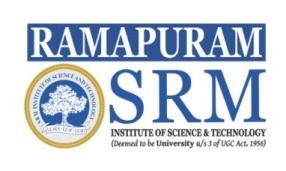
**SRM Institute of Science & Technology**

**Faculty of Engineering & Technology**

Ramapuram Campus

Unit 3

1. A device which converts electrical energy in the form of a current into optical energy is called as \_\_\_\_\_\_\_\_\_\_\_

**a) Optical source**

b) Optical coupler

c) Optical isolator

d) Circulator

Ans :a

2.How many types of sources of optical light are available?

a) One

b) Two

**c) Three**

d) Four

Ans : c

3. The frequency of the absorbed or emitted radiation is related to the difference in energy E between the higher energy state E2 and the lower energy state E1. State what h stands for in the given equation?

E = E2 - E1 = hf

a) Gravitation constant

**b) Planck’s constant**

c) Permittivity

d) Attenuation constant

Ans : B

4. 4. The radiation emission process (emission of a proton at frequency) can occur in \_\_\_\_\_\_\_\_\_\_ ways.

a) Two

**b) Three**

c) Four

d) One

Ans : B

5. Which process gives the laser its special properties as an optical source?

a) Dispersion

b) Stimulated absorption

c) Spontaneous emission

**d) Stimulated emission**

Ans :D

6. An incandescent lamp is operating at a temperature of 1000K at an operating frequency of 5.2×1014 Hz. Calculate the ratio of stimulated emission rate to spontaneous emission rate.

a) 3×10-13

**b) 1.47×10-11**

c) 2×10-12

d) 1.5×10-13

ANs: B

Explanation: The ratio of the stimulated emission rate to the spontaneous emission rate is given by-

Stimulated emission rate/ Spontaneous emission rate = 1/exp (hf/KT)-1.

7. The lower energy level contains more atoms than upper level under the conditions of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

a) Isothermal packaging

b) Population inversion

**c) Thermal equilibrium**

d) Pumping

Ans : C

8. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in the laser occurs when a photon colliding with an excited atom causes the stimulated emission of a second photon.

**a) Light amplification**

b) Attenuation

c) Dispersion

d) Population inversion

Ans : A

9.A semiconductor laser crystal of length 5 cm, refractive index 1.8 is used as an optical source. Determine the frequency separation of the modes.

a) 2.8 GHz

b) 1.2 GHz

**c) 1.6 GHz**

d) 2 GHz

Answer: c

Explanation: The modes of laser are separated by a frequency internal δf and this separation is given by-

δf = c/2nL

Where

c = velocity of light

n = Refractive index

L = Length of the crystal.

10. An injection laser has active cavity losses of 25 cm-1 and the reflectivity of each laser facet is 30%. Determine the laser gain coefficient for the cavity it has a length of 500μm.

a) 46 cm-1

b) 51 cm-1

c) 50 cm-1

**d) 49.07 cm-1**

Answer: d

Explanation: The laser gain coefficient is equivalent to the threshold gain per unit length and is given by –

gth = α + 1/L ln (1/r)

Where

α = active cavity loss

L = Length of the cavity

r = reflectivity.

11. A perfect semiconductor crystal containing no impurities or lattice defects is called as \_\_\_\_\_\_\_\_\_\_

**a) Intrinsic semiconductor**

b) Extrinsic semiconductor

c) Excitation

d) Valence electron

Answer: a

12. What is done to create an extrinsic semiconductor?

a) Refractive index is decreased

**b) Doping the material with impurities**

c) Increase the band-gap of the material

d) Stimulated emission

Answer: b

13. The majority of the carriers in a p-type semiconductor are \_\_\_\_\_\_\_\_\_\_

**a) Holes**

b) Electrons

c) Photons

d) Neutrons

Ans: A

14. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ is used when the optical emission results from the application of electric field.

a) Radiation

b) Efficiency

**c) Electro-luminescence**

d) Magnetron oscillator

Answer: c

15. Which impurity is added to gallium phosphide to make it an efficient light emitter?

a) Silicon

b) Hydrogen

**c) Nitrogen**

d) Phosphorus

Answer: c

16. Population inversion is obtained at a p-n junction by \_\_\_\_\_\_\_\_\_\_

a) Heavy doping of p-type material

b) Heavy doping of n-type material

c) Light doping of p-type material

**d) Heavy doping of both p-type and n-type material**

Ans : D

17. How many types of hetero-junctions are available?

**a) Two**

b) One

c) Three

d) Four

Answer: a

18. The \_\_\_\_\_\_\_\_\_\_\_\_\_\_ system is best developed and is used for fabricating both lasers and LEDs for the shorter wavelength region.

a) InP

b) GaSb

c) GaAs/GaSb

**d) GaAs/Alga AS DH**

Answer: d

19. Stimulated emission by recombination of injected carriers is encouraged in \_\_\_\_\_\_\_\_\_\_

**a) Semiconductor injection laser**

b) Gas laser

c) Chemist laser

d) Dye laser

Answer: a

20. In semiconductor injection laser, narrow line bandwidth is of the order?

**a) 1 nm or less**

b) 4 nm

c) 5 nm

d) 3 nm

Answer: a

21. The total efficiency of an injection laser with GaAs active region is 12%. The applied voltage is 3.6 V and band gap energy for GaAs is 2.34 eV. Determine external power efficiency.

