K.S.R. COLLEGE OF ENGINEERING (Autonomous) R 2018

SEMESTER – I / II

18PH043	ENGINEERING PHYSICS (Common to EC,EE,CS & IT)	L	T	P	C
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Prerequisite: *Basic knowledge on physics*

Objectives:

- *Compute and analyze various problems related to Engineering Physics.*
- *Understand the various optoelectronic devices and its applications in the field of Engineering and also to explore the prism concepts of Quantum physics.*
- *Understand the basic concepts behind the types of advanced materials & nanotechnology, sensors, transducers and Laser.*

UNIT - I QUANTUM PHYSICS [9]

Black body radiation – Planck's theory (derivation) – Deduction of Wien's displacement law and Rayleigh – Jeans' Law from Planck's theory – Compton effect – Theory and experimental verification – Matter waves – Schrödinger's wave equation – Time independent and time dependent equations – Physical significance of wave function – Particle in a one dimensional box, Scanning Electron Microscopy (SEM),Transmission Electron Microscopy (TEM), .

UNIT - II OPTOELECTRONIC DEVICES [9]

Photoconductive materials – Light Dependent Resistor (LDR) – Working – Applications – Photovoltaic materials – Solar cell – Construction, working and applications – Light Emitting Diode (LED) – Principle, construction and working - Liquid crystal Display (LCD) – Types and applications.

UNIT - III ADVANCED MATERIALS AND NANOTECHNOLOGY [9]

New Engineering Materials: metallic glasses – preparation, properties and applications – Shape memory alloys (SMA) – characteristics, properties of Ni Ti alloy applications – advantages and disadvantages of SMA.Nanomaterials: Properties-Top-down process: Ball Milling method – Bottom-up process: Vapour Phase Deposition method- Carbon nano tube (CNT): Properties, preparation by electric arc method, Applications

UNIT - IV LASER TECHNOLOGY [9]

Introduction – Principle of Spontaneous emission and stimulated emission – Population inversion, pumping – Einstein's A and B coefficients (derivation). Types of lasers – Nd-YAG, CO_2 and Semiconductor lasers (homo-junction and hetero-junction) – Qualitative Industrial Applications: Lasers in welding, heat treatment and cutting – Medical applications – Holography (construction and reconstruction).

UNIT - V SENSOR TECHNOLOGY [9]

Definition – Principle of sensor & transducer – classification – types of Sensors – resolution, accuracy, sensitivity, – Inductive sensor – Linear Variable Differential Transistor (LVDT) – Thermal sensors – Thermocouple – Magnetic sensors – Strain gauge torque meters – biosensors – electronic nose –electronic tongue – medical, food and agricultural applications.

Total = 45 Periods

Course Outcomes: On Completion of this course, the student will be able to

- *Enumerate the preambles of quantum physics and implement its concepts to tackle the cumbersome engineering problems.*
- *Explore the concepts of optoelectronic devices for the fabrication of electronic devices.*
- *Apply the techniques for manufacturing of advanced materials aided with Nano properties*
- *Categorize the types of laser and utilize it for specific application based on their desirable requisite.*
- *Utilize the conceived concepts and techniques for sensors and transducers.*

Text Book :

1 R. Murugasen and Er. Kiruthiga Sivaprasath,"Modern Physics" S. Chand & Co, New Delhi 2018.

2 Dr.M. Arumugam, "Engineering Physics",Anuradha Publications, Kumbakonam,2017.

Reference Books :

1 R.K.Gaur & S.L.Gupta, "Engineering Physics", Dhanpat Rai Publication, New Delhi, 2014.

2 A.K.Sawhney, "A Course in Electrical and Electronic Measurements and Instrumentation",Dhanpat rai &Co Delhi, 2012.

3 www.fadooengineers.com

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K.S.R COLLEGE OF ENGINEERING (Autonomous), TIRUCHENGODE – 637 215
DEPARTMENT OF PHYSICS
COURSE / LESSON PLAN SCHEDULE

SUBJECT : ENGINEERING PHYSICS

COURSE CODE: 18PH043

A. TEXT BOOK:

1. R. Murugasen and Er. Kiruthiga Sivaprasath,''Modern Physics'' S. Chand & Co, New Delhi 2018.
2. Dr.M. Arumugam, "Engineering Physics",Anuradha Publications, Kumbakonam,2017.

B. REFERENCE BOOK:

1. R.K.Gaur & S.L.Gupta, "Engineering Physics", Dhanpat Rai Publication, New Delhi, 2014.
2. A.K.Sawhney, "A Course in Electrical and Electronic Measurements and Instrumentation",Dhanpat rai &Co Delhi, 2012.

C. LEGEND:

L – Lecture
T – Tutorial
OHP – Over Head Projector
Rx – Reference
PPT – Power point
BB – Black Board

S. No	Lecture Hour	Topics to be covered	Teaching Aid Required
UNIT I – QUANTUM PHYSICS			
1	L1	Black body radiation – Planck's theory (derivation)	BB
2	L2	Deduction of Wien's displacement law and Rayleigh – Jeans' Law from Planck's theory	BB
3	L3	Compton effect – Theory and experimental verification	BB
4	L4	Matter waves – Schrödinger's wave equation	BB
5	L5	Time independent and time dependent equations	BB
6	L6	Physical significance of wave function	BB
7	L7	Particle in a one dimensional box	BB
8	L8	Scanning Electron Microscopy (SEM)	BB
9	L9	Transmission Electron Microscopy (TEM)	BB
UNIT II - OPTOELECTRONIC DEVICES			
10	L10	Photoconductive materials – Introduction	BB
11	L11	Working and application of Light Dependent Resistor (LDR)	BB
12	L12	Photovoltaic materials – Introduction	BB
13	L13	Construction, working and applications of Solar cell	BB
14	L14	Light emitting diode – principle and working	BB
15	L15	Applications of LED	BB
16	L16	Principle and construction of Liquid crystal Display	BB
17	L17	Working of Liquid crystal Display	BB

18	L18	Types and applications of Liquid crystal Display	BB
UNIT III - ADVANCED MATERIALS AND NANOTECHNOLOGY			
19	L19	Metallic glasses – preparation properties and applications	BB
20	L20	Shape memory alloys (SMA) – characteristics	BB
21	L21	Properties of Ni Ti alloy applications	BB
22	L22	Advantages and disadvantages of SMA.	BB
23	L23	Nanomaterials – introduction and properties	BB
24	L24	Top down process – Ball Milling method	BB
25	L25	Bottom up process - Vapour Phase Deposition method	BB
26	L26	Carbon Nano Tube - Properties and applications	BB
27	L27	Preparation of CNT by electric arc method	BB
UNIT IV– LASER TECHNOLOGY			
28	L28	Laser - Introduction	BB
29	L29	Principle of Spontaneous emission and stimulated emission	BB
30	L30	Population inversion and pumping methods	BB
31	L31	Einstein's A and B coefficients (derivation)	BB
32	L32	Types of lasers – Nd-YAG laser	BB
33	L33	CO_2 laser	BB
34	L34	Semiconductor lasers (homo-junction and hetero-junction)	BB
35	L35	Lasers in welding, cutting and heat treatment	BB
36	L36	Medical applications – Holography (construction and reconstruction).	BB
UNIT V - SENSOR TECHNOLOGY			
37	L37	Definition – Principle of sensor & transducer	BB
38	L38	Types of Sensors	BB
39	L39	Resolution, accuracy and sensitivity	BB
40	L40	Inductive sensor - Introduction	BB
41	L41	Linear Variable Differential Transistor (LVDT)	BB
42	L42	Thermal sensors – Thermocouple	BB
43	L43	Magnetic sensors – Strain Gauge and Torque meters	BB
44	L44	Biosensors – Electronic nose and Electronic tongue	BB
45	L45	Medical, food and agricultural applications of biosensors	BB

K. S. R. COLLEGE OF ENGINEERING, TIRUCHENGODE – 637 215.
(An autonomous institution)
DEPARTMENT OF PHYSICS
ENGINEERING PHYSICS
FIRST YEAR - I SEMESTER -

QUESTION BANK

PART – A: 2 MARKS QUESTION AND ANSWERS

UNIT- I : QUANTUM PHYSICS

1. Explain Planck's hypothesis? Mention any two postulates of Planck's quantum theory? [R, C01]

The black body radiation chamber is filled up not only with radiations but also with large number of oscillating particles. The particles can vibrate in all possible frequencies. The frequency of radiations emitted by an oscillator is the same as that of the frequency of the vibrating particles.

The oscillatory particles cannot emit energy continuously. They will radiate energy only in the form of a discrete packet of energy, i.e., a small unit called quantum or photon.

2. What is meant by blackbody and blackbody radiation?[R, C01, Jun 2012]

A perfect blackbody is one which absorbs radiation of all wavelengths incident on it. Further, such a body cannot transmit or reflect any radiation and therefore it appears black. A black body can radiate energy in all possible wavelengths when it is heated to a suitable temperature. The radiation emitted from black body is known as blackbody radiation or total radiation.

3. State Compton Effect. (or) Give a brief account on Compton Effect.[R, C01]

When a monochromatic beam of X – rays having wavelength 'λ' is allowed to fall on a block of paraffin or carbon, the beam is scattered into two components. One of the components has a wavelength equal to the incident wavelength. This phenomenon in which there is a change in wavelength of the scattered X – rays is called Compton shift and this effect is known as Compton Effect.

