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Name of the Program: B.Sc. in EEE
Semester: 8th

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

Mid-Semester Examination
Course No.: EEE 4841
Course Title: Microwave Engineering

Summer Semester, A. Y. 2022-2023
Time: 90 Minutes
Full Marks: 75

There are **3 (three)** questions. Answer all **3 (three)** questions. The symbols have their usual meanings. Programmable calculators are not allowed. Marks of each question and corresponding COs and POs are written in the brackets.

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1. a) Formulate the following expressions for voltage v and current i on an ideal transmission line with characteristic impedance, Z_0 and phase velocity, v_p. **13 (CO1, PO1)**

$$v(z,t) = f_1\left(t - \frac{z}{v_p}\right) + f_2\left(t + \frac{z}{v_p}\right)$$

$$i(z,t) = \frac{1}{Z_0}\left[f_1\left(t - \frac{z}{v_p}\right) - f_2\left(t + \frac{z}{v_p}\right)\right].$$

b) The load $Z_L = 40 - j30\ \Omega$ is connected to a transmission line with characteristic impedance 50 Ω. A and B are two points on the line and they are 3 cm and 10 cm away from the load, respectively. At time instant t_1, the reflected voltage is $V_- = 10\angle 0^0$V at A. The operating frequency is 6 GHz. Determine incident voltage, incident current, and reflected current at B at $t_1+T/6$. **12 (CO2, PO2)**

2. a) Show that the propagation constant, $\gamma = \sqrt{(R+j\omega L)(G+j\omega C)} = \alpha + j\beta$, where $V(z) = Ve^{-\gamma z}$ represents the voltage wave equation for lossy transmission line. Mention the significance of the attenuation constant, α. **10 (CO1, PO1)**

b) A transmission line is connected to the load $40 - j30\ \Omega$. The line has characteristic impedance 50 Ω. The operating frequency is 6 GHz. The maximum voltage amplitude on the line is 10 V. Determine: **15 (CO2, PO2)**

i) input impedance at a point 2 cm away from the load,
ii) insertion loss (IL) at the point of the load,
iii) the minimum current amplitude on the line and
iv) the shortest distance from the load in cm for which the impedance is purely resistive.

3. a) Show that the same Smith chart can be alternately used as either impedance Smith chart or admittance Smith chart by simply rotating halfway (180^0) on SWR circle. **10 (CO1, PO1)**

b) Determine the necessary distances and lengths for designing a single-stub series tuner for matching a load $Z_L = (30 - j40)\ \Omega$. The characteristic impedance of the transmission line is 50 Ω. Use short circuited stubs. Show distances and lengths in terms of wavelength (λ). **15 (CO3, PO3)**