**SRM Institute of Science and Technology**

**Batch-II**

**SET-B**

**College of Engineering and Technology**

**DEPARTMENT OF ECE**

SRM Nagar, Kattankulathur – 603203, Chengalpattu District, Tamil Nadu

**Academic Year: 2022-23 (Even)**

**Test: CLAT-2** **Date: 04-04-2023**

**Course Code & Title: 18ECC302J–Microwave and Optical Communication** **Duration: 12.30PM–02.15PM**

**Year & Sem:** **III / VI** **Max. Marks:** **50**

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|  | **18ECC302J - Microwave & Optical Communications** | **Program Outcomes (POs)** | | | | | | | | | | | | | | |
| **Graduate Attributes** | | | | | | | | | | | | **PSO** | | |
| **S. No.** | **Course Outcomes (COs)** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **1** | **2** | **3** |
| 1 | Demonstrate the knowledge on the theory of microwave transmission, microwave generators and associated components | 3 | - | - | 3 | - | - | - | - | - | - | - | - | - | - | 1 |
| 2 | Analyse the microwave passive devices and components | - | 2 | - | 3 | - | - | - | - | - | - | - | - | 2 | - | - |
| 3 | Incorporate microwave measurements and associated techniques with equipment | - | - | 3 | 2 | - | - | - | - | - | - | - | - | - | - | 3 |
| 4 | Gain knowledge of the fundamentals on light transmission through fiber | - | 3 | - | 2 | - | - | - | - | - | - | - | - | - | - | 1 |
| 5 | Develop a basic optical communication system | - | 3 | - | - | 3 | - | - | - | - | - | - | - | 2 | - | - |
| 6 | Implement the working principle of microwave components, microwave measurements, optical sources, detector and fibers | - | - | 3 | - | 3 | - | - | - | - | - | - | - | - | - | 3 |