4. Discuss the special cases of ϕ.[App, C01]

In Compton experiment, scattered beam consists of X – rays of two components, one with an equal to the incident wavelength and the other with a higher wavelength compared to the incident wavelength. The Compton shift or Compton wavelength is given by,

$$d\lambda = \lambda' - \lambda = \frac{h}{m_0 c}(1 - \cos\phi)$$

When the scattering angle $\phi = 0$, $d\lambda = 0$

When the scattering angle $\phi = 90°$, $d\lambda = \frac{h}{m_0 c} = 0.02427Å$

When the scattering angle $\phi = 180°$, $d\lambda = \frac{2h}{m_0 c} = 0.04854Å$

5. Explain the phenomenon that can be explained by quantum mechanics.[U, C01]

i. Quantum mechanics is used to explain the concept of photoelectric effect.
ii. Based on quantum ideas, the problem of specific heat of solids at low temperature is explained successfully.
iii. The atomic structure and the origin of spectral lines are explained by Bohr, based on quantum concepts.
iv. The phenomenon like scattering of X – rays is explained by Compton, based on quantum ideas.

6. What are the different types of scattering of X – rays?[R, C01]

Coherent scattering or Classical scattering
Incoherent scattering or Compton scattering

7. **What are the physical significances of the wave function? [R, C01, Jun 2012, Jan 2013, AU Jan 2013, Jun 2013, AU June 2013, Jan 2014, June 2014, Jan 2015]**

It relates the particles and wave nature of matter elastically.

It provides the information about the particle behavior.

It is a complex quantity and hence we cannot measure it.

The square of the wave function is a measure of the probability of finding the particle at a particular position. It cannot predict the exact location of the particles.

8. **What is meant by photon? Give its properties.[R, C01]**

The discrete energy values in the form of small packets or quanta's of definite frequency or wavelengths are called photons. Photons propagate like a particle with speed of light as 3 X 10^8 m/s.

Properties:

Photons will not have any charge. They are neutral and hence they are not affected by magnetic and electric field.

They do not ionize gases.

The energy of one photon is given by E = hν which varies with respect to the type of radiation frequencies.

Mass of a photon is given by m =$\frac{h}{c\lambda}$ and momentum of the photon is given by p = $\frac{h}{\lambda}$

9. **What is wave function?[R, C01]**

A variable quantity which characterizes de – Broglie waves is known as wave function and is denoted by the symbol Ψ. The value of the wave function associated with a moving particle at a point (x, y, z) and times' gives the probability of finding the particle at that time and at that point.

10. **What is Schrödinger wave equation?[R, C01]**

Schrödinger wave equation is a mathematical equation to describe the dual nature of matter waves. Schrödinger equation is one of the basic quantum mechanical equations. This equation is used to describe both macroscopic as well as microscopic particles.

11. **Write down the Schrödinger time independent and dependent wave equation and explain why Schrödinger time independent equation is widely used rather than Schrödinger time dependent wave equation? [U, C01]**

Schrödinger time independent equation,

$$\nabla^2 \Psi + \frac{2m}{\hbar^2} (E - V) \Psi = 0$$

Schrödinger time dependent equation,

$$H \Psi = E \Psi$$

Where, ∇ is the Laplacian operator

E is the energy operator (E = i $\hbar \frac{d}{dt}$)

H is the Hamiltonian operator (H = - $\frac{\hbar^2}{2m} \nabla^2$ + V)

Schrödinger time dependent wave equation is very complex to solve rather than Schrödinger time independent equation.

12. **Explain zero point energy of a particle in a 1-dimensional box.[U, C01]**

The possible energies of a particle in one dimensional box having length 'L' is given by,

$$E = \frac{n^2 h^2}{8mL^2}$$

If n = 1, then E = $\frac{h^2}{8mL^2}$

This is the energy of the ground state of the particle. Since, the particle in a box cannot be at rest, its minimum energy is positive and is often called as the zero point energy.

13. Define Wien's displacement law and write its limitation.[R, C01, Dec 2012, AU Jan 2014, AU Dec 2014, Jan 2015]

According to Wien's displacement law in the energy spectrum of a black body, the product of the wavelength corresponding to maximum energy (λ_m) and absolute temperature is a constant. i.e., λ_m T = constant.

Limitations: It is applicable for short wavelengths only.

14. State Rayleigh – Jean's law. What are its limitations? [R, C01]

According to Rayleigh – Jean's law, the energy distribution in the black body spectrum is given by,

$$E_\lambda = \frac{8\pi kT}{\lambda^4}$$

Where, k is Boltzmann constant. The energy distribution is directly proportional to the absolute temperature and is inversely proportional to the fourth power of the wavelength.

Limitations: It is applicable for longer wavelength only.

15. State Planck's radiation law. [R, C01, AU 2013]

According to Planck's theory, energy is emitted in the form of packets or quanta called photons and energy of photon is given by E = nhν, where n = 1, 2, 3, etc. In black body radiation, total energy of photons within the wavelength range 'λ' and 'λ + dλ' is given by,

$$E_\lambda = \frac{8\pi hc}{\lambda^5[e^{\frac{h\gamma}{kT}} - 1)}$$

16. What is meant by perfect black body.[R, C01]

A body which absorbs radiations of all wavelengths incident on it and also emits all the wavelengths of radiations is called the perfect black body.

17. What is black body and what are its characteristics? ?[R, C01, AUJune 2013, Jun 2013]

A Perfect black body is the one which absorbs radiation of all wavelength incidents on it and also emit all wavelength of radiation.

Characteristics:

Practically, there is no perfect black body

We can artificially paint the black colour over the surface to make black body.

It is a perfect absorber and radiator.

Radiation emitted from black body is known as blackbody radiation.

18. Define Eigen value and Eigen function. [R, C01]

Eigen value is the energy of the particle and it is represented by 'E_n'.

Eigen function is the state or the wave function of the particle and it is represented by 'Ψ_n'.

19. What is matter wave? (or) What is de – Broglie wave?[R, C01, Jan 2014]

All the matter particles like electron, neutron, atom or molecules have an associated wave with them, called as matter wave or de – Broglie wave.

20. Write an expression for the wavelength of matter waves. (or) What is de – Broglie wave equation?[R, C01]

de – Broglie wavelength (λ) = $\frac{h}{mv} = \frac{h}{p} = \frac{h}{\sqrt{2mE}}$

Where, h is the Planck's constant
m is the mass of the particle
v is the velocity of the particle
p is the momentum of the particle
E is the energy of the particle.

21. State the properties of the matter waves. [R, C01]

The wavelength associated with matter wave get shorter when the mass of the particles becomes larger.

Matter waves are electromagnetic waves.

The function of matter wave is to guide the matter particles, hence it is called as pilot wave.

These waves can travel faster than the velocity of light.

The velocity of matter wave is not a constant.

The phase velocity of matter waves is inversely proportional to its wavelength.

22. Explain the significance of de – Broglie equation.[U, C01]

de – Broglie equation connects the particle and its associated waves.

It gives the matter waves wavelength $\lambda = \frac{h}{mv}$.

23. Distinguish degenerate and non degenerate state? Give example. [An, C01]

Degeneracy:

Different wave functions with three different quantum numbers may have same energy value. We have same energy value but different Eigen functions. Such states and energy levels are called degenerate state.

Examples, Three different states having quantum numbers (1, 1, 2), (1, 2, 1) and (2, 1, 1) have the same energy.

Non – degeneracy:

If only one energy Eigen function corresponding to certain energy, the state and the energy level are said to be non – degenerate state.

Examples, the quantum numbers (111) has the energy $\frac{3h^2}{8ma^2}$, no other state has this energy.

24. Explain the entities that can be determined from Schrödinger's wave equation. [U, C01]

It is used to find the electron in the metal.

It is used to find the energy levels of an electron in an infinite potential well.

It is used to describe both macroscopic as well as microscopic particles.

25. Define normalization process and write down the normalized wave function for an electron in a one dimensional potential well. [R, C01]

Normalization is the process of finding the probability or probability density of a particle inside any potential well. For a one dimensional potential well of length 'L' meter, the normalized wave function is given by,

$$\Psi_n = \sqrt{\frac{2}{L}} \sin \frac{n\pi x}{L}$$

26. Explain the special features of quantum theory of radiation.[U, C01]

We can deduce Stefan – Boltzmann's law, Wien's displacement law and Rayleigh – Jean's law from quantum theory of radiation. Wien's displacement law holds good only for shorter wavelength and Rayleigh – Jean's law Holds good only for longer wavelength. But Planck's quantum theory of radiation holds good both for longer and shorter wavelengths. According to quantum theory of radiation, we know that the exchange of energy values between the light radiation and particles have discrete energy values known as photons.

27. Deduce Rayleigh – Jean's law from Planck's quantum theory of radiation.[Ap, C01]

Planck's quantum theory of radiation in terms of wavelength is,

$$E_\lambda \, d\lambda = \frac{8\pi hc}{\lambda^5} \left[\frac{1}{e^{(hc|\lambda kT)} - 1} \right]$$

When λ is very large, ν is very small, $\frac{h\nu}{kT} \ll 1$ and $e^{(h\nu|kT)} \approx 1+(h\nu|kT)$

Therefore, $E_\lambda = \frac{8\pi hc}{\lambda^5} \left[\frac{1}{1+\frac{h\gamma}{kT} - 1} \right]$

$$= \frac{8\pi hc}{\lambda^5} \left[\frac{kT\lambda}{hc} \right]$$

$$E_\lambda = \frac{8\pi kT}{\lambda^4}$$

This is Rayleigh – Jean's law.

28. What is normalization and how it differs from wave function? [An, C01]

Wave function determines the probability of finding a particle at that point and at that time whereas the normalization is the process by which the particle can be found inside the box.

29. Why the photons are not affected by electric and magnetic fields ?Justify [E, C01]

The photons are not affected by electric and magnetic fields because they are charge less particle.

