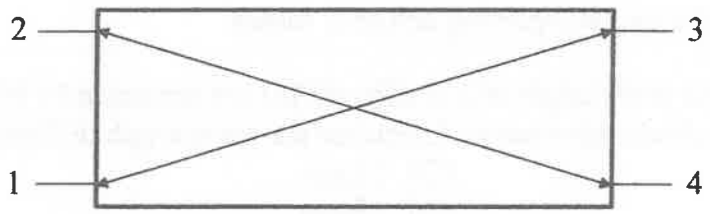
c. The diagram to show distance time history of electrons on Klystron amplifier is called ________. 1 1 1 4

(A) Apple Gate Diagram (B) Velocity Modulation Diagram
(C) Bunching Diagram (D) Asynchronous Diagram

7.a.i. A photodiode along with preamplifier linked in a circuit, which convert light into electric voltage of the required amplitude. Identify the circuits and explain its operation with equivalent diagram. 6 4 4 2

ii. In fiber optics, a beam of light carriers on optical signal through the core of an optical fiber cable. As it propagates through the cable, the beam of light signals losses it strength. Find the phenomenon and explain it causes, types with relevant diagram. 12 4 5

b. Consider the following statements about directional coupler shown in the figure. 1 4 3 2



1. Ports 1 and 2 are decouple
2. Ports 3 and 4 are decouple
3. Ports 1 and 3 are decouple
4. Ports 1 and 4 are decouple

Which of the above statements are correct?

(A) 1 and 2 only (B) 3 and 4 only
(C) 1,2 and 3 (D) 2,3 and 4

c. The fiber has a radius a = 50μm, core and cladding refractive index $n_1 = 1.49$, $n_2 = 1.46$ and the wavelength $\lambda = 1 \times 10^{-6}$ m, Calculate the V number of fiber 1 3 4 2

(A) 76.4 (B) 81.6
(C) 78.4 (D) 121

* * * * *

Reg. No.															

B.Tech. DEGREE EXAMINATION, MAY 2023
OPEN BOOK EXAMINATION
Sixth Semester

18ECC302J – MICROWAVE AND OPTICAL COMMUNICATIONS
(For the candidates admitted from the academic year 2018-2019 to 2019-2020)

- Specific approved THREE text books (Printed or photocopy) recommended for the course
- Handwritten class notes (certified by the faculty handling the course / head of the department)

Time: 3 Hours Max. Marks: 100

Answer **FIVE** questions
(Question No 1 is compulsory)

Marks BL CO PO

1.a.i. In a Microwave Solid state device, a field induced transfer of conduction band electrons from a high mobility lower energy valley to low mobility higher energy valley takes place. Name the device and the phenomenon due to this effect. Illustrate the principle in which it results in microwave oscillations with diagram. 8 3 1 4

ii. A high power microwave oscillator used in RADAR is operated with the following parameters. Anode Voltage = 25KV, Beam current = 25A, Magnetic Density = 0.34 Wb/m^2, Radius of cathode cylinder = 5cm, Radius of anode cylinder = 10cm. Calculate the angular frequency, the cut-off voltage, the cut-off Magnetic flux density. 10 2 1 1

b. Which of the following microwave tube uses both axial magnetic field and Radial electric field? 1 2 1 1

(A) Magnetron (B) Reflex Klystron
(C) Klystron (D) Travelling wave tube

c. If the length of the intrinsic region in IMPATT diode is 2μm and the carrier drift velocity are 10^7cm/s, then the drift time of the carrier is 1 3 1 4

(A) 10^{-11} seconds (B) 2×10^{-11} seconds
(C) 2.5×10^{-11} seconds (D) 4×10^{-11} seconds

2.a.i. Design an attenuator using a rectangular to circular transition and a circular to rectangular transition, and demonstrate that the attenuation produced by the designed attenuator is given in decibels by $A = -40 \log (\sin\theta)$, where θ is the angle the resistive card makes with the direction of the electric field. 10 4 2 2

ii. In a microwave passive device, an equal power is fed from the collinear arms and there is no power output in the side arm. Name the device and prove the above statement using S-Matrix 8 1 2 2

b. __________ is a three port microwave device that can be lossless and matched at all ports 1 2 2 4

(A) Hybrid Junction (B) Magic Tee
(C) Circulator (D) Isolator

c. $S_{12} = 0.85{-}45^\circ$ and $S_{21} = 0.85 - 45^\circ$ for a two port network. Then the two port network is 1 2 2 4
(A) Non – reciprocal (B) Lossless
(C) Reciprocal (D) Lossy

