SHRI MATA VAISHNO DEVI UNIVERSITY, KATRA
School of Electronics and Communication Engineering
B. Tech. (ECE) Minor I Examination (EVEN) 2022-23

Entry No: | | | | | | | | | | **Total Number of Pages: [01]**

Date: **Total Number of Questions: [01]**

Course Title: MICROWAVE ENGINEERING
Course Code: ECL 3050

Time Allowed: 1.5 Hours **Max Marks: [20]**

Instructions / NOTE

i. Attempt All Questions.
ii. Support your answer with neat freehand sketches/diagrams, wherever appropriate.
iii. Assume an appropriate data / information, wherever necessary / missing.

	Section - A		
Q1.	(a) The evanescence mode occurs when _____ =_____.	[01]	CO1
	(b) In a rectangular waveguide with dimension $a > b$, The cut-off frequency of TE_{21} is _____ than TM_{12}.	[01]	CO2
	(c) In an air-filled rectangular waveguide, at a specific frequency, the characteristic impedance in TE_{mn} is _____ than TM_{mn} where m and n are the number of wave-halves present in the waveguide walls a and b, respectively.	[01]	CO1
	(d) As per IEEE, L-band of the electromagnetic spectrum extends from _____ to _____ GHz.	[01]	CO1
	(e) In an air-filled rectangular waveguide, the phase velocity is _____ than the speed of light.	[01]	CO2
	Section - B		
Q2.	Define the following terms in context of the waveguide. (a) Dominant Mode (b) Degenerate Mode (c) Standard waveguide	[03]	CO2
Q3.	Compare the advantages and disadvantages of a waveguide with respect to a two-wire transmission line in the tabular form.	[03]	CO1
Q4.	A rectangular waveguide with dimensions a=5cm, b=2.5 cm is to operate below 7 GHz. The guide is filled with a medium characterized by σ=0, ε_r=4, μ_r=1. (a)How many TE and TM modes can propagate through it? (b) Calculate the cutoff frequency of each mode?	[05]	CO2
Q5.	Compare the cross-sectional area of a circular waveguide to the standard rectangular waveguide for the same cut-off frequency, operating in their respective dominant modes. Given X'np=1.841, Xnp=3.832.	[04]	CO2

Course Outcomes

CO1: To learn the basic concepts of Microwave Engineering and its applications
CO2: To gain knowledge about the wave propagation through the guided media
CO3: To apply the basic analysis techniques to the microwave devices
CO4: To gain the working knowledge of different types of sources at microwave frequency
CO5: To learn the measurement techniques at microwave frequency

CO	Questions Mapping	Total Marks	Total Number of Students (to be appeared in Exam)
CO1	1(a),1(c),1(d),3	06	
CO2	1(b),1(e),2,4,5	14	
CO3	0	0	
CO4	0	0	
CO5	0	0	

SHRI MATA VAISHNO DEVI UNIVERSITY, KATRA
School of Electronics and Communication Engineering
B. Tech. (ECE) Major Examination (Even) 2022-23

Entry No: | | | | | | | | 0 | 3 |
Date:

Total Number of Pages: [02]
Total Number of Questions: [07]

Course Title: Microwave Engineering
Course Code: ECL 3050

Time Allowed: 3.0 Hours **Max Marks: [50]**

Instructions / NOTE

i. Attempt All Questions.
ii. Support your answer with neat freehand sketches/diagrams, wherever appropriate.
iii. Assume an appropriate data / information, wherever necessary / missing.