30. In Compton scattering, the incident photons have wavelength 0.5 nm. Calculate the wavelength of scattered radiation if they are viewed at an angle of 45^0 to the direction of incidence. [R, C01]

Change in wavelength $(\lambda' - \lambda) = \frac{h}{m_{0c}}(1 - \cos\phi)$

Therefore, Wavelength of scattered radiation (λ')

$$= \lambda + \frac{h}{m_{0c}}(1 - \cos\phi)$$

$$= 0.5 \times 10^{-9} + \frac{6.626 \times 10^{-34}}{9.1 \times 10^{-31} \times 3 \times 10^{8}}(1 - \cos 45°)$$

$\boldsymbol{\lambda'}$ **= 0.5007 nm.**

31. Find the energy of an electron moving in one dimension in an infinitely high potential box of width 0.1 nm. (or) An electron is trapped in a cubical box of side 1$\mathring{A}$. Find the energy for the ground state and the first excited state. [R, C01]

Energy of an electron $E_n = \frac{n^2h^2}{8mL^2}$

1. For ground state n = 1,

   Energy of an electron $E_1 = \frac{(6.626 \times 10^{-34})^2}{8 \times 9.1 \times 10^{-31} \times (0.1 \times 10^{-9})^2}$

   $= 6.022 \times 10^{-18}$ J (or) 37.64 eV.

2. For first excited state, n = 2,

   $E_{exc} = 4 \times 37.64$

   = 150.56 eV.

32. Calculate the wavelength associated with the electron speed is 0.001 C.[R, C01]

de – Broglie wavelength $(\lambda) = \frac{h}{mv}$

$$\lambda = \frac{6.626 \times 10^{-34}}{9.1 \times 10^{-31} \times 0.001 \times 3 \times 10^{8}}$$

= **2.424×10^{-9} m (or) 2.424 nm.**

33. Find the change in wavelength of an X – ray photon when it is scattered through an angle of 900 by a free electron. [R, C01]

Compton wavelength $\lambda = \frac{h}{m_{0c}}$

$= \frac{6.626 \times 10^{-34}}{9.1 \times 10^{-31} \times 3 \times 10^{8}}$ = **0.0242×10^{-10} m (or) 0.0242 $\mathring{A}$**

34. Calculate the de – Broglie wavelength of an electron of energy 100 eV. [R, C01, Jun 2015]

de – Broglie wavelength $(\lambda) = \frac{h}{mv} = \frac{h}{p} = \frac{h}{\sqrt{2mE}}$

$$= \frac{6.626 \times 10^{-34}}{\sqrt{2 \times 9.1 \times 10^{-31} \times 100 \times 1.6 \times 10^{-19}}}$$

λ = 1.235×10^{-10} m (or) 1.235 $\mathring{A}$

35. For a free particle moving within a 1Dimensional box potential box, the ground state energy cannot be zero. Why? [R, C01, AU Jan 2014]

For ground state n=1,

$E_n = \frac{n^2h^2}{8mL^2}$ *so En is equal to zero*

UNIT- II : OPTOELECTONIC DEVICES

1. What are solar cells? [R, CO2]

Solar cells are a p – n junction device that is based on the principle of photo – electric effect. It directly converts light energy into electrical energy and hence, it is also known as photo – voltaic cell. Example : Ga-As solar cell.

2. **State the principle of photo – voltaic cell. [R, CO2]**

Photo – voltaic cell works on the principle of photo – voltaic effect. It is the generation of the potential difference at the junction of two different materials in response to visible or other radiation.

3. **Mention two important solar cell parameters**. **[R, CO2]**

Short circuit current (I_{sc}) and open circuit voltage (I_{oc}) are the important solar cell parameters.

4. **Elaborate Fill factor. [R, CO2]**

The fill factor of a solar cell is given by the relation

$$f = \frac{\text{Maximum output power}}{V_{oc}\ X\ V_{sc}},$$

where V_{oc} = Open circuit voltage

and V_{sc} = Short circuit current

Its value lies between 0.65 and 0.8

5. **How the efficiency of the solar cell can be measured? [U , CO2]**

The efficiency of a solar cell is the ratio of the total power converted by the solar cell to the total solar cell power available for energy conversion.

$$\eta = \frac{\text{Pmax}}{\text{Light intensity XArea of the solarcell}},$$

It is found to vary between 10 to 15 %.

6. **Explain the important factor that affect solar cell. (U, CO2)**

The important factor affecting solar cell is the band- gap energy. It should be comparable with the energy of the photons present in the solar spectrum so as to absorb, more number of photons. Example : Si

7. **Mention any four solar cell materials with their corresponding energy gap values. (R, CO2)**

Material	Energy gap (eV)
Ga As	1.40
Si	1.11
Cd S	2.42
Cd Se	1.74

8. **Classify the different types of solar cells. (An, CO2)**

   i. p-n homojunction
   ii. p-n heterojunction
   iii. Schottky barrier
   iv. Semiconductor electrolyte

9. **State any four applications of solar cell. (R, CO2)**

   i. Telecommunication photo-voltaic (PV) systems are used in remote areas such as mountain tops, islands etc.
   ii. PV systems are used to power railway systems, fog, fire and fiood hazard warnings etc.
   iii. Defense equipment like remote radar is powered by PV system.
   iv. PV powered water pumps are used to provide portable water flow.

10. **What are display devices? (R, CO2)**

Display devices are an output unit which gives verbal representation of data. They are of 2 types - active display device and passive display device.

11. Differentiate active display device and passive display device. (An, CO2)

S.No	**Active display device**	**Passive display device**
1.	The device which emits radiation on its own is known as active display device	The device which modulation incident radiation to provide necessary display information is known as passive display device
2.	Ex : CRT, LED	Ex : LCD

12. Define : LED(R, CO2)

Light emitting diode (LED) is a semiconductor p- n junction diode which converts electrical energy to light energy under forward biasing. It emits light in both visible and IR region

13. Mention the types of LED.(U,CO4)

(i) Planar (or) surface emitting LED

(ii) Dome shaped LED

14. State the principle used in LED.(R, CO2)

Injection luminescence is the principle used in LED. When LED is forward biased, the majority charge carrion moves from p to n and similarly from n to p region and becomes excess minority carriers. These minority carriers diffuses through the junction and recombines with the majority carriers is n and p regions respectively to produce light.

15. What is the principle used in PIN photo diode? (R, CO2)

This diode works in reverse bias condition. Under reverse biasing, when light is made to fall on the neutral (or) intrinsic region (i) electron hole pairs are generated. These electrons and holes are accelerated by the external electric filed, which results in photo – current. This light is converted into electrical signal.

16. What is APD? (R, CO2)

Avalanche photo diode has a sophisticated structure to produce more photo current. It works in reverse bias. By avalanche effect more numbers of electron hole pairs are created, which results in large photo current.

17. Explain the advantage of dome shaped LED over planar LED? (An, CO2)

In planar LED, reflection loss is more because most of the emitted light strikes the material interface at an angle greater than the critical angle. Therefore they are totally internally reflected and will not come out of the interface, thus the light is lost.

But in dome shaped LED, the angle at which the light strikes the interface can be made less than the critical angle by making the ‘p’ material in the shape of a semispherical dome. Hence the light is not lost.

18. Why is LED not made of Si (or) Ge. Give reason? (U, CO2)

(i) Fundamental band gap in elemental semiconductor is indirect.

(ii) They have low optical absorption coefficients with absorption edges are in infra-red region.

19. Give the materials used for manufacturing LED’s and respective colors of light emitted by LED in forward bias condition. (R, CO2)

S.No	Materials	Colour
1.	GaAsP	Red ,Yellow or Orange
2.	GaP	Green
3.	SiC	Blue
4.	GaAs	Infrared (invisible)

20. Write down the advantage of LED's. (R, CO2)

Advantage of LEDs include

(i) Low cost
(ii) Low Power Consumption
(iii) Very fast operation
(iv) Small size and weight
(v) Long life
(vi) No effect of mechanical vibration
(vii) Generates different colors.

21. How can the efficiency of the PV cell be improved? (An, CO2)

The efficiency can be improved by adjusting the light facing angle of the cell all the day.

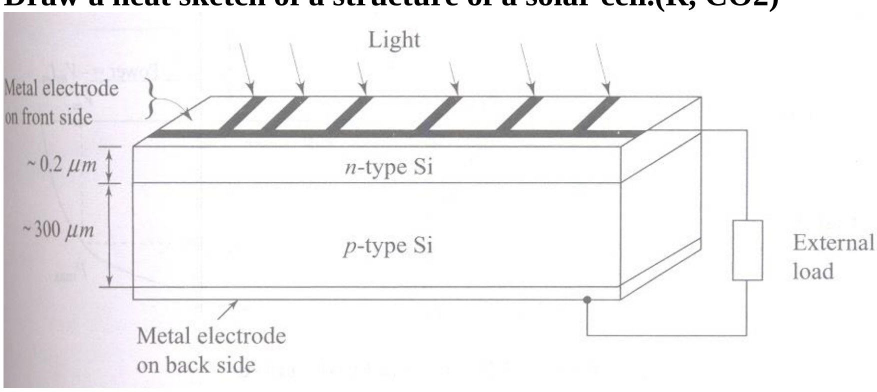
22. Mention two application of LED. (R, CO2)

(i) LED's are used as potential source for optical fibre communication.
(ii) There are used as fast speed switches.
(iii) They are used in solid- state video display.
(iv) They are used as numerical display in watches, calculator etc.

23. What happens to the solar cell working if the energy of the photon is less than the energy of the band gap? (An, CO2)

When the solar cell is exposed to the solar radiation the photon that has the energy less than the band gap makes no contribution to the cell output. It is wasted as heat.

24. Draw a neat sketch of a structure of a solar cell.(R, CO2)



25. What is seven segment displays and give its types. (R, CO2)

A display consisting of seven LED's arranged in seven segments is called seven segment display. The seven LED's are arranged in a rectangular fashion. It is of two types.

(i) Common anode type, (ii) Common cathode type.

26. What is a Voltage indicator? (R, CO2)

A voltage indicator uses a high impedance voltage detection circuit per phase, to sense and illuminate AC/DC voltages. The amount of the current that flows through the voltage detection circuit depends upon the phase and ground voltages, which allows the multiple current paths passing through at least four LEDs.