3.a.i. Name the device which provides information about the voltage or energy of the signal as a function of frequency. Also, demonstrate its working methodology with suitable diagram. 10 4 3 4

ii. 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 V_{max} = 2.5V, and V_{min} = 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. 8 4 3 4

b. What device that sweeps over a band of frequencies to determine what frequency are being produced by a specific circuit under test and the amplitude of each frequency component? 1 1 3 4
(A) Frequency counter (B) Cavity wave meter
(C) Bolometer (D) Spectrum Analyser

c. Assertion (A): The impedance of a matched load is equal to characteristic impedance of Line. 1 4 3 4
Reason (R): A matched termination absorbs the entire power incident on it.
(A) Both A and R are correct and R is correct explanation of A (B) Both A and R are correct but R is not correct explanation of A
(C) A is correct but R is wrong (D) A is wrong but R is correct

4.a.i. Identify a device which is made up of group III & V elements and it has a heterojunction. Illustrate its structure with radiation pattern. 10 2 4 4

ii. A InGaAs diode with $P^+\pi Pn^+$ configuration which converts a tight signal to electrical signal. Explain the operation of the diode. 4 5 4 2

iii. The same diode has the following parameter. η = 70%, λ = 900nm, suppose a 0.7μw of optical power produces a multiplied photo current of 12μA, Calculate the multiplication factor M. 4 5 4 2

b. The glass – air interface has the critical angle of 42°, and light is incident on the interface at 62°, then the light wave will be 1 4 4 2
(A) Totally internally reflected back (B) Parallel to the glass surface
(C) Refracted into the air (D) Reflected into the air

c. Find the amount of light gathering into a fiber if core-cladding index difference is 2% and refractive index is 1.480. 1 4 4 2
(A) 0.52 (B) 0.296
(C) 0.13 (D) 0.356

5.a.i. Make analysis which determines the dispersion limitation of an 2km optical fiber link desire to operate at 20Mbps. The LED transmitter and the Si PIN receiver have rise times of 8ns and 12ns, respectively. The GI index fiber has material dispersion D = 0.1 ns/km-nm and BW = 35 MHz. The LED spectral width is 40nm. Can the system be designed to operate with NRZ format? 5 4 5 4

ii. Analyse the optical communication system design based on the losses to transmit signal over the required distance and illustrate the equation to connect required power and losses of the system. 5 4 5 2

iii. A passive non reciprocal device, transmit an optical signal in one direction and avoid reflection of laser. Identify the device and explain its operation principles. 4 3 5 4

iv. Consider a commercially available 32×32 single mode fiber made from a cascade of 3dB fused fiber 2×2 coupler, where 5% of power is lost in each element. Estimate the excess, splitting and total losses. 4 5 5 2

b. Assume that the input wavelength of 2×2 silicon MZI are separated by 9GHz with n_{eff} = 1.5 in a silicon waveguide. Calculate the wavelength difference 1 4 5 2
(A) 10mm (B) 11mm
(C) 9mm (D) 12mm

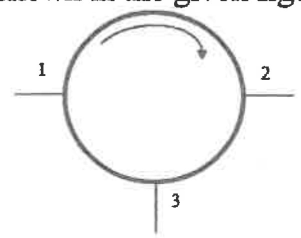
c. When the number of channels is very large and wavelength are spaced close together, for example 0.1nm, the system often referred to as 1 4 5 2
(A) WDM (B) WSN
(C) DWDM (D) TDM

6.a.i. What is mechanical tuning and electronic tuning in a reflex Klystron? Also explain how bunching time can be altered in a reflex Klystron. 5 2 1 1

ii. A Reflex Klystron is to be operated at a frequency of 10GHz, which dc beam voltage of 300V, and repeller space of 0.1cm for 7/4 mode. Calculate P_{RFmax} and corresponding repeller voltage for a beam current of 20mA. 5 2 1 1

iii. In a microwave transit time device the application of current pulse forms the high field avalanche zone and that propagates faster than the saturated velocity of the carriers that become confined in the low field region. Identify the device, draw the structure and explain its various regions of operation with characteristics curve. 8 1 1 1

b. A three port circulator is shown in the given figure. It's scattering matrix is 1 3 2 2



(A) $\begin{bmatrix} 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix}$ (B) $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 1 & 0 & 1 \end{bmatrix}$

(C) $\begin{bmatrix} 1 & 0 & 1 \\ 0 & 0 & 0 \\ 1 & 0 & 1 \end{bmatrix}$ (D) $\begin{bmatrix} 1 & 1 & 1 \\ 1 & 0 & 1 \\ 1 & 1 & 1 \end{bmatrix}$