Section - A

Q1	(i) In TEm,n mode, m and n are integers denoting the number of (A) 1/2 the wavelengths of intensity between each pair of walls (B) 1/3 the wavelengths of intensity between each pair of walls (C) 1/4 the wavelengths of intensity between each pair of walls (D) 1/8 the wavelengths of intensity between each pair of walls	01 x5 =5	CO1
	(ii) GaAs is used in the fabrication of GUNN diodes because: (A) GaAs is cost effective (B) It less temperature sensitive (C) it has low conduction band electrons (D) less forbidden energy gap		CO4
	(iii) The number of modes of operation for n-type GaAs Gunn Diode is: (A) two (B) three (C) four (D) five		CO4
	(iv)Smith chart is based on the polar plot of____. (A) Reactance (B) Voltage (C) Current (D) Voltage reflection co-efficient		CO5
	(v)The correct sequence of parts in klystron amplifier are_____. (A)anode, catcher cavity, cathode, buncher cavity (B)cathode, buncher cavity, catcher cavity, collector (C)anode, buncher cavity, catcher cavity, cathode (D)cathode, catcher cavity, anode, buncher cavity		CO1
Q2.	(i). A standard air-filled rectangular waveguide with dimensions a=8cm, b=4cm operates at 3.4 GHz. For dominant mode of the wave propagation, the phase velocity of signal is v_p. The value of v_p/c where c is the speed of light in vacuum is _____.	02 X 10 = 20	CO2
	(ii) A reflex Klystron is operating at 9GHz at beam voltage of 600 V. The repeller space is 0.1 cm and tube oscillates at the top of the n=2 or mode 1 $^3/_4$ mode. If beam coupling coefficient β=1.0, neglecting the beam loading, the required repeller voltage and efficiencies are ____ V and ___, respectively.		CO1
	(iii)The dispersion equation of a waveguide which relates the wavenumber k to the frequency ω is given as $k(\omega) = \frac{1}{c}\sqrt{\omega^2 - \omega_0^2}$ were c=3x10^8 m/s and ω_0 is constant. If the group velocity is 2x10^8 m/s, the phase velocity is _____ m/s.		CO1 CO2
	(iv)A rectangular waveguide of width w and height h has cut-off frequencies for TE_{10} and TE_{11} modes in the ratio of 1:2. The aspect ratio of the guide w/h is _____.		CO3
	(v) A matched isolator has an insertion loss of 0.5dB and isolation of 30 dB. The port at which signal is fed and taken out are named as port #1 and Port #2. The value of S_{11}, S_{12}, S_{21}, and S_{22} are ___, ___, ___,and ___, respectively.		

Entry No:
Date:

	(vi)An IMPATT diode has a drift velocity=2×10^7 cm/s, drift length=5μm. The resonant frequency is _____ GHz. (vii).In a certain Gunn diode of 10μm active length, the drift velocity of electron is 2×10^7cm/s. The natural resonance frequency is _____ GHz. (viii).In a two cavity klystron, the bunching cavity gap and the dc electron velocity are 1mm, and 1.88×10^7 m/s, the gap transit angle and the beam coupling coefficient at 3GHz are ____ radian and ___, respectively. (ix) A slotted line section is used to measure the frequency and it is found that the difference between successive nulls is 1.85cm. Given that the guide dimension of 3cm × 1.5cm, the operating frequencies in the dominant mode and next higher mode are_____ GHz and _____ GHz, respectively. (x) In a Klystron amplifier, for Vo=900V, and the buncher cavity gap=4cm, the electron velocity and the gap-transit time are_____ m/s and _____seconds, respectively.		CO4 CO4 CO5 CO4
3.	With the help of a neat diagram, explain the working of a TRAPATT. What are the applications of the TRAPATT ?	5	CO4
4.	What do you mean by the velocity and current density modulation in a Klystron? Find the expression for the velocity modulation in a two cavity Klystron. Also find the expression for the induced current in the Catcher cavity.	5	CO3
5.	Find the expression for resistive cut off and resonance frequencies in a Tunnel diode.	4	CO3
6.	What is Faraday's rotation? Find the expression for the tilt in the axis polarization of wave in the ferrite material.	5	CO1
7.	A lossless standard air filled waveguide of length $3\lambda_g/4$ where λ_g is guided wavelength operates in dominant mode at 4GHz. The operating frequency is twice the cut-off frequency. This guide is terminated with a load impedance of 400 Ω at one end. Find the followings: (i) Dimension of the guide (ii) Characteristic impedance of the guide. (iii) Can TM_{21} mode propagate through this guide? Justify. (iv) Dominant mode input impedance of the guide when other end is terminated with 400 Ω.	 1+ 1+ 1+ 3	CO4

Given: Charge of electron =$1.60217663 \times 10^{-19}$ coulombs
Mass of electron = $9.1093837 \times 10^{-31}$ kilograms

