_y(x, y, z)$, $H_y(x,y,z)$ in terms of waveguide modes for an TEmm wave propagating in the Z direction in a rectangular waveguide with the broader dimension a along the x axis and the hammer dimension b along the y axis. **(10 marks)**

c) Prove that the propagation constant in a losy waveguide is given by:

$$\gamma^2 = \beta^2(1-j)(\tan\delta_m + \tan\delta_e)$$

where the symbols have the usual meaning**.** **(7 marks)**

Question Four

a) Describe using suitable diagrams, avalanche multiplication in Read diode.

b) Explain the main electrical features of the following microwave devices.

(i) IMPATT diode
(ii) TRAPAT diode
(iii) BARITT diode **(6 marks)**

c) Draw the equivalent circuit of Manley-Rome power relations for an ideal non-linear reactance and state its significance. **(4 marks)**

d) State **FIVE** advantages of the up-converter parametric amplifier over the negative resistance parametric amplifier. **(5 marks)**

Question Five

a) Write down the following matrices applicable to microwave circuit networks and state clearly the input variable and output variable.

(i) Impedance matrix
(ii) Admittance matrix
(iii) Scattering P. matrix **(6 marks)**

b) Describe the procedures for measuring:

(i) Low microwave power levels
(ii) High microwave power levels **(8 marks)**

c) Describe with a schematic diagram, the principle of operation of a four port microwave circulator. **(6 marks)**