The Open University of Sri Lanka
Faculty of Engineering Technology
Department of Electrical and Computer Engineering

Study Programme	: Bachelor of Technology Honours in Engineering
Name of the Examination	: Final Examination
Course Code and Title	**: EEX7333 Microwave Devices and Antennas**
Academic Year	: 2023/2024
Date	: 2nd March 2025
Time	: 13:30 – 16:30 hrs
Duration	: **03 hours**

General Instructions

1. Read all the instructions carefully before answering the questions.
2. This is a Closed Book Test (CBT).
3. This question paper consists of **five (05)** questions in **four (04)** pages.
4. Answer **all five (05) questions.**
5. All questions carry equal marks.
6. The answer for each question should commence from a new page.
7. Answers should be in clear handwriting.
8. Do not use a Red color pen.
9. All the notations have their usual meaning.
10. Assume any missing parameters with suitable values.

Q1 Review of Basic Electromagnetic Theories

a) State and explain Gauss's law for electric fields and Gauss's law for magnetic fields.

[04 marks]

b) Write Maxwell's equations in differential and integral forms.

[04 marks]

c) Explain the concept of Poynting vector.

[04 marks]

d) The magnetic field intensity of a uniform plane wave in free space is given by

$$\mathbf{H} = H_0 \cos(\omega t - \beta x)\, \hat{\mathbf{a}}_z$$

Determine the corresponding electric field intensity **E**, electric flux density **D**, and magnetic flux density **B**.

Assume that for free space, $\varepsilon_{0=} 8.854 * 10^{-12}\, F/M$ and $\mu_0 = 4\pi * 10^{-7}\, H/m$.

[08 marks]

Q2 Transmission Lines

a) Explain the significance of characteristic impedance of a transmission line.

[04 marks]

b) Define reflection coefficient and voltage standing wave ratio (VSWR), and derive their relationship.

[04 marks]

c) What are the conditions for a lossless transmission line? How do these conditions affect the wave propagation?

[04 marks]

d) A transmission line has a characteristic impedance of 75 Ω, an attenuation constant $\alpha = 0.02$ Np/m, phase velocity $v = 0.5 * 10^8\, m/s$ and operates at a frequency of 800 MHz. Determine the values of R, L, C and G.

[08 marks]

Q3 Waveguide Theory

a) Explain the concept of wave impedance in a rectangular waveguide.

[04 marks]

b) Briefly explain TE, TM and TEM waves in a waveguide? [06 marks]

c) A rectangular waveguide operates at 12 GHz with cross-sectional dimensions $a = 4$ cm and $b = 2.5$ cm for TE_{11} mode. Determine the following.

i) Cut-off frequency
ii) Guided wavelength
iii) Phase velocity
iv) Group velocity

[10 marks]

Q4 Microwave Antennas

a) Define the term 'beamwidth' of an antenna and explain its impact on directivity.

[04 marks]

b) Explain the concept of polarization and discuss two different types of polarization used in antennas.

[04 marks]

c) What is the key difference between isotropic and practical antennas?

[02 marks]

d) A parabolic reflector antenna has an aperture efficiency of 0.7 and a diameter of 3 m. Determine its gain at an operating frequency of 5 GHz.

[04 marks]

e) An antenna radiation pattern is given by

$$U(\theta, \emptyset) = \sin^2\theta \sin\emptyset \qquad 0 \leq \theta \leq \pi,\ 0 \leq \emptyset \leq 2\pi$$

Determine the directivity of the antenna.

[06 marks]

Q5 Microwave Sources and Circuits

a) Draw and explain the working principle of a magic tee.

[05 marks]

b) Describe the function of a circulator in microwave circuits and give a practical application.

[05 marks]

c) Explain the working principle of a Gunn diode and its application in microwave engineering.

[05 marks]

d) Discuss the role of ferrite materials used in microwave components and explain how they do enable non-reciprocal behavior.

[05 marks]