Course Outcomes

CO1:To learn the basic concepts of Microwave Engineering and its applications
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CO3:To apply the basic analysis techniques to the microwave devices
CO4:To gain the working knowledge of different types of sources at microwave frequency
CO5:To learn the measurement techniques at microwave frequency

CO	Q. No.	Marks	Number of Students
CO1	1(i),1(v),2(ii),2(iii),6	11	
CO2	2(i), 2(iv),7	10	
CO3	2(v),4,5	11	
CO4	1(ii),1(iii),2(vi),2(vii),2(Viii),2(X),3	15	
CO5	1(iv),2(ix),	03	

CO4 CO4

SHRI MATA VAISHNO DEVI UNIVERSITY, KATRA
School of Electronics and Communication Engineering
B. Tech. (ECE) Minor II Examination (EVEN) 2022-23

Entry No: | | | | | | | | | | |

Date:

Total Number of Pages: [01]

Total Number of Questions: [05]

Course Title: MICROWAVE ENGINEERING

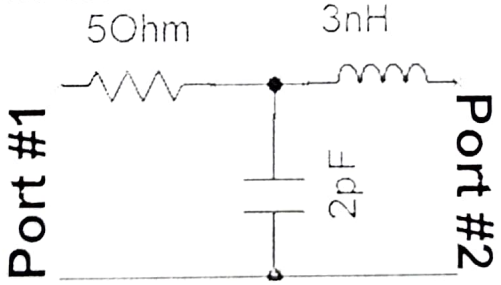
Course Code: ECL 3050

Time Allowed: 1.5 Hours **Max Marks: [20]**

Instructions NOTE

5

i. Attempt All Questions.
ii. Support your answer with neat freehand sketches/diagrams, wherever appropriate.
iii. Assume an appropriate data / information, wherever necessary / missing.

	Section - A		
Q1.	(a) S_{11} is the _____ coefficient at the input side of a microwave network.	[01]	CO3
	(b) ____ is the non-reciprocal material.	[01]	CO1
	(c) In a directional coupler, the sum of the directivity and coupling on the dB scale = ___.	[01]	CO2
	(d) For a two port reciprocal lossless network, the $\|S_{11}\|$=0.8 then S_{21} is ___ dB.	[01]	CO4
	(e) In an Isolator, S_{21}___ S_{12}.	[01]	CO1
	Section - B		
Q2.	With the neat diagram, explain the working of a rat-race coupler. Also develop its S-Matrix. List a few applications of this device.	[04]	CO3
Q3.	With the neat diagram, explain the working of a rotary –vane attenuator.	[03]	CO3
Q4.	Incident power to a directional coupler is 90 watts. It has coupling factor of 20 dB, directivity of 35 dB, and insertion loss of 0.5dB. Find the output power at the main arm, isolated, and coupled ports.	[03]	CO5
Q5.	In the following network, the port impedances and the operating frequency are 50 Ω and 1GHz, respectively (a) Find the ABCD parameters (b) Develop the S-parameters from the above. 	[03] [02]	CO3

Course Outcomes
CO1 To learn the basic concepts of Microwave Engineering and its applications
CO2 To gain knowledge about the wave propagation through the guided media
CO3 To apply the basic analysis techniques to the microwave devices
CO4 To gain the working knowledge of different types of sources at microwave frequency
CO5 To learn the measurement techniques at microwave frequency

CO	Questions Mapping	Total Marks	Total Number of Students (to be appeared in Exam)
CO1	1(b),1(e)	02	90
CO2	1(c)	01	90
CO3	1(a),2,3,5	13	90
CO4	--	00	90
CO5	1(d), 4	04	90

SHRI MATA VAISHNO DEVI UNIVERSITY, KATRA
School of Electronics and Communication Engineering
B. Tech. (ECE) Mid-Term Examination (Even) 2021-22

Entry No: | | | | | | | | | |

Date:

Total Number of Pages: [02]

Total Number of Questions: [05]

Course Title: MICROWAVE ENGINEERING

Course Code: ECL3050

Time Allowed: 1.5 Hours **Max Marks: [30]**

Instructions / NOTE

i. Attempt All Questions.
ii. Support your answer with neat freehand sketches/diagrams, wherever appropriate.
iii. Assume an appropriate data / information, wherever necessary / missing.