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| **Part – A**  **(5 × 10 = 50 Marks)**  **Instructions: Answer any FIVE Questions.** | | | | | |
| **Q. No.** | **Question** | **Marks** | **BL** | **CO** | **PO** |
| **1** | **(A)** A non reciprocal device whose power flow is only from the nth port to the (n+1)th port in one direction is a  (a)Directional coupler (b) Isolator  **(c) Circulator** (d) Attenuator  **(B)** What are the advantages of S-Parameters compared with Y or Z parameters?  1.It helps in ease of measurement of power at high frequencies compared to voltage and current measured at open and short circuit terminals. (1Mark)  2.The terminal voltages and currents vary in magnitude at points along a lossless transmission line but S-parameters are basically travelling waves ,they do not vary along the transmission line. (1Mark)  3.The matched loads are used for terminating the ports while using S-Parameters rather than open and short the circuits as in Z,Y parameters.So the capacitance and inductance effects do not affect the network. (1Mark)  **(C)** A 20 dB directional coupler is found to be given 3 dBm as output power through a coupled port.If the isolation is specified as  55 dB, find the power available at the isolated port.  Given the coupling factor C=20dB  Power through the coupling port P4=3 dBm  Isolation ,I=55dB (2Marks)  Directivity=Isolation(dB) - Coupling factor(dB)  D=I-C=55-20=35dB  D=10logP4/P3  =35 (1Mark)  logP4/P3=3.5  So P4/P3=103.5 where P4=3dBm  10log(P4/10-3)=3  P4=10-3x100.3  =1.99526x10-3W (1Mark)  P3=1.99526x10-3/103.5  Power available at the isolated port P3=0.63mW (2Marks) | 1  3  6 | 1  1  2 | 2  2  2 | 4  4  2 |
| **2** | **(A)** The dominant TE mode in rectangular waveguides is  (a) TE01 (b) TE11  (c) TE20 **(d) TE10**  **(B)** Name the device which uses a dielectric slab to introduce a modification in the phase with respect to electric field distribution along the waveguide. Enumerate its working with a neat diagram.  The device is Phase Shifter (1Mark)  Fixed amount of phase shifts can be obtained by use of capacitive or inductive irises in the waveguide or by inserting dielectric rods or by reducing the wider dimension of a rectangular waveguide.  Physical Construction (2 Marks)    The physical Construction of phase shifter consists of a dielectric slab or vane to minimise reflection effects inserted through the longitudinal slot cut alongthe wider dimension of the waveguide as shown below  (2Marks)  The electric field distribution in the broader dimension of the waveguide will be modified by the dielectric slab so that it is distorted from sinusoidal to the oneshown below  (1Mark)  If the vane is inserted deeper,there is more change in the medium and greater the phase shift.The amount of phase shift is maximum when the slab is at the centre and minimum when it is adjacent to the wall of the waveguide.  **(C)** An air-filled rectangular waveguide has dimensions a=5 cm and b=3 cm.The signal frequency is 6GHz. Compute the cut-off frequency for the TM11 mode  cut-off frequency fc= (1 Mark)  m=1 and n=1  =0.477x1010x (2 Marks)  =5.83GHz | 1  6        3 | 1  3  2 | 2  2  2 | 4  4  2 |
| **3** | **(A)**  Which of the following ports are isolated ports in a hybrid TEE  (**a) Port 1 and 2** (b) Port 2 and 4  (c) Port 1 and 3 (d) Port 1 and 4  **(B)** In a microwave passive device,when waves enter through the side arm,the waves that leave the main arms are equal in magnitude and opposite in phase. Identify the device,explain its operation with neat diagram and derive its S-Matrix.Also prove that it is a 3-dB splitter  The device is E-Plane TEE. If an input power is made to propagate in to port 3,the two outputs at port 1 and 2 will have a phase shift of 180 deg. (1 Mark)  (2 Marks)  E plane TEE is a waveguide TEE in which the axis of its side arm is parallel to the E field of the main guide.  (4 Marks)  If the amplitude of the input wave at port 3 is A,the amplitudes of the waves at ports 1 and 2 are same and equal A/.They are out of phase when its collinear arms lengths are same.When the power incident at port 3 is P,the powers that appear at ports 1 and 2 are P/2 each.  P3=P, P2=P/2 P1-P/2  P3=P1+P2=2P1=2P2  The amount of power coming out of ports 1 and 2 in decibels is  10log10=10log10 =10log10=10log10()= -3dB .That is why ,it is called a 3dB splitter. (2 Marks) | 1  9 | 1  3 | 2  2 | 4  4 |
| **4** | **(A)** A transmission line must be matched to the load to  (a) transfer maximum voltage to the load  **(b) transfer maximum power to the load**  (c) reduce the load current  (d) transfer maximum current to the load  **(B)** Identify the device which completely absorbs the power for propagation in one direction and provides lossless transmission in the opposite direction.Explain its operation and write its scattering matrix.  The device is Isolator (1 Mark)    (3 Marks)  **(C)** Name the device which is used to adjust the power level of the microwave signal.With suitable diagram,explain the method where the reduction in power level is measured accurately even if the power level is larger.  The device is attenuator (1 Mark)  (1Mark)(3Marks) | 1  4  5 | 1  2  3 | 2  2  3 | 4  3  3 |
| **5** | **(A)** Baretters have  **(a) Positive temperature coefficient of resistance**  (b) Negative temperature coefficient of resistance  (c) Both positive and negative temperature coefficient of resistance  (d) Neither positive nor negative temperature coefficient of  resistance  **(B)** Consider a microwave source fed to a microstrip load. Both the source and load is not perfectly matched to each other and hence standing waves are produced whose Vmax is 2.5V and Vmin is 1V measured from the slotted section at the distance of 8.5cm and 7.5cm respectively. The generator transfers an input power of 15dB and the load produces an output power of 12dB and it reflects 3dB power back to the source. Find the wavelength, SWR, reflection coefficient, attenuation loss and insertion loss  Vmax=2.5V  Vmin=1V  Reflected power from load to source=3dB  Consider Vmin distance as d1=7.5cm and  Vmax distance as d2=8.5cm  d2-d1=1cm (1 Mark)  λg/4=d2-d1=1cm and hence **λg=4 cm** (2 Marks)  **VSWR**=Vmax/Vmin =2.5V/1V = **2.5** (1 Mark)  **Reflection Coefficient ρ**=S-1/S+1= **0.42** (2 Marks)  **Attenuation loss**=Pin-Pout =15dB-12dB = **3dB** (2 Marks)  Insertion Loss=Power reflected from the load back to the source+attenuation loss  =3dB+3dB (1 Mark)  **Insertion Loss** = **6dB** | 1  9 | 1  3 | 3  3 | 3  3 |
| **6** | **(A)** Which method use short circuit plunger to measure scattering parameters?  **(a) Deschamps method**  (b) Slottedline method  (c) Cavity perturbation method  (d) Waveguide method  **(B)** Name the method which determines voltage reflection coefficient for frequency selectivity measurement of a reflection cavity.Explain it with a neat diagram.  The method is reflectometer method of measurement of Q (1M)    (4M)  **(C)** Identify the method used to measure VSWR whose value is greater than 10.Explain the same with proper graphical representation.  For measuring high VSWR ,double minimum method is used(1M)  (1M)  (2Marks) | 1  5  4 | 1  3  2 | 3  3  3 | 3  3  3 |
| **7** | **(A)** Identify the method which is not used for impedance measurement from the following  (a) using Magic TEE (b) using slotted line  (c) using reflectometer **(d) using wavemeter**  **(B)** Explain the frequency measurement technique which uses cylindrical cavity and movable short with suitable diagram.  The technique is wavemeter method of measuring the frequency  (2 Marks)  A typical wavemeter is a cylindrical cavity with a variable short circuit termination which changes the resonance frequency of the cavity by changing the cavity length.Explanation about the method is needed. (4 Marks)  (3Marks) | 1  9 | 1  3 | 3  3 | 3  3 |

**Course Outcome (CO) and Bloom’s level (BL) Coverage in Questions**

**Evaluation Sheet**

**Name of the Student:**

**Register No.:**

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| **Part - A (5 × 10 = 70 Marks)** | | | | | |
| **Q. No.** | **CO** | **PO** | **Max. Marks** | **Marks Obtained** | **Total** |
| **1 (A)** |  |  |  |  |  |
| **1 (B)** |  |  |  |  |
| **1 (C)** |  |  |  |  |
| **2 (A)** |  |  |  |  |
| **2 (B)** |  |  |  |  |
| **2 (C)** |  |  |  |  |
| **3 (A)** |  |  |  |  |
| **3 (B)** |  |  |  |  |
| **4 (A)** |  |  |  |  |
| **4 (B)** |  |  |  |  |
| **4 (C)** |  |  |  |  |
| **5 (A)** |  |  |  |  |
| **5 (B)** |  |  |  |  |
| **6 (A)** |  |  |  |  |
| **6 (B)** |  |  |  |  |
| **6 (C)** |  |  |  |  |
| **7(A)** |  |  |  |  |
| **7(B)** |  |  |  |  |

**Consolidated Marks:**

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| **CO** | **Max. Marks** | **Marks Obtained** |  | **PO** | **Max. Marks** | **Marks Obtained** |
| **2** | **35** |  |  | **2** | **9** |  |
| **3** | **35** |  |  | **3** | **39** |  |
| **Total** | **70** |  |  | **4** | **22** |  |
|  |  |  |  | **Total** | **70** |  |

**Signature of the Question paper Setter Signature of the Course Co-ordinator**

**Signature of the Academic Advisor**