27. List out the advantages of installing VI. (R, CO2)

(i) It has high impedance.
(ii) The potted construction adds additional electrical strength to VI.
(iii) The lead wires will not vibrate loose causing a short circuit to ground.
(iv) An optional adaptor provides physical protection to the wires. Thus over current protection protects the VI and lead wires from shorting to ground or another bare conductor.

28. Calculate the band – gap energy of Ga As p semiconductor whose output wavelength is 675 Å. (App, CO2)

Given : $\lambda = 675$ Å $= 675 \times 10^{-10}$ m.

Eg =? $h = 6.626 \times 10^{-34}$ J sec, $C = 3 \times 10^{8}$ m/s

$$Eg = \frac{hc}{\lambda} \quad Eg = \frac{6.626 \times 10^{-34} \times 3 \times 10^{8}}{6.751 \times 10^{-10}}$$

$Eg = 2.944 \times 10^{-19}$ J

$$= \frac{2.944 \times 10^{-19}}{1.6 \times 10^{-19}} = 1.8 eV.$$

29. V_{oc}, I_{sc} and fill factor of a solar cell are 600mV, 160 mA and 81.4 % . Find out the the power generated by the solar cell and if incident solar power is 840W,find its conversion efficiency, the area of the solar cell is one unit. (App, CO2)

Given : V_{oc} = 600 mV, I_{sc} = 160mA, fill factor = 81.4 % area = 1 unit, Efficiency = ?,Pin = 840W.

Output power = $V_{oc} \times I_{sc} \times FF$

$$= 600 \times 10^{-3} \times 160 \times 10^{-3} \times \frac{81.4}{100}$$

Power = 78.14 mW

$$\text{Efficiency} = \frac{\text{Power (output)}}{\text{Power incident}} \times 100$$

$$= \frac{78.14 \times 10^{-3}}{840} \times 100$$

Efficiency (η) = 9.3 %

30. The band gap of si 1.12eV and that of GaAs is 1.424eV.what are the cut of wavelength for these materials so that they can be utilized for fabrication of a solar cell?(App,CO2)

Given : Eg = 1.12eV, Eg = 1.424eV, λ_c = ?
(si) (GaAs)

$$\lambda_c = \frac{hc}{Eg} = \frac{6.626 \times 10^{-34} \times 3 \times 10^{8}}{Eg \times 1.6 \times 10^{-19}} = \frac{1.24}{Eg} \mu m$$

$$\lambda_c(si) = \frac{1.24}{1.12} = 1.10 \mu m$$

$$\lambda_c(GaAs) = \frac{1.24}{1.424} = \mathbf{0.87 \mu m}$$

UNIT- III : ADVANCED MATERIALS AND NANOTECHNOLOGY

1. **What are metallic glasses? [R, CO 3] (AU Che 2008, AU Che 2014)**

Metallic glasses are non-crystalline or amorphous in nature. The properties of the metallic glasses are the combination of both metals and alloys. However, the structure of the metallic glasses is non-crystalline / amorphous which is quite unusual and distinct from crystalline structure of metals and alloys. Metallic glasses are newly developed engineering materials with high strength, good magnetic properties and better corrosion resistance. These are metal alloys of no long range atomic order.

2. **What are the advantages of using metallic glasses as transformer core materials? / Why metallic glasses are preferred as transformer core material in power lines? [AP, CO 3] (AU Cbe 2009, KSRCE 2014)**

Metallic glasses are ferromagnetic. They posses low magnetic losses, high permeability and saturation magnetization with low coactivity. They also have extreme mechanical hardness, excellent initial permeability and zero magnetization. These properties make them useful as transformer core materials. Moreover power transformers made of magnetic glass are smaller in size and efficient in their performance.

3. **What are the applications of metallic glasses? [R, CO 3]**

The following are the applications of metallic glasses:

- Core materials in power distribution transformers
- Magnetic shielding materials, magnetic sensors, recording heads
- Switching mode transformers and high frequency supplies
- Active material in rewritable compact disc.
- Useful as reinforcing elements in concrete, plastic or rubber.
- Used to make razor blades

4. **Classiify the types of metallic glasses? Give examples. [U, CO 3]**

Metallic glasses are of two types

(i) Metal – metal glasses

Examples: Ni-Nb and Cu-Zr

(ii) Metal-Metalloid glasses

Examples: $Fe_{67}CO_{18}B_{14}Si_1$ and $Fe_{40}Ni_{38}M0_4B_{18}$

5. **Mention some properties of metallic glasses. [R, CO 3]**

- They are ductile, malleable, brittle and opaque.
- The strength and toughness is very high
- The electrical resistivity is high and also has high corrosion resistance.

6. **State the structural properties of metallic glasses. [R, CO 3]**

- They do not have any crystal defects such as grain boundaries dislocation etc.
- Metallic glasses have tetrahedral close packing (TCP) in contrast to hexagonal packing (HCP) of the crystalline solid.

7. **What are the mechanical properties of metallic glasses?[R, CO 3]**

- Extremely high strength due to the absence of point defects, dislocation and slip plane.
- They have high elasticity and ductility.
- Metallic glasses have both soft magnetic and hard magnetic properties.
- They exhibit high saturation magnetization.
- The core losses of metallic glasses are very less.

8. **What are the electrical properties of metallic glasses? [R, CO 3]**

- Electrical resistivity of metallic glasses is high and it does not vary much with temperature.
- Due to high resistivity, the eddy current loss is very small.

9. **Explain why metallic glasses are used for manufacturing precision measurement instrument. [AP, CO 3]**

Metallic glasses are used for designing of tools in precision instruments due to the zero thermal expansion coefficient and temperature coefficient of Young's modulus.

10. **What are the chemical properties of metallic glasses? [R, CO 3]**

- They are highly resistant to corrosion due to the formation of protective oxide film in chromium containing glasses.
- They are highly reactive and stable.

11. **Name any two examples of metallic glasses. [R, CO 3]**

- Copper – Zirconium alloy ($Cu_{66}Zr_{33}$)
- Iron – Boron alloy ($Fe_{80}B_{20}$)
- Platinum – Phosphorous ($Pt_{75}P_{25}$)
- Zirconium – Palladium alloy ($Zr_{70}Pd_{30}$)

12. **Give two applications of metallic glasses. [R, CO 3]**

- They used in cores of high power transformers.
- They are used to make different kinds of springs
- They are used to make computer memories, magneto-resistance sensors etc.
- They are used in nuclear reactors.

13. **What is glass transition temperature?[R, CO 3]**

The temperature at which, the liquid like atomic arrangement can be frozen into solid is called the glass transition temperature.

14. **What is meant by quenching?[R, CO 3] AU Che 2014**

Quenching is a technique used to form metallic glasses, quenching means rapid cooling.

15. **What are shape memory alloys?/How SMA are trained?[R, CO 3], AU Che 2014.**

The group of metallic alloys that demonstrate the ability to return to their original shape or size when subjected to the appropriate thermal procedure (heating/cooling) is known as shape memory alloys (SMAs). At the lower temperature, they have rubber (plastic) feel and can be deformed by the applications of a small force, while at high temperature they become like a metal and hence, any induced strain is not recoverable.

16. **Define shape memory effect. [R, CO 3] (AU Cbe 2011, AU Che 2013)**

At lower temperature the SMA will in martensite structure and when it is heated it will change to austenite structure and while cooling it will regain its martensite form. This is called shape memory effect.

17. **Categorize the types of shape memory alloys? [U, CO 3]**

Shape memory alloys are of two types:

One way shape memory alloys

Two way shape memory alloys

18. **What are the crystal structures or phases exhibited by SMA's? [R, CO 3]**

- ❖ Austenite phase which exhibited at high temperatures
- ❖ Martensite phase which is exhibited at lower temperatures

19. **What are Shape memory alloys and give some examples. [R, CO 3]**

The groups of metallic alloys that demonstrate the ability to return to their original shape or size when subjected to heating or cooling are known as shape memory alloys.

(Ex): Ag-Cd, Ni-Al, Ni-Ti etc.,

20. **What are the properties Shape memory alloys?[R, CO 3]**

- ❖ The shape memory effect existing in SMA is due to the change in crystalline Structure by the temperature and stress.
- ❖ The phase transformation by heating and cooling exhibits the hysteresis
- ❖ They have excellent corrosion resistance, susceptibility and higher ductility
- ❖ They have ability to return to its original shape upon unloading after a substantial deformation i.e., super- elasticity.

21. **Why Ni - Ti alloy is exceedingly difficult to make?[E, CO 3]**

- ❖ Melting temperature is high.
- ❖ Machine, milling, welding and soldering is very difficult.

22. **Define Superelasticity or Pseudoelsaticity.[R, CO 3]**

The ability of the SMA to return to its original shape upon unloading after a substantial deformation is known as Superelasticity or Pseudoelsaticity.

23. **Summarize the merits of SMA's. [U, CO 3]**

- ❖ They have a good bio - compatibility.
- ❖ They find diversified applications.
- ❖ They are flexible and non - corrosive.
- ❖ They have simple, compact and safety mechanisms.

24. **What are the demerits of SMA's? [R, CO 3]**

- ❖ They have low fatigue strength.
- ❖ Low energy efficiency.
- ❖ Limited bandwidth due to heating and cooling restrictions.
- ❖ They are expensive and difficult to machine, compared to other materials such as Steel and Aluminum.

25. **Compare the two phases which occur in shape memory alloy. [AN, CO 3] (AU Che 2013)**

Martensite is an interstitial super solution of carbon in α-iron and it crystallizes into twinned structure. The SMA will have this at lower temperatures and it is soft in this phase.

Austenite is te solid solution of carbon and other alloying elements in γ-iron and it crystallizes into cubic structure. The SMA will attain this structure at higher temperature and it is hard in this phase.