	Section - A		
Q1	(i) A typical Microwave oven operates at _____ GHz. (A) 1.45 GHz (B) 2.45 GHz (C) 2.0 GHz (D) 2.25 GHz	1x5	CO1
	(ii) The phase velocity in the waveguide is _____ the unguided medium. (A) greater than (B) smaller than (C) equal to (D) none of above		CO2
	(iii)A waveguide acts as a _____ filter. (A) bandpass (B) bandstop (C) lowpass (D) highpass		CO2
	(iv)For the same cutoff frequency in a given mode, the cross-sectional area of a rectangular waveguide is ____ the circular waveguide. (Select most appropriate) (A) smaller than (B) larger than (C) equal to (D) unequal to		CO2
	(v) In a two port network, diagonal elements (S_{11},S_{22}) of S-Matrix are zero when _____. (A) all ports are matched (B) the network is reciprocal (C) the network is lossless (D) none of above.		CO3
Q2	(i) S- and Ku-bands of the electromagnetic spectrum extend from ____ to _____ GHz, and ____ to ____ GHz, respectively.	2x5	CO1
	(ii) In a rectangular waveguide, the wave is propagating in positive z direction, the wider (a) and narrower (b) dimensions of the guide are aligned along x-, and y-axis, respectively. The electric field component in x-direction (Ex) in the dominant mode is _____.		CO2
	(iii) The cut-off frequency of the air-filled standard rectangular waveguide operating in TE_{32} mode with the width a=10mm is____ GHz.		CO2
	(iv) In a reciprocal two port network, if the output port is perfectly matched, the S_{11} and S_{21} are $0.8\angle -45^0$ and $0.2\angle 45^0$, the return loss and insertion loss are _____dB and ___dB, respectively.		CO3
	(v) In a lossless two port network _____=1		CO3
	Section - B		
Q3	Explain the following terms. (i) Evanescence mode (ii) Dominant Mode (iii) Degenerate Mode	3	CO1
Q4	A lossless air filled cylindrical waveguide of an inside diameter 3cm, is operating at 14 GHz. For the TM mode propagating in +Z direction, find the cutoff frequency, wavelength in the guide, phase velocity in the guide, and the wave impedance. It is given that X_{11} =3.832 and X'_{11} =1.841, respectively.	4	CO2

Q5	In a standard rectangular waveguide, the dominant mode cutoff frequency is 10 GHz. Find the cut-off frequency of TE_{20} and TM_{31} Modes. Is it possible to obtain the real characteristic impedance at 30GHz in all these three modes? Justify with the analysis.	5
Q6	The normalized impedance matrix of a certain lumped element network is given below. $[Z]=\begin{bmatrix} 0.25 & 0.5 & 0.3 \\ 0.3 & 0 & 0.25 \\ 0.2 & 0.1 & 0 \end{bmatrix}$ Find the scattering matrix of the network and comment on its reciprocal and lossless properties.	3

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CO	Questions Mapping	Total Marks	Total Number of Students (to be appeared in Exam)
CO1	1(i), 2(i),3	06	106
CO2	1(ii), 1(iii),1(iv),2(ii),2(iii), 4,5	16	106
CO3	1(v), 2(iv),2(v),6	08	106
CO4	----------		106
CO5	----------		106

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SHRI MATA VAISHNO DEVI UNIVERSITY, KATRA
School of Electronics and Communication Engineering
B. Tech. (ECE) Major Examination (Even) 2021-22

Entry No: | | | | | | | | 6 |

Total Number of Pages: [02]

Date:

Total Number of Questions: [08]