**a) 7.8 %**

b) 10 %

c) 12 %

d) 6 %

Answer: a

Explanation: The total external power efficiency is defined as

η = ηT(Eq/V)\*100

= 0.12 (2.34/3.6) \*100

= 7.8 %.

22. Laser modes are generally separated by few \_\_\_\_\_\_\_\_\_\_

a) Tenths of micrometer

**b) Tenths of nanometer**

c) Tenths of Pico-meter

d) Tenths of millimeter

Answer: b

23. The spectral width of emission from the single mode device is \_\_\_\_\_\_\_\_\_\_

**a) Smaller than broadened transition line-width**

b) Larger than broadened transition line-width

c) Equal the broadened transition line-width

d) Cannot be determined

Answer: a

24. Single longitudinal mode operation is obtained by \_\_\_\_\_\_\_\_\_\_

a) Eliminating all transverse mode

b) Eliminating all longitudinal modes

c) Increasing the length of cavity

**d) Reducing the length of cavity**

Answer: d

25. In a DH laser, the sides of cavity are formed by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

a) Cutting the edges of device

**b) Roughening the edges of device**

c) Softening the edges of device

d) Covering the sides with ceramics

Answer: b

26. Gain guided laser structure are \_\_\_\_\_\_\_\_\_\_

a) Chemical laser

b) Gas laser

**c) DH injection laser**

d) Quantum well laser

View Answer

Answer: c

27. A correct DH structure will restrict the vertical width of the waveguide region is?

a) 0.5μm.

b) 0.69 μm

c) 0.65 μm

**d) Less than 0.4 μm**

Answer: d

28. The absence of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in LEDs limits the internal quantum efficiency.

a) Proper semiconductor

b) Adequate power supply

**c) Optical amplification through stimulated emission**

d) Optical amplification through spontaneous emission

Answer: c

29.The excess density of electrons Δn and holes Δp in an LED is \_\_\_\_\_\_\_\_\_\_\_\_

**a) Equal**

b) Δp more than Δn

c) Δn more than Δp

d) Does not affects the LED

Answer: a

30.The hole concentration in extrinsic materials is \_\_\_\_\_\_\_\_\_ electron concentration.

**a) much greater than**

b) lesser than

c) equal to

d) negligible difference with

Answer: a

31. Determine the total carrier recombination lifetime of a double heterojunction LED where the radioactive and nonradioactive recombination lifetime of minority carriers in active region are 70 ns and 100 ns respectively.

**a) 41.17 ns**

b) 35 ns

c) 40 ns

d) 37.5 ns

Answer: a

Explanation: The total carrier recombination lifetime is given by

τ = τrτnr/τr+τnr = 70× 100/70 + 100 ns = 41.17 ns

Where

τr = radiative recombination lifetime of minority carriers

τnr = nonradioactive recombination lifetime of minority carriers.

32. Determine the internal quantum efficiency generated within a device when it has a radiative recombination lifetime of 80 ns and total carrier recombination lifetime of 40 ns.

a) 20 %

**b) 80 %**

c) 30 %

d) 40 %

Answer: b

Explanation: The internal quantum efficiency of device is given by

ηint = τ/τr = 40/80 ×100 = 80%

Where

τ = total carrier recombination lifetime

τr = radiative recombination lifetime.

33.Compute power internally generated within a double-heterojunction LED if it has internal quantum efficiency of 64.5 % and drive current of 40 mA with a peak emission wavelength of 0.82 μm.

a) 0.09

**b) 0.039**

c) 0.04

d) 0.06

Answer: b

Explanation: The power internally generated within device i.e. double-heterojunction LED can be computed by

Pint = ηinthci/eλ = 0.645×6.626×10-34×3×108×40×10-3/ 1.602×10-19 × 0.82 × 10-6

= 0.039 W

Where

ηint = internal quantum efficiency

h = Planck’s constant

c = velocity of light

i = drive current

e = electron charge

λ = wavelength.