26. **Name some applications of shape memory alloys.[R, CO 3]**
    - They are used in eye glass frames, toys, etc.
    - They are used in fire safety valves, coffee maker, etc.
    - They are used in relays and activators.
    - They are used as artificial hip-joints, bone-plates, etc.
27. .**What is transformation temperature? [R, CO 3]**

    In shape memory alloy, the shape recovery process occurs not at a single temperature rather it occurs over a range of temperatures. This range of temperature at which SMA switches from new shape to its original shape is called transformation temperature or memory transfer temperature.
28. **What are nanoparticles? (or) what are nanophase materials?[R, CO 3] (AU Che 2014)**

    Nanoparticles are simply particles that have three dimensional nanoscales, i.e., the particle is between 1 and 100 nm in each spatial dimension. A nanometer is a unit of measure equal to one-billionth of a meter, or three to five atoms across.
29. **Define the term nanotechnology. [R, CO 3]**

    Nanotechnology is the design, fabrication and use of nanostructure systems and the growing, shaping or assembling of such systems either mechanically, chemically or biologically to form nanoscale architectures, systems and devices.
30. **What is the importance of nanomaterials and criticize its role in science and technology? [E, CO 3]**

    Nanoscale science and engineering seek to discover, describe, and manipulate unique properties of matter at the nanoscale in order to develop new capabilities with potential applications across all fields of science, engineering, technology, and medicine. Nanostructured materials are in wide use in information technology, integrated into complex products such as the hard disk drives that store information and the silicon integrated circuit chips that process information in every Internet server and personal computer and nanostructured cemented carbide coatings are used on some Navy ships for their increased durability.
31. **Compare top-down and bottom – up processes briefly./Give any methods of templating the growth of nano particles. [U, CO 3] (AU Che 2009, KSRCE 2014)**

    <u>Top-down process</u> In top down processes, the building of nanostructures starting with small components like atoms and molecules that are removed from a bulk material so as to obtain N desired microstructure.

    Examples: Nanolithography, ball milling etc.....

    <u>Bottom – up process</u>

    This processes building larger objects from smaller building blocks. Nanotechnology seeks to use atoms and molecules as those building blocks. This is opposite of the top-down approach. Instead of taking material away to make structures, bottom-up approach selectively adds atoms to create structures

    Examples: Pulsed laser deposition, chemical vapour deposition.
32. **How the nanosized powder is obtained by sol-gel technique? [AP, CO 3]**

    Sol-gel is a useful self assembly process for nanomaterials formation. Solid particles in a liquid in a liquid or a colloid that is suspended in a liquid is called a sol. It is a subclass of colloids. Gels are nothing but a continuous network of particles with pores filled with liquid or polymer containing liquid. A sol-gel process involves formation of sols in a liquid and then connecting the sol particles to form a network. By drying the liquid, it is possible to obtain powder, thin films or even monolithic solid.
33. **Mention some of the applications of nanomaterials. [R, CO 3]**
    - Nanomaterials are used in electronics, magnetic and opto-electronics, bio-medical,cosmetics, energy and materials applications
    - It is used in quantum computing and display technologies
    - Nano tubes based biosensors are used for cancer diagnostics
    - It is used for the preparation of quantum dot devices, carbon nano tubes, photoelectrochemical cells, etc....

34. State the different forms of nanomaterials. [U, CO 3]

Nanorods, nanodots, carbon nanotubes and fullerences.

35. What are arm chair, Zig-Zag and chiral structure of nano tubes? [R, CO 3] (AU Cbe 2009, AU Cbe 2011, AU Cbe 2014)

When the axis of the nano tube parallel to the C-C bonds of the carbon hexagons,a structure is obtained and it is referred to as the "armchair" structure.

The Zigzag and the chiral structure are formed by rolling such that axis of the tube is not parallel to C-C bonds.

Zigzag structure consists of tube axis perpendicular to C-C bonds. In chiral structure,C-C bond is inclined to tube axis.

36. Define carbon nanotubes. [R, CO 3] (AU Cbe 2011, AU Che 2013, KSRCE 2014)

Carbon nanotubes can be considered as cylinders made of graphite sheet mostly closed at the ends, with carbon atoms spread at the apexes of the hexagons, just like on a graphite sheet.

37. Give some properties of carbon nanotubes .[R, CO 3] (AU Che 2013)

There are many useful and unique properties of CNTs. The short list includes:

- High electrical conductivity
- Very high tensile strength and elasticity
- Highly flexible, It can be bent considerably without damage
- High thermal conductivity
- Low thermal expansion coefficient
- Good field emission of electrons
- High aspect ratio

38. Give the application of sol- gel technique/What is the purpose of sol-gel technique. [R, CO 3] (AU Cbe 2010)

- This method is used to produce the lightest materials
- Optical coating, protective and decorative coatings can be done by this method
- Sol-gel chemical routed ceramic fibers are used for fiber optic sensors and thermal insulation
- Silica solution is formed by this method
- The ultra fine particles prepared by these techniques are used for dental and bio medical applications.

39. Why nanomaterials exhibit different physical and mechanical properties?[U, CO 3]

In nanomaterial's, the grain size is in the range of 1 to 100 nm. Hence as the grain size decreases, there is a significant increase in the volume fraction at grain boundaries or interfaces. Thus this characteristic strongly alters he physical and mechanical properties.

40. Name any two methods to produce (or) synthesis nanomaterials.[R, CO 3] (AU Cbe 2011)

- Sol-gel technique
- Chemical Vapour deposition

41. Examine the properties of materials that change at nanoscale stating few examples?/Give any four property changes that can be observed when a bulk material is synthesized as nanomaterials. [AN, CO 3] (AU Cbe 2010, AU Che 2014)

- The nanomaterials have high strength, hardness, mobility and toughness
- Nano size particles absorb light and emit an appropriate color. This is a size dependent property
- Nano particle size below 100nm have lower melting point compare with bulk form
- Electrical resitivity of nano sized materials is generally higher than the polycrystalline materials.

42. Give the different types of structures of carbon nanotubes. [R, CO 3]

- Zig –Zag carbon nanotubes
- Arm chair carbon nanotubes
- Helical carbon nanotubes

43. What are the applications of carbon nanotubes? [R, CO 3]

- It is used to develop the flat panel display, Television and computer monitors
- It is used for the interconnections in the molecular electronics
- It is used as the Hydrogen storage materials
- It enhances the reaction rate between the chemicals

44. Write the various forms of carbon nanotubes? [R, CO 3]

- Single wall nano tubes
- Multi wall nano tubes
- Single walled nano-horns.

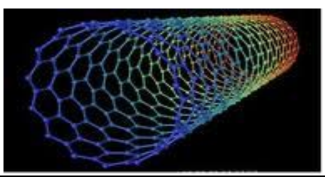
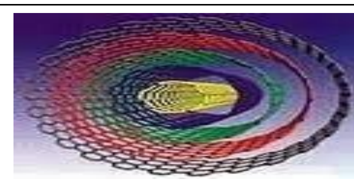
45. Give the importance of mechanical properties of nanophase materials [U, CO 3]

- Grain size decreases strength of the material increases.
- Melting point reduced when the grain size is reduced
- The temperature of super elasticity is found to decrease in grain size
- It is used as probe tips for very high resolution scanning probe microscope
- They are very stiffer and resistant to damage from physical force

46. What is meant by field emission? [R, CO 3]

When a small electric field is applied parallel to the axis of a nano tube, electrons are emitted at a very high rate from the ends of the tube. This is called field emission.

47. Differentiate single wall and multi wall carbon nanotubes. [AN, CO 3]

S.No	Single wall	Multi wall
1.		
2.	It consists of one tube of graphite	It consists of several number of concentric graphite tubes
3.	They have diameter range from 1 to 2 nm	They have outer diameter range from 2 to 25 nm
4.	Conductivity is high	Conductivity is less than SWCNT

48. What are the methods used to fabricate carbon nanotubes? [R, CO 3]

- Pulsed laser deposition
- Chemical vapour deposition

49. List out the important steps involved in chemical vapour deposition? [AN, CO 3]

- Vaporization and transport of precursor molecules into reactor.
- Diffusion of precursor molecules to the surface of particle.
- Adsorption of precursor molecules to the surface of particle.
- Decomposition of precursor molecules on the surface and incorporation into solid films.

50. What are the applications of chemical vapour deposition technique? [R, CO 3]

- It is used to produce nanomaterials like metals and alloys, carbides, nitrides, oxides etc.
- It is used to produce the semiconductor devices like integrated circuits, sensors, opto electronic devices etc.
- It is used in optical fibers which are used for telecommunications.
- It is used in the production of novel powders and fibers, catalysts, nano machines etc.

51. Write any two properties of nanomaterials. [R, CO 3] (AU Cbe 2009, AU Cbe 2010)

- Interparticle spacing is very less.
- Energy bands will be very narrow.
- Ionization potential is found to be high.
- Large number of atoms will be present on the surface and hence possess local magnetic moment within themselves.
- Due to large magnetic moment, nano-materials exhibits spontaneous magnetization at smaller sizes.

52. **What is fullerene? [R, CO 3] (AU Che 2012)**

Fullerene is a form of carbon having a large spheroidal molecule consisting of a hollow cage of sixty or more number of carbon atoms. They are produced by the action of an electric discharge between carbon electrodes in an inert atmosphere.

53. **What is the principle of sol-gel method ? [R, CO 3]**

The Principle of sol-gel method is hydrolysis of liquid precursors and formation of colloidal solutions (salts)

54. **What is meant by plasma arching? [R, CO 3]**

Plasma arching is the method used to produce nano particle. When a metal is heated to a very high temperature it forms plasma. When helium gas is passes the metal vapour nucleates on the helium gas to form nano particles on a colder collector rod.