Course Title: MICROWAVE ENGINEERING

Course Code: ECL3050

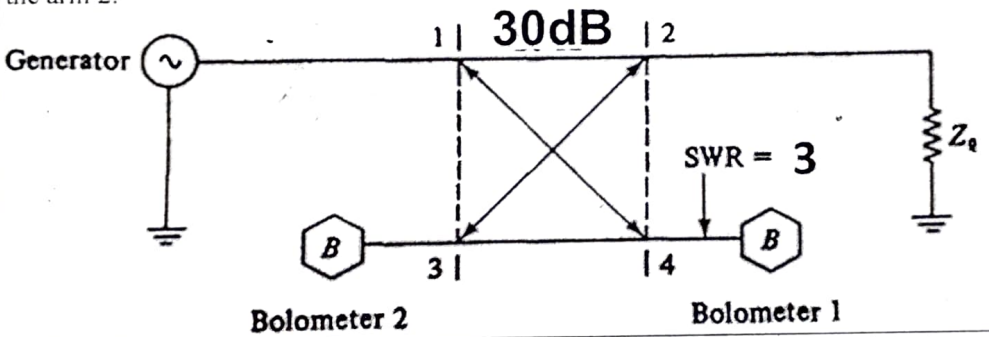
Time Allowed: 3.0 Hours **Max Marks: [50]**

Instructions / NOTE

i. Attempt All Questions.
ii. Support your answer with neat freehand sketches/diagrams, wherever appropriate.
iii. Assume an appropriate data / information, wherever necessary / missing.

	Section - A		
Q1.	(i)K-band frequencies are in which of the following ranges? D A. 12-18GHz A B. 8-12 GHz C. 2-4GHz D. 18-27GHz	1x5	CO1
	(ii) S_{11} is the A. reflection coefficient of the input side B. transmission coefficient of the input side C. reflection coefficient of the output side D. transmission coefficient of the output side		CO2
	(iii)For a passive, lossless, and reciprocal four port network, it is possible A. to match all the four ports simultaneously B. to match only two ports simultaneously C. to match only three ports simultaneously D. none of above.		CO2
	(iv) Circulators can be designed by using A. two transmission lines B. two Magic tees C. two attenuators D. Two waveguides		CO3
	(v)Beam –coupling coefficient in the Klystron is a function of A. beam voltage B. transit angle C. input voltage D. depth of velocity modulation		CO4
Q2.	(i) A two-port network fed at port#1 has the insertion loss and the isolation of 0.3dB and 40dB, respectively. If the network is perfectly matched, its S_{11}, S_{12}, S_{21}, and S_{22} magnitudes are 0, 0.01, 0.96, and 0, respectively.	2x10	CO3
	(ii) In a directional coupler, the incident power in the main arm and the power in the auxiliary arm are 500mW and 400 μW, respectively. The coupling factor is 30.9 dB. If the isolation is 60 dB then directivity is _____ dB.		CO3
	(iii)In a Silicon based IMPATT diode, the drift length and drift velocity are 3μm and 10^7cm/s, respectively. The operating frequency and transit time are 16.67 GHz, and 0.029 second.		CO4
	(iv)A typical Gunn diode has operating frequency of 10 GHz, device length of 80μm, voltage pulse applied =25V. The threshold electric field is 3125 V/cm.		CO4
	(v) A slotted section waveguide of the cross-sectional dimension 3cm×1.5cm is used to measure the operating frequency in the dominant mode. If the distance between two nulls is 1.85cm, the operating frequency is 16.21 GHz.		CO5
	(vi) In a two cavity Klystron, the operating frequency, the beam voltage, and the bunching cavity gap are 3.2GHz, 900V and 10^{-3}m, respectively. The electron velocity and the transit angle are ___ m/s, and ___ degree, respectively.		CO4
	(vii) From the center, the radius of the Smith chart is 5cm and on the same radial line, the load is located at 2 cm away from it. The magnitude of the reflection coefficient and the VSWR are _____ and _____, respectively.		CO5
	(viii) For the beam voltage V_0=1000V, the gap distance d= 5mm, the applied ac signal= 0.5sin $(2\pi\times10\times10^6 t)$, in a Klystron, the beam coupling coefficient (β_i), and the maximum velocity at		CO4