34. The Lambertian intensity distribution \_\_\_\_\_\_\_\_\_\_ the external power efficiency by some percent.

**a) Reduces**

b) Does not affects

c) Increases

d) Have a negligible effect

View Answer

Answer: a

35.The amount of radiance in planer type of LED structures is \_\_\_\_\_\_\_\_\_\_\_\_

**a) Low**

b) High

c) Zero

d) Negligible

Answer: a

36. In optical fiber communication \_\_\_\_\_\_\_\_\_\_\_\_\_ major types of LED structures are used.

a) 2

b) 4

**c) 6**

d) 3

Answer: c

37. As compared to planar LED structure, Dome LEDs have \_\_\_\_\_\_\_\_\_\_\_\_\_\_ External power efficiency \_\_\_\_\_\_\_\_\_\_\_ effective emission area and \_\_\_\_\_\_\_\_\_\_\_\_\_ radiance.

a) Greater, lesser, reduced

**b) Higher, greater, reduced**

c) Higher, lesser, increased

d) Greater, greater, increased

Answer: b

38.In surface emitter LEDs, more advantage can be obtained by using \_\_\_\_\_\_\_\_\_\_\_\_

a) BH structures

b) QC structures

**c) DH structures**

d) Gain-guided structure

Answer: c

39. Internal absorption in DH surface emitter Burros type LEDs is \_\_\_\_\_\_\_\_\_\_\_\_

a) Cannot be determined

b) Negligible

c) High

**d) Very low**

Answer: d

40. DH surface emitter generally give \_\_\_\_\_\_\_\_\_\_\_\_

**a) More coupled optical power**

b) Less coupled optical power

c) Low current densities

d) Low radiance emission into-fiber

Answer: a

41. In a multimode fiber, much of light coupled in the fiber from an LED is \_\_\_\_\_\_\_\_\_\_\_\_

a) Increased

b) Reduced

**c) Lost**

d) Unaffected

Answer: c

42. The active layer of E-LED is heavily doped with \_\_\_\_\_\_\_\_\_\_\_\_

**a) Zn**

b) Eu

c) Cu

d) Sn

Answer: a

43. The majority of the carriers in a p-type semiconductor are \_\_\_\_\_\_\_\_\_\_

**a) Holes**

b) Electrons

c) Photons

d) Neutrons

Answer: a

44. \_\_\_\_\_\_\_\_\_\_\_\_ confinement is used to increase the carrier concentration recombination at the active region

**a) Carrier**

b) Optical

c)Electrical

d)Signal

Answer: a

45 \_\_\_\_\_\_\_\_\_\_\_ is the ratio of electron-hole pairs generated to the incident photons

a)Power efficiency

**b) Quantum efficiency**

c)Signal efficiency

d)Carrier efficiency

Answer : b

**Part B**

**4 Marks questions**

1. Define Luminescence. Mention the types of luminescence
2. State the difference between luminescence and incandescence
3. Write the expression for the radiated power P in Injection Luminescence. Also Sketch the spectral distribution of the radiated power P as a function of Eph
4. With the aid of neat diagram explain the phenomenon of Photoluminescence
5. Phosphorescence is also called delayed fluorescence. Justify the statement. Also compare the features of fluorescence and phosphorescence
6. With the aid of neat diagrams, explain the principle of Injection Luminescence and state the expression for the emitted photon energy
7. State the phenomenon of Cathodoluminescence. Mention the applications of Cathodoluminescence
8. Contrast radiative and nonradiative recombination process
9. Explain the need of double heterostructure in LED and LASER's. Give its significance.
10. What are the basic LED configurations being used for fibre optics?
11. Define Quantum efficiency?
12. List the types and advantages of photodiodes.
13. What is LASER? Describe its properties.
14. What are the direct-band gap and indirect band gap materials?
15. What are light source materials?
16. Define responsivity?
17. What is meant by impact ionization in APD?
18. What do you mean by avalanche effect?
19. What are the conditions required to achieve a high signal to Noise ratio in a photodiode?
20. What are PIN Photodiodes?
21. What is the avalanche photodiode?
22. Difference between PIN photodiode and Avalanche photodiode?
23. State the threshold condition for LASER Oscillation.
24. Give the principle of photodetector.
25. Compare PIN and APD devices.
26. Explain the phenomenon of optical pumping?
27. GaAs has Band Gap energy of 1.43eV at 3000 K. Determine the wavelength above which the photodetector fabricated from this material cease to operate.

**PART C**

**12 Marks Questions**

1. Draw and explain the LED structures based Double Heterostructure configuration.
2. Discuss the principle of operation of LASER diodes.
3. Explain briefly the three key processes involved in the laser action.Describe for a FabryPerot resonator laser diode, modes and threshold conditions. Obtain its rate equations for steady state output.
4. What type of materials are used for optical sources? What are the advantages of double Heterostructure?
5. Compare surface emitting and edge emitting LED structures.
6. Explain the basic LED configurations used as optical sources. Derive the expression for quantum efficiency and optical power generated in LED’s.
7. Draw the structure of Edge-Emitting LED and explain the operation.
8. Derive Einstein relationship and Threshold condition for Lasing action.
9. Sketch the structure of LASER and explain its working principle.
10. Explain in detail the Laser Diode structures and its Radiation Pattern.
11. With a neat sketch explain the principle and operation of PIN Photodiode.
12. With a neat sketch explain the principle and operation of Avalanche photodiodes.
13. Discuss in detail the effect of the various noise mechanisms in a photodetector and its signal to noise ratio.