Punjab Engineering College
(Deemed to be University)
End-Term Examination
December 2022

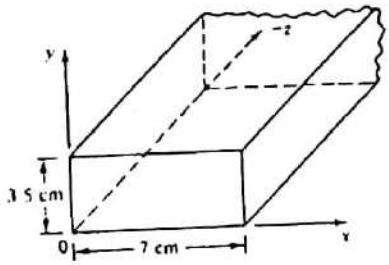
20105097

Programme : **B.E (Electronics & Communication)**
Course Name: **Microwave Engineering**
Maximum Marks: **50**

Year/Semester: **2223I/5th**
Course Code: **EC1353**
Time allowed: **3 Hours**

Notes:

1. All questions are compulsory.
2. Unless stated otherwise, the symbols have their usual meanings in context with subject. Assume suitably and state additional data required, if any.
3. The candidates, before starting to write the solutions, should please check the question paper for any discrepancy, and ensure that they have been delivered the question paper of right course code.

Q. No		Questions	Marks
1	(a)	An air-filled rectangular waveguide of inside dimensions operates in the dominant TE_{10} mode as shown in Fig. 1. Calculate i. cut-off frequency, and ii. guided wavelength at frequency 5 GHz.  Fig. 1	2.5+2.5
	(b)	A 50 Ω transmission line is matched to a 10 V source and feeds a load $Z_L = 100$ Ω. If the line is 2.3λ long and has an attenuation constant $\alpha = 0.5$ dB/λ, calculate i. the power that is delivered by the source, ii. the power that is delivered to the load, and iii. the power that is lost in the line.	2+2+1
2	(a)	How measurement of parameters at microwave frequencies differs from that of RF frequencies? Explain in detail.	5
	(b)	Explain the working of a Faraday-rotation isolator with the help of a diagram.	5
3	(a)	How does velocity modulation take place in Reflex Klystron? Illustrate with the help of diagram.	5
	(b)	An IMPATT diode has the following parameters: Carrier drift velocity: $v_d = 2 \times 10^7$ cm/s	2.5+2.5

		Drift-region length: $L = 6\ \mu m$ Maximum operating voltage: $V_{0max} = 100$ V Maximum operating current: $I_{0max} = 200$ mA Efficiency: $\eta = 15\ \%$ Breakdown voltage: $V_{bd} = 90$ V Evaluate: i. The maximum CW output power in watts. ii. The resonant frequency in gigahertz.	
4	(a)	Describe the different modes of wave propagation with the help of diagrams.	5
	(b)	Design a loop antenna having radiation resistance of 192.3 Ω with turns i. $N = 5$, and ii. $N = 10$.	2.5+2.5
5	(a)	i. Why is FM CW radar preferred over CW radar? ii. Demonstrate the principle of operation of FM CW radar with the help of a block diagram?	1+4
	(b)	A radar system with cross-section area of 20 m^2 operates at 3 cm wavelength with a peak power of 500 kW. The minimum detectable signal S_{min} is 10^{-12} W. Evaluate the range of the radar if i. the capture area of its antenna is 5 m^2. ii. the antenna is of rectangular shape with 5 m width and 2.7 m height and antenna aperture efficiency is 0.6.	2+3

Punjab Engineering College
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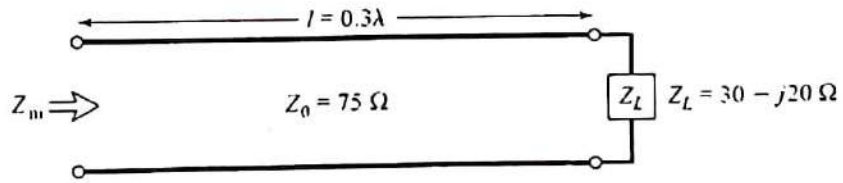
Mid-Term Examination
October, 2022

Programme: **B.E (Electronics & Communication)**
Course Name: **Microwave Engineering**
Maximum Marks: **20**

Year/Semester: **22231/5th**
Course Code: **EC1353**
Time allowed: **1.5 Hours**

Notes:

1. All questions are compulsory.
2. Unless stated otherwise, the symbols have their usual meanings in context with subject. Assume suitably and state, additional data required, if any.
3. The candidates, before starting to write the solutions, should please check the question paper for any discrepancy, and ensure that they have been delivered the question paper of right course code.

Q. No			Marks
1	(a)	A transmission line of characteristic impedance Z_0 is feeding an infinitely long transmission line with characteristic impedance Z_1. i. Show that the transmission coefficient equals the algebraic sum of 1 plus the reflection coefficient. ii. If $Z_0 = 75 + j0.01\Omega$ and $Z_1 = 70 + j50\Omega$, compute reflection coefficient and transmission coefficient.	(2+1)
	(b)	A transmission line has the following per-unit-length parameters: $L = 8$ nH/m, $C = 0.23$ pF/m, $R = 2.0\ \Omega$/m, and $G = 0.5$ mmho/m. Calculate the propagation constant and characteristic impedance of this line at 1 GHz.	1
2	(a)	Use the Smith chart to find the following quantities for the transmission line circuit shown in Fig. 1 i. The SWR on the line ii. The reflection coefficient at the load iii. The load admittance iv. The input impedance of the line  Fig. 1	2
	(b)	Design a circular waveguide which has a cutoff frequency of 9 GHz in dominant TE mode if it is i. Air-filled	2

		ii. Dielectric-filled with relative dielectric constant, $\epsilon_r = 4$ **Values of p'_{nm} for TE Modes of a Circular Waveguide** n | p'_{n1} | p'_{n2} | p'_{n3} 0 | 3.832 | 7.016 | 10.174 1 | 1.841 | 5.331 | 8.536 2 | 3.054 | 6.706 | 9.970	
3	(a)	i. Calculate the group velocity for a waveguide mode propagating in an air-filled guide. ii. Compare this velocity to the phase velocity and speed of light.	(1+1)
	(b)	How can we measure impedance using a microwave test bench? Explain with the help of diagram.	2
4	(a)	i. Describe the working of a 4-port circulator. ii. Formulate the scattering matrix for an ideal 4-port circulator.	2
	(b)	A 20 dBm power source is connected to the input of a directional coupler having a coupling factor of 20 dB, a directivity of 35 dB, and an insertion loss of 0.5 dB. If all ports are matched, evaluate the output power at coupled and isolated ports.	2
5	(a)	A 2-port network is known to have the following scattering matrix $[S] = \begin{bmatrix} 0.15\angle 0° & 0.85\angle -45° \\ 0.85\angle 45° & 0.2\angle 0° \end{bmatrix}$ Evaluate the return loss seen at port 1 for the following conditions: i. If port 2 is terminated with a matched load. ii. If port 2 is terminated with a short circuit.	2
	(b)	What are the different modes of operation of Gunn oscillators. Explain in detail.	2