55. **What is meant by metallic nano clusters? [R, CO 3]**

The clusters formed by alkali metals, alkaline earth metals and transition metals are called metallic nano clusters. Ex: $C_{60}(NaCl)_n$

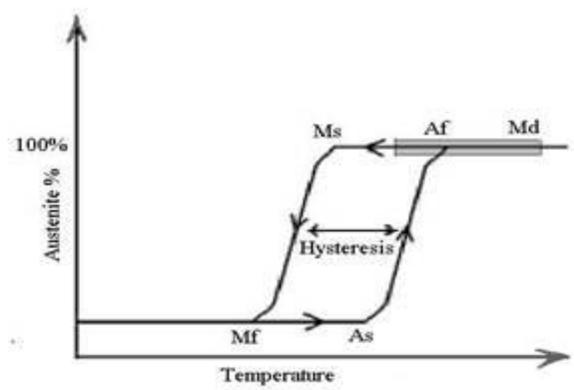
56. **What is blue shift? Why it occurs for nanoparticles? [AP, CO 3]) (KSRCE 2014)**

Blue shift represents the transition of the optical absorption spectrum to the high-frequency range of the light radiation. This effect in nano particles are due to the fact that, size reduction of a semiconductor crystal is accompanied with band gap widening. Ex: Blue shift observed in $CuCl_2$ nanoparticles.

57. **Distinguish ordinary metal and metallic glass. [AN, CO 3] (AU Che 2012)**

S.No	Ordinary Metal	Metallic Glass
1.	They are made up of silica.	They are made of alloy metals.
2.	They are transparent.	They are opaque.
3.	Covalent bond is observed.	Metallic bond is observed.
4.	They assemble on a crystalline lattice.	They do not assemble on a crystalline lattice, also known as amorphous metals.

58. **Draw the typical transformation hysteresis curve in SMA representing Mf, Ms, As and Af. [U, CO 3]**



59. **Justify the property of high hardness in carbon nanotubes. [E, CO 3]**

The high hardness in CNT is due to the strength of sp^2 carbon- carbon bonds. Standard single-walled carbon nanotubes can withstand a pressure up to 25 GPa without deformation.

60. **Develop the strategy that how the nanomaterials can be made eco-friendly. [C, CO 3]**

Nanomaterials will be as highly selective and efficient catalysts for chemical and energy conversion processes. This will be important economically not only for energy and chemical production but also for conservation and environmental applications. Thus, nanomaterials may play an important role in photoconversion devices, fuel cell devices, bioconversion (energy) and bioprocessing (food and agriculture) systems, and waste and pollution control systems and also in therapeutic, diagnostic devices, and biocompatible materials for implants and prostheses.

UNIT- IV : LASER TECHNOLOGY

1. **Define LASER.[R, CO4]**
   Lasers are the coherent light sources having high intensity, high monochromaticity, high coherence and high directionality. Laser is acronym for Light Amplification by Stimulated Emission of Radiation.
2. **What is spontaneous emission?[R, CO4]**
   Emission of light photons takes place immediately without any inducement during the transition of atoms from higher energy levels to lower energy levels is called spontaneous emission.
3. **What is stimulated emission?[R, CO4, AU2013]**
   Emission of a light photon takes place through an inducement given by a photon having energy equal to the emitted photon's energy is called stimulated emission.
4. **Define pumping action. How many pumping methods are available?[R, CO4]**
   Pumping is the mechanism of exciting atoms from the lower energy state to a higher energy state by supplying energy from an external source. The most commonly used pumping mechanisms are 1. Optical pumping 2. Electrical pumping 3.Direct conversion.
5. **What are the difference between ordinary light and laser?[An, CO4]**
   Ordinary light differs from laser light since ordinary light is less intense, polychromatic and incoherent. But laser light is more intense, monochromatic and coherent.
6. **Define population inversion and why is population inversion necessary for LASER action?[R, U, CO4, Dec 2012]**
   Normally the population of atoms is more in the lower energy level than in the higher energy level. But in the case of lasers, the number of atoms in the higher energy levels at which the laser transition starts is more than the number atoms in the lower energy level at which the laser transition ends. This condition in the active medium of the laser source is called population inversion.
7. **What is meant by optical resonator?[R, CO4]**
   It is a pair of reflecting surfaces (mirrors) of which one is being a perfect reflector and other being a partial reflector. It is used for amplification of photons thereby producing an intense and highly coherent output.
8. **What are the uses of N_2 and He in CO_2 laser?[U, CO4]**
   Nitrogen helps to increases the population of the upper level of CO_2**,** while helium helps to depopulate the lower level.
9. **Write the difference between photography and holography?[An, CO4]**

S.No	Photography	Holography
1.	Ordinary light is used	Laser is used
2.	Amplitude recording	Both amplitude and phase recording
3.	Two dimension recording	Three dimensional recording
4.	Lens (camera) is used	Generally no lens is used
5.	Ordinary film	Very high resolution film
6.	No need for vibration isolation table	Vibration isolation table is required
7.	When cut into pieces, information is lost	when cut into pieces, each bit carries full information

10. **State the properties of laser beam.[R, CO4]**
    Laser beam has high intensity, high monochromocity, high coherence and high directionality.
11. **Explain metastable state.[U, CO4]**
    The metastable states are the energy levels in an atomic system where the life time of atoms is very large. This property helps in achieving the population inversion.
12. **Define holography and hologram.[R, CO4]** Holography is a technique of recording the amplitude and phase of the light waves reflected from an object. Hence, a three dimensional image of the object can be obtained. The recorded photograph is called a hologram.
13. **Write the principle of semiconductor laser.[R, CO4]**

When a forward bias is applied to the laser diode, the holes are released from the p- region and electrons are released from the n-region of the diode. After some time, the recombination of holes and electrons takes place and results in the recombination radiation. If the junction current is large enough, stimulated emission takes place followed by population inversion. This will finally leads to high power laser output.

14. What is semiconductor Laser? [R, CO4]

The semiconductor laser is very small in size and appearance. It is similar to a transistor and has the operation like LED but the output beam has the characteristics of laser light. The material which often used in the semiconductor laser is the Gallium Arsenide, therefore semiconductor laser is sometimes known as Gallium Arsenide Laser. It is also called injection laser.

15. What are the applications of CO_2 laser?[R, CO4]

CO_2 laser is widely used in material processing such as drilling, cutting, etching, welding, melting, annealing, also in pollution monitoring, remote sensing, open air communication, in LIDAR (Light Detection and Ranging), in medical field to perform microsurgery and bloodless surgery.

16. What are the basic requirements for the laser systems?[R, CO4]

i. Active medium
ii. Pumping system
iii. Optical resonator

17. What are the conditions required for laser action?[U, CO4]

i. Emission of light radiation should be stimulated emission.
ii. The higher energy state should have a longer mean lifetime that is it should be a metastable.
iii. The number of atoms in the higher energy state E2 must be greater than that in E1.

18. Give the applications of laser in medical field.[R, CO4, AU2013]

i. It is used for cancer operation and treatment of brain tumors.
ii. It is used to carry out, micro surgery, neurosurgery and cosmetic plastic surgery.
iii. It is used to drill minute holes inside the cell walls of human body without destroying.
iv. It is used for the treatment of detached retina.

19. Define the terms active medium and active material.[R, CO4]

The medium in which the population inversion takes place is known as active medium.
The material which is used to achieve population inversion is known as active material.

20. Mention the applications of lasers in industries.[R, CO4]

i. It is used for welding, drilling, cutting, etc.
ii. It is used to produce small holes in diamonds and hard steels.
iii. It is used to test the quality of the materials.
iv. Various isotopes of elements can be separated.

21. What are the different types of lasers available?[U, CO4]

i. Solid state laser (Ruby laser, Nd-YAG laser)
ii. Gas laser (CO2 laser, He-Ne laser)
iii. Semiconductor laser (Ga As laser)
iv. Liquid laser (Europium chilate laser)
v. Dye laser (Coumarin dye laser)

22. What are the applications of Nd-YAG laser?[R, CO4]

i. It is used in long distance communication.
ii. They also find applications in resistor trimming, scribing, micro machining operations as well as drilling, welding etc.
iii. The find applications in medical field like endoscopy, neurosurgery, dental surgery and general surgery.
iv. It is used in radio sensing applications.

23. State the applications of laser in scientific and engineering field.[R, CO4]

i. It can be modulated to transmit thousands of programs at a time on radio and television.
ii. Using laser we can get three dimensional lenses less photography.

iii. Computer printouts done with laser printers.
iv. They are used in computer storage devices and to design integrated circuits.

24. Give the applications of Holography.[U, CO4]

ii. Holograms are used in the preparation of photographic masks
iii. In nondestructive testing, holograms are used extensively.
iv. During the identification of figure, holograms are used.
v. They are also used in optical signal process, data storage etc.

25. How the light emitting diode differs from a laser diode?[An, CO4]

S.No	LED	LASER DIODE
1.	Small current is enough	It requires high current
2.	Emission of light is due to spontaneous emission	Emission of light is due to stimulated emission
3.	No optical resonator on LED	Highly polished junction of the diode is used as an optical resonator
4.	Power output and intensity of LED are low	Power output and intensity of laser diode are high

26. What are Coherent sources?[R, CO4]

Coherent sources are the sources of light radiation which have same wavelength and frequency. There is no difference in amplitude and phase of the emitted photons.

27. Explain the importance of holographic storage.[U, CO4]

i. Each point of an object is recorded on the whole hologram.
ii. LASER is used for recording and reconstructing process.
iii. From each point of a hologram we can construct the image.
iv. The phase and amplitude information in the reflected waves from the object are Completely recorded in the hologram.

