Reg. No.															

B.Tech. DEGREE EXAMINATION, MAY 2024
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

		Marks	BL	CO	PO
Question No.1 is compulsory					
1.a.i.	Consider a solid state microwave device, a cathode, an anode, a collector, a cavity to modulate the electron velocity and a cavity to extract the energy from bunched electrons. Assume cathode to anode DC voltage to be V_0 and the modulating cavity voltage be $V_1 \sin \omega t$, then derive the expression for (1) Final electron transit time as a function of DC transit time (2) Final beam current as a function of DC current	10	3	1	4
ii.	A linear-beam tube has two cavities, a cathode and a collector that have the following parameters: $V_0 = 900V$, $I_0 = 30mA$, $f = 8GHz$, d =1 mm, L=4 cm, $R_{SH} = 40k\Omega$. (1) Identify the microwave source and sketch the apple gate diagram. (2) Determine the DC electron velocity and DC electron transit time.	8	3	1	4
b.	The product of XJ(X) is maximum when X is equal to (A) 0.582 (B) 2.408 (C) 1.25 (D) 0.52	1	2	1	4
c.	The transit angle θ_0 of the electron in reflex klystron must be (A) $2n\pi$ (B) $2n\pi - \pi$ (C) $2n\pi - n$ (D) $2n\pi - \pi/2$	1	2	1	4
2.a.i.	A hybrid tee, combination of E and H plane tee consists of 4 ports, draw its picture with arms/ ports and derive its 'S' matrix. Considering property of symmetry unitary property.	9	3	2	4
ii.	A three port circulator has an insertion loss of 1 dB isolation of 30 dB and VSWR= 1.5. derive its 'S' matrix.	9	4	2	2
b.	In hybrids the outputs are decoupled. (A) When 3 output port in match terminated (B) When 2 port in match terminated (C) When 4 port in match terminated (D) No port in match terminated	1	1	2	2

c.	A microwave circulator is a _____ (A) 4 port μW device (B) 3 port μW junction (C) Multiport unidirectional coupler (D) 3 dB μW device	1	1	2	2
3.a.i.	Describe parameter used for frequency selectivity measurement of a cavity resonator and how we can measure that parameter through VSWR measurement. Explain it including diagrams.	9	2	3	3
ii.	A microwave source is given a power at 50 W. Find the sensor that can be used to measure this power and explain its measuring methods with suitable pictures.	9	2	3	4
b.	We use two 20 dB directional couplers along with two detectors in which technique of impedance measurement? (A) Slotted line (B) Reflectometre (C) Heterodyne method (D) Calorimeter	1	2	2	3
c.	While measuring guide wavelength the termination of the bench must be _____ (A) Short (B) Open (C) Close (D) High	1	1	3	3
4.a.i.	Identify the module suitable for converting electrical signal into an optical signal. Sketch its block diagram and explain each unit function in detail.	9	3	6	3
ii.	Identify the phenomenon where signal distortion happens due to broadening of the pulse and categorize its types. Explain the type of distortion that occurs in single mode fiber.	9	3	4	2
b.	The device that uses two interfering paths of different lengths to resolve wavelengths (A) Coupler (B) Splitter (C) Interferometer (D) Filter	1	1	4	2
c.	The dispersion arises from the variable of the refractive index of the core material as a function of wavelength is _____ (A) Waveguide dispersion (B) Material dispersion (C) Modal dispersion (D) Hybrid dispersion	1	1	4	2
5.a.i.	Derive the budget analysis for determining the dispersion limitation of an optical fiber link and deduce its elements that limit the system speed.	9	3	5	2
ii.	An optical fiber system is to be designed to operate over 8 km length. The rise time of chosen components are, source 8ns, fiber intermodal dispersion 5 ns km^{-1}, intramodal dispersion 1 $nskm^{-1}$, detector 6 ns. From system rise time considerations, estimate the maximum bit rate using NRZ format.	4	4	5	2
iii.	And identify the WDM component which works on the principle of partial interference of the incident beam with itself in a mirroed resonant cavity to produce transmission peaks and nulls in the frequency domain. Explain its principle of operation.	5	3	5	2

b.	Spot the technique where light is modulated by radio frequency and transmitted over an optical fiber to access the dead zones (A) Radio over fiber (B) Fiber optics (C) Photonic communications (D) Opto electronics	1	1	5	2
c.	If the bandgap of the material is 1.51 eV, the peak emission wavelength is (A) 820 nm (B) 1550 nm (C) 850 nm (D) 1310 nm	1	3	5	2
6.a.i.	Explain the phenomenon of negative differential resistance in certain bulk materials. List its salient features.	4	1	1	1
ii.	Identify the diode in which a high-field avalanche zone propagates through if and fills the depletion layer with a dense plasma of electrons and holes. Discuss its functionality with necessary diagrams.	8	2	1	1
iii.	An X-band magnetron has an anode voltage $V_0 = 40kV$ and current $I_0 = 60A$. With magnetic flux density of $B_0 = 0.02Wb/m^2$. The radii of cathode and anode are a = 5cm and b =10 cm. calculate cyclotron angular frequency, hull cut-off voltage and hull cut-off magnetic field.	6	4	1	1
b.	The total phase-shift around in a n-cavity magnetron is (A) $n\pi$ (B) $\frac{n\pi}{2}$ (C) $2n\pi$ (D) $n^2\pi$	1	1	1	4
c.	The structure of the read diode is (A) $p^+ - n - p^+$ (B) $n^+ - p - p^+$ (C) $n^+ - p - i - p^+$ (D) $p^+ - i - n^+$	1	1	1	4
7.a.i.	Justify multiplexing need for optical fiber communications and explain how DWDM work with illustrations.	9	2	1	5
ii.	A double heterojunction LED emitting a peak wavelength of 1310 nm has radiative and non-radiative recombination times of 40 ns and 120 ns respectively. The drive current is 40 mA. Find the bulk recombination time, internal power level.	6	4	1	4
iii.	An optical fiber link of 5 km with an attenuation of 4.5 dB/km. The splice losses for the link are estimated at 1.2 dB/km and the connector losses at the source and the detector are 3.5 dB and 2.5 dB respectively. Assume that there is no dispersion effect. Find the total channel loss.	3	4	1	5
b.	A ray not confined to a single plane instead tends to follow on a helical type path along the fiber is _____ (A) Spiral ray (B) Skew ray (C) Circular ray (D) Bent ray	1	1	1	4
c.	The optical circulator exhibits insertion loss of around_____ (A) 1 dB (B) 0 dB (C) Infinite (D) 100 dB	1	1	1	4

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