$f = \frac{1}{2\pi}$

	the output of the buncher cavity are _____ and _____ m/s, respectively. (ix) The Gyrator is a_____ Ferrite device which can be used as a _____ (x) The cut-off frequency of a coaxial cable is _____ GHz.		CO1
	Section - B		
Q3.	What is the Faraday's rotation? Find the expression for the rotation of the polarization direction when the wave is passing through the Ferrite rod aligned along the +z direction.	2+2	CO1
Q4.	With the neat diagram, explain the operating mechanism of a TRAPATT Diode. Also, enumerate a few applications of this device.	3+1	CO4
Q5	With the neat diagram, explain the working of a precision rotary phase shifter.	4	CO2
Q6	What is the two valley model theory used in the Gunn Diode? What are the three conditions which must be satisfied in order to exhibit negative resistance by this device?	3+1	CO4
Q7	A directional coupler with infinite directivity and a coupling of 30dB is used to monitor the power delivered to a load Z_l as shown in the following figure. Bolometer 1 introduces a VSWR of 3 on the arm 4 and Bolometer 2 is matched to the arm 3. If Bolometer 1 reads 9mW and Bolometer 2 reads 4mW, find (a) amount of the power dissipated in the load and (b) VSWR on the arm 2.  Bolometer 2 Bolometer 1	2+2	CO3
Q8	A magic–T is terminated at collinear ports 1 and 2 and difference port 4 by impedances of reflection coefficients Γ_1=0.5, Γ_2=0.6, and Γ_4=0.8, respectively. If 1W power is fed at port 3, calculate the power reflected at port 3 and power transmitted to other three ports.	5	CO3

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CO	Questions Mapping	Total Marks	Total Number of Students (to be appeared in Exam)
CO1	1(i), 2(x),3	07	105
CO2	1(ii),1(iii), 2(ix), 5	08	105
CO3	1(iv),2(i),2(ii),7,8	14	105
CO4	1(v),2(iii), 2(iv), 2(vi), 2(viii), 4, 6	17	105
CO5	2(v),2(vii)	04	105

SHRI MATA VAISHNO DEVI UNIVERSITY, KATRA
School of Electronics and Communication Engineering
B. Tech. (ECE) Minor I Examination (EVEN) 2022-23

Entry No: 0 5 **Total Number of Pages:** [01]

Date: **Total Number of Questions:** [01]

Course Title: MICROWAVE ENGINEERING

Course Code: ECL 3050

Time Allowed: 1.5 Hours **Max Marks: [20]**

Instructions / NOTE

i. Attempt All Questions.
ii. Support your answer with neat freehand sketches/diagrams, wherever appropriate.
iii. Assume an appropriate data / information, wherever necessary / missing.

Section - A

Q1	(a) The evanescence mode occurs when ____ = ____	[01]	CO1
	(b) In a rectangular waveguide with dimension $a > b$, The cut-off frequency of TE_{21} is ____ than TM_{12}.	[01]	CO2
	(c) In an air-filled rectangular waveguide, at a specific frequency, the characteristic impedance in TE_{mn} is ____ than TM_{mn} where m and n are the number of wave-halves present in the waveguide walls a and b, respectively.	[01]	CO1
	(d) As per IEEE, L-band of the electromagnetic spectrum extends from ____ to ____ GHz	[01]	CO1
	(e) In an air-filled rectangular waveguide, the phase velocity is ____ than the speed of light.	[01]	CO2

Section - B

Q2.	Define the following terms in context of the waveguide. (a) Dominant Mode (b) Degenerate Mode (c) Standard waveguide	[03]	CO2
Q3.	Compare the advantages and disadvantages of a waveguide with respect to a two-wire transmission line in the tabular form.	[03]	CO1
Q4.	A rectangular waveguide with dimensions a=5cm, b=2.5 cm is to operate below 7 GHz. The guide is filled with a medium characterized by $\sigma=0$, $\varepsilon r=4$, $\mu r=1$. (a)How many TE and TM modes can propagate through it? (b) Calculate the cutoff frequency of each mode?	[05]	CO2
Q5.	Compare the cross-sectional area of a circular waveguide to the standard rectangular waveguide for the same cut-off frequency, operating in their respective dominant modes. Given $X_{np}=1.841$, $X_{np}=3.832$.	[04]	CO2

Course Outcomes

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CO1	1(a),1(c),1(d),3	06	
CO2	1(b),1(e),2,4,5	14	
CO3	0	0	
CO4	0	0	
CO5	0	0	