28. Distinguish between homojunction and heterojunction.[An, CO4]

S. No	Homojunction	Heterojunction
1	The p-n junction is made by the same semiconductor	The p-n junction is made by the different semiconductor
2	It has only one junction	It has one or two heterojunction
3	The output power is low	The output power is high
4	e.g., Ga As, In P	e.g., Ga Al As, I Al P

29. What are difference Ruby and Nd-YAG Laser?[An, CO4]

S. No	Ruby Laser	Nd-YAG Laser
1	It is a three level laser	It is a four level laser
2	Elliptical cavity resonator is not used	Elliptical cavity resonator is used
3	Power output is 10^4 to 10^5 Watts	Power output is 2x 10^4 Watts
4	Wavelength of output is 6943Å	Wavelength of output is 1.064μm

30. Distinguish between spontaneous and simulated emissions of radiation.[An, CO4,Jun 2012]

S. No	Spontaneous Emission	Stimulated Emission
1	The emission of light photons takes place without any external influence.	The emission of light photons takes place with external influence.
2	Emitted photons are in random direction	Emitted photons are in single direction
3	Polychromatic	Monochromatic
4	Low intensity	High intensity

31. What are Einstein's relations or Einstein's coefficient?[App, CO4]

In Einstein's theory of spontaneous emission and stimulated emission, we have

$$B_{21} = B_{12}$$

$$\frac{A_{21}}{B_{21}} = \frac{8\pi h\gamma^3}{c^3}$$

32. Calculate the wavelength of emission from Ga As whose band gap is 1.44eV.[Ap, CO4]

Given:

Energy gap E_g = 1.44eV = 1.44x 1.6x 10^{-19}J

Wavelength $\lambda = \frac{hc}{E_g}$

$= \frac{6.626\times10^{-34}\times3\times10^{8}}{1.44\times1.6\times10^{-19}}$ = **8626Å**

33. An atom is stimulated from the ground state energy of 1x 10^{-34}J to an excited level of 7.62x10^{-34}J.What is the frequency of the stimulating photon. [App, CO4]

Given:

E_1 = 1x 10^{-34}J

E_2 = 7.62x 10^{-34}J

$\nu = \frac{E_2 - E_1}{h}$

$= \frac{7.62\times10^{-34} - 1.0\times10^{-34}}{6.62\times10^{-34}}$ = **1Hertz**

34. Calculate the number of photons from green light of mercury (λ= 4961 Å) requires to do 1J of work. [App, CO4]

Energy E =h $\nu = \frac{hc}{\lambda}$

$= \frac{6.626\times10^{-34}\times3\times10^{8}}{4961\times10^{-10}}$

$= 4.0063\times 10^{-19}$J

No of photons (n) = $\frac{1}{E}$ Joules

$=\frac{1}{4961\times10^{-19}}$ = $2.496\times\mathbf{10^{18}}$

UNIT- V : SENSOR TECHNOLOGY

1. Define: Sensor.[R, CO5]

A device that responds to a physical stimulus and transmits the resulting impulse. It is a device like photoelectric cell ,that receives and responds to a signal or stimulus. The sensor output will be in the form of electrical or optical signal.

2. Mention the types of sensors. [U, CO5]

Based on physical, chemical and biological laws it is classified into three types namely

- Active and Passive sensors
- Contact and non-contact sensors
- Absolute and relative sensors

3. What are Active and passive sensors? Give some examples. [R, CO5]

Active sensor: a sensor that requires external power to operate. Examples: the carbon microphone, thermistors, strain gauges, capacitive and inductive sensors, etc. Other name: parametric sensors
Passive sensor: generates its own electric signal and does not require a power source Examples: thermocouples, magnetic microphones, piezoelectric sensors .Other name: self-generating sensors.

4. What do you mean by Contact and non- contact sensors? [U, CO5]

Contact sensor: a sensor that requires physical contact with the stimulus. Examples: strain gauges, most temperature sensors
Non-contact sensor: requires no physical contact. Examples: most optical and magnetic sensors, infrared thermometers, etc.

5. Define : Absolute sensor and Relative sensor and give some example[R, CO5]

Absolute sensor: a sensor that reacts to a stimulus on an absolute scale. Examples: Thermistors, strain gauges, etc., Relative sensor: the stimulus is sensed relative to a fixed or variable reference. Examples: Thermocouple measures the temperature difference, pressure is often measured relative to atmospheric pressure.

6. **Define the term sensitivity in sensors. [R, CO5]**
   Sensitivity is an absolute quantity, the smallest absolute amount of change that can be detected by a measurement.
7. **What do you mean by the term Accuracy in sensors. [U, CO5]**
   Accuracy is the the amount of uncertainty in a measurement with respect to an absolute standard.Accuracy specifications usually contain the effect of errors due to gain and offset parameters. Offset errors can begiven as a unit of measurement such as volts or ohms and are independent of the magnitude of the input signal being measured
8. **Define the term Resolution in sensors. [R, CO5]**
   It is the ratio between the maximum signal measured to the smallest part that can be resolved – usually with an analog-todigital (A/D) converter.It is the degree to which a change can be theoretically detected, usually expressed as a number of bits. This relates the number of bits of resolution to the actual voltage measurements.
9. **What do you mean by inductive sensor? [R, CO5]**
   Inductive sensor translate movement into change in the inductance between magnetically coupled parts.The inductance principle is also used in differential transformers to measure translational and rotational displacements. Example : Inductive displacement transducer , LVDT.
10. **What do you mean by resistive sensor? [R, CO5]**
    A resistive sensor is a transducer or electromechanical device that converts the mechanical change such as displacement into an electrical signal that can be monitored. Resistive sensors are among the most common in instrumentation.
11. **What is magnetic sensor? [R, CO5]**
    Magnetic sensors are the sensors which uses the changes in magnetic field for their operations.Signal processing is required for signal output. As the conventional sensors, magnetic sensors do not give parameters directly. It is used to measure current, speed, position and displacement.
12. **Mention the types of magnetic sensors. [R, CO5]**
    On the basis of sensing the variation of magnetic fields, magnetic sensors are of three types,
    - Low field sensor
    - Earth field sensor
    - BIAS magnetic field sensor.
13. **State the purpose of using potentiometer in displacement sensor? [An, CO5]**
    A potentiometer can be used to convert rotary or linear displacement to a voltage.
14. **What do you mean by strain gauge? [R, CO5]**
    Strain is a normalized measure of deformation representing the displacement between particles in the body relative to a reference length.A strain gauge is a device used to measure the strain of an object. It consists of a length of metal resistance wire formed in zigzag pattern. As the object is deformed the foil is deformed causing its electrical resistance to change.
15. **List out the types of strain gauge? [U, CO5]**
    - Unbounded strain gauge
    - Bonded strain gauge
    - Fine wire strain gauge.
16. **Mention the types of electrical strain gauges? [R, CO5]**
    - Inductive
    - Capacitive
    - Piezo electric
    - Resistance types

17. Name few materials used in binding of strain gauge? [U, CO5]

- Ceramic cement
- Epoxy
- Nitrocellulose

18. What are the types of bimetallic sensors? [R, CO5]

- Spiral type
- Helix type
- Flat type
- Cantilever type

19. What are Analogue sensors? [R, CO5]

Analogue Sensors produce a continuous output signal or voltage which is generally proportional to the quantity being measured. Physical quantities such as Temperature, Speed, Pressure, Displacement, Strain etc are all analogue quantities as they tend to be continuous in nature. For example, the temperature of a liquid can be measured using a thermometer or thermocouple which continuously responds to temperature changes as the liquid is heated up or cooled down.

20. What are Digital Sensors? [R, CO5]

Digital Sensors produce a discrete digital output signals or voltages that are a digital representation of the quantity being measured. Digital sensors produce a Binary output signal in the form of a logic "1" or a logic "0", ("ON" or "OFF"). This means then that a digital signal only produces discrete (non-continuous) values which may be outputted as a single "bit", (serial transmission) or by combining the bits to produce a single "byte" output (parallel transmission).

21. What is thermocouple and in which type of sensor it is used ? [Ap, CO5]

A thermocouple is an electrical device consisting of two dissimilar electrical conductors forming electrical junctions at differing temperatures. A thermocouple produces a temperature-dependent voltage as a result of the thermoelectric effect, and this voltage can be interpreted to measure temperature. Thermocouples are a widely used type of temperature sensor.

22. What is a Temperature Sensor? [R, CO5]

A sensor which gives the measurement of temperature as an electrical signal is termed as Temperature sensor.This electrical signal will be in the form of electrical voltage and is proportional to the temperature measurement

23. Define a transducer. [R, CO5]

Transducer' is 'a device that transfers power from one system to another in the same or in the different form'.

24. Mention the types of transducer. [R, CO5]

The transducer can be classified on the basics of transduction form used,

- Primary and secondary transducer
- Passive and active transducer
- Analog and digital transducer
- Transducers and inverse transducer

25. What is a biosensor? [R, CO5]

It is an analytical device which incorporates a biologically active element with an appropriate physical transducer to generate a measurable signal proportional to the concentration of chemical species in any type of sample.

26. List out the Types of Biosensors. [U, CO5]

There are different types of Biosensors based on the sensor devices and the biological materials and some of them are

- Electrochemical Biosensor
- Amperometric Biosensor
- Potentiometric Biosensor

- Thermometric Biosensor
- Optical Biosensors
- Piezoelectric Biosensors
- Immuno–Biosensors

27. Outline the importance of Biosensors. [An, CO5]

The applications of different types of biosensors are

- Food analysis
- Study of Biomolecules and their interactions
- Drug development, crime detection
- Medical diagnosis

28. What do you mean by electronic nose in biosensor? [R, CO5]

E-nose: It is an intelligent device, able to mimic human olfactory function. It is broadly used for the detection, recognition and classification of volatile compounds and odours. E-nose consist of sensing element, signal collection unit and suitable pattern recognition algorithm. In agricultural applications, the e-nose has been implemented successfully for the fruit ripeness determination, detection of soil borne pathogens, inspection of fish etc.

29. What do you mean by electronic tongue in biosensor? [R, CO5]

The electronic tongue is an instrument that measures and compares tastes. The electronic tongue is an analytical instrument comprising an array of nonspecific, low-selective, chemical sensors with high stability and cross-sensitivity to different species in solution and an appropriate method of PARC and/or multivariate calibration for data processing. Electronic tongues use chemometric methods and artificial intelligence to achieve a similar goal, i.e., discriminate, identify or quantify the sample.

30. Mention few advantages of Biosensors. [R, CO5]

- It is a sophisticated tools for the detection and monitoring of phytopathogens.
- It gives specific and accurate readings.
- It is easy to handle.
- It can also measure non-polar molecules.
- There is no need of continuous monitoring.

31. List out the disadvantages of Biosensors. [U, CO5]

- Heat sterilization is not possible
- High cost
- Lack of reusability - Some types of biosensors such as colorimetric test strips has single use
- It only focus on the scientific basis of the technology

32. Compile the role of biosensor in food security? [C, CO5]

It is used for the,

- Detection of bacteria
- Detection of contaminant residues and pesticides
- Detection of heavy metals

PART- B: 16 MARK QUESTIONS

UNIT-I: QUANTUM PHYSICS

1. What is meant by blackbody radiation? Derive an expression for Planck's radiation law and Discuss the same for shorter and longer wavelengths.[R, App, CO1, Jun 2015]

2. What is Compton Effect? Give the theory of Compton Effect with experimental verification and show that the Compton shift purely depends on the angle of scattering.(R, App, CO1, Jun 2012, June 2013, AU Jan 14, AU Dec 2014, Jan 2015)

3. Derive time dependent Schrodinger wave equation and hence deduce the time independent Schrodinger wave equation. And solve Schrodinger wave equation for a particle in a one Dimensional box and obtain the energy Eigen values. (R, App, CO1, Dec 2005, 2012, AU Jan 2013, Jan 2014, Jun 2014, AU Dec 2014)
4. What is the principle of electron microscope? Write the construction and working of TEM with its applications. (R, CO1, Dec 2006, Jan 2014)
5. Derive an expression for energy distribution based on the concept of quantum theory of black body radiation and deduce Wien's displacement law and Rayleigh-Jeans law. (R, App, CO1, June 2005)
6. Explain the construction and working of SEM with neat diagram.(R, CO1, Dec 2012, AU June 2013, Jun 13, AU Jan 2014)
7. Explain briefly the development of quantum theory with applications. [U, CO1]
8. Derive the time independent Schrödinger wave equation for a particle. Hence obtain the expression for the Energy levels of a free particle in an one dimensional potential well. (R, App, CO1, Jun 2012, AU June 2013, Jan 2014, AU Dec 2014, Jan 2015, June 2015)
9. Solve the Schrodinger wave equation for an electron moving in cubical and rectangular boxes. (R, CO1)
10. Derive an expression for de Broglie wavelength. Hence deduce the same in terms of energy and voltage. (R, App, CO1)
11. What is a principle of electron microscope? Draw the construction of electron microscope and explain its working. Give its advantages, disadvantages and applications. (R, CO1)

UNIT- II : OPTOELECTONIC DEVICES

1. Explain with a neat sketch the construction, working and VI characteristics of a solar cell.[U, CO2]
2. Discuss in detail the working of Ga As solar cell with neat sketch. Also, mention few applications of solar cell. [An, CO2]
3. Briefly describe how a p n junction diode acts as a light emitting diode. [R, CO2]
4. Explain with a neat sketch the basic principle, working and the applications of LED. [U, CO2].
5. State the expression depicting V-I characteristics of a solar cell and obtain the expression for open- circuit voltage and maximum power output and hence obtain an expression for efficiency of a PN junction solar cell. [R, CO2]
6. (a)Explain seven segment display and its classification in detail with a neat diagram. [U, CO2]. (b)Give a brief description on voltage indicator and its applications. [R, CO2]

UNIT- III : ADVANCED MATERIALS AND NANOTECHNOLOGY

1. What are nano phase materials? Explain how the physical properties vary with geometry. [R, U, CO 3](AU Che 2003)
2. What are nano phase materials? Discuss how the mechanical and magnetic properties of
3. nanomaterials vary with particle size. [R, U, CO 3] (AU Che 2005)
4. Give the concept, properties and applications of metallic glasses.[R] (AU Cbe 2011, AU Che013)
5. What is meant by SMA? Explain its working. [R, U, CO 3] (AU Che 2006)
6. What are bioglasses? Explain their properties and applications. [R, CO 3]
7. Give the various characteristics and applications of shape memory alloys. [R, CO 5] (AU Che 2007, AU Che 2013)
8. What is meant by nano phase materials? List out the properties and applications of it. [R, CO 3] (KSRCE 2014)
9. How are metallic glasses prepared? Explain how the melt spinner device can be used to produce metallic glasses. [R, App, CO 3]
10. i) Write a short note on shape memory alloys and their applications. [R, CO 3] (AU Che 2013, AU Che 2014)ii) What are metallic glasses? How they are prepared? [R, App, CO 3] (AU Che 2014, KSRCE 2014)
11. Describe the electrodeposition technique with neat diagram. Explain the nucleation mechanism in this method with its advantages. [R, U, CO 3] (AU Che 2013, KSRCE 2014)

12. Describe the hydrolysis and condensation of metal alkoxides and solvent removal of sol gel method. [R, CO 3] (AU Che 13, KSRCE 2014)
13. What are nanomaterials? Describe their synthesis and properties based on pulsed laser deposition technique. [R, App, CO 3] (AU Cbe 2011, AU Che 2013, AU Che 2014, KSRCE 2014)
14. Define metallic glass. Explain how metallic glasses are prepared and how it is different from their crystalline counterparts. [R, AN, CO 3] (AU Cbe 2010)
15. What are SMAs? Explain their properties. [R, U, CO 3] (AU Cbe 2014, KSRCE 2014)
16. Write the advantages and disadvantages of SMA materials. [U, CO 3] (AU Che 2013, KSRCE 2014)

UNIT- IV : LASER TECHNOLOGY

1. With a neat diagram, explain the construction and working of CO_2 laser? and give its merits, demerits, applications.[E, CO4,Dec 2007, 05, 04, Apr 2006, AU 2013]
2. a. With a neat diagram, explain the construction and working of semiconductor laser? [E,U, CO4]
   b. Give the advantages, disadvantages and applications of semiconductor laser. [R, CO4]
3. Discuss the various methods to achieve population inversion. What are the essential parts of laser system? (OR) What are different pumping mechanism used in LASER's given example for each[An, CO4]
4. Discuss the Einstein's theory of stimulated absorption, spontaneous and stimulated emission of radiation. What are the conditions for light amplification?[An, CO4, June 2012]
5. What is meant by Holography? Describe the construction and reconstruction of a hologram. [R, CO4,Dec 2004, Jun 2012, Dec 2012]
6. Discuss the application of laser in various fields.[R, CO4,Dec 2007, 2012]
7. Give the application of laser in welding, heat treatment and cutting.[R, CO4]
8. With a neat diagram explain the principle construction and working of homojunction semiconductor laser and give its merits, demerits and applications.[E, CO4]
9. Explain the working and construction of Nd- YAG laser. Classify different types of lasers based on active medium, with sufficient examples and give its merits, demerits and applications.[U, CO4,Nov 2002, Dec 2012]
10. What is Electroluminescence? Explain the construction and working of a Ga As semiconductor laser and give its merits, demerits and applications.[R, CO4]

UNIT- V : SENSOR TECHNOLOGY

1. Explain the principle, construction and working of a liner voltage differential transformer (L.V.D.T). [E, CO5]
2. Describe the construction, theory and working of thermocouples. [R, CO5]
3. What are magnetic sensors? Explain the operation of strain gauge and arrive at the Gauss factor of it. [A, CO5]

*****ALL THE BEST*****

Reg. No. : | | | | | | | |

K.S.R. COLLEGE OF ENGINEERING, TIRUCHENGODE – 637 215

(AUTONOMOUS)

B. E. / B.Tech. DEGREE END SEMESTER EXAMINATION, APRIL / MAY - 2019

First / Second Semester

18PH043 – ENGINEERING PHYSICS

(Common to CSE, EEE, ECE & IT)

(Regulations 2018)

Time: Three hours

Maximum Marks: 100

Answer ALL Questions

PART A — (10 x 2 = 20 Marks)

1. State Wien's displacement law.

2. List out the physical significance of wave function (Ψ).

3. Give the important applications of solar cell.

4. Justify why LED's are not made up of Si.

5. Infer the term quenching.

6. Point out the different structures of CNT's.

7. Calculate the wavelength of emission from GaAs semiconductor laser whose band gap value is 1.44 eV.

8. Distinguish between photography and holography.

9. Mention the different types of sensors.

10. Outline the important applications of biosensors.

PART B — (5 x 16 = 80 Marks)

11. (a) Give the theory of Compton effect and deduce an expression for Compton shift. (16)

(OR)

(b) (i) Obtain the expression for Schrodinger time independent wave equation. (8)

(ii) Distinguish between SEM and TEM. (8)

12. (a) What is meant by LED? Explain the principle, working and applications of LED with a neat diagram. (16)

(OR)

(b) Discuss the types of LCD and list out the applications of LCD. (16)

13. (a) Give the concept, properties and applications of shape memory alloys. (16)

(OR)

(b) (i) Illustrate the synthesis of nano particles using vapour phase deposition method. (8)

(ii) Explain how carbon nano tubes are fabricated using the electric arc method. (8)

14. (a) Deliberate the vibrational modes of CO_2 molecule and explain the construction and working of CO_2 laser. (16)

(OR)

(b) (i) Describe the construction and reconstruction of hologram. (8)

(ii) Discuss the applications of laser in various fields. (8)

15. (a) Explain the principle, construction and working of a linear variable differential transformer. (16)

(OR)

(b) (i) Give a detailed account on working of strain gauge. (10)

(ii) Write a short notes on working of thermocouples. (6)

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