EASWARI ENGINEERING COLLEGE, RAMAPURAM, CHENNAI-89
DEPARTMENT OF PHYSICS
PHYSICS FOR CIVIL ENGINEERING (PH8201)

PART – A QUESTION & ANSWERS

UNIT I – THERMAL PERFOMANCE OF BUILDINGS

1. Define Fenestration. ***(AU Jan 2017)***

Fenestration is defined as any opening or arrangement of openings, in a building (normally fixed with glazing)

2. What are various fenestration systems?

There are various fenestration systems like glazing, windows, curtain walls, sloped glazing and exterior doors.

3. What are three main components of fenestration?

1. Glazing

It is the main part of fenestration that lets the light through and it is usually glass (occasionally plastic). A layer is called a glazer or a pane or a lite.

2. Framing

It is the material that holds the glazing in place and attaches it to the rest of the enclosure. It is usually made of wood, metal, plastic or fiberglass.

3. Shading devices and/or screens

A unit may or may not have shading. Either from other building components or shading devices that may or may not be an integral part of the overall assembly.

4. What is total heat transfer through fenestration?

The heat gain through fenestration consists of two main components:

$Q_{thermal}$ = heat transfer between indoor and outdoor air.

This is positive or negative depending on temperature.

Q_{solar}= heat transfer from solar radiation.

This is always a positive number.

The total heat transfer through fenestration

$Q_{total} = Q_{thermal} + Q_{solar}$

5. What is thermal insulation?

Thermal insulation is to resist the flow of heat to and from a body. It is a material that reduces the rate of heat flow.

It is the reduction of heat transfer (i.e the transfer of thermal energy between object of differing temperature) between objects in thermal contact or in range of radiative influence.

6. Mention few methods of thermal insulation.

- Use of materials with low conductivity
- Thickness of walls and roofs
- Provision of air spaces
- Heat insulation by orientation
- Thermal insulation by shading
- Providing sufficient height of ceiling
- Using thermal insulating materials

7. What are benefits of thermal insulation?

a. Due to thermal insulation, the room remains cooler in summer and warmer in winter than outside. Hence a room provided with thermal insulation gives comfort both in summer and winter.

b. Energy saving: Due to thermal insulation transfer of heat between inside and outside of the room is restricted. This result in less quantity of energy required for maintaining the desired temperature in the room.

8. What is thermal performance of buildings?

It refers to the process of modelling the energy transfer between building and its surroundings.

9. What is thermal comfort?

It is the condition of mind that expresses satisfaction with the thermal environment and is assessed by subjective evaluation. It is the occupant's satisfaction with the surrounding thermal conditions.

10. What is need for shading devices?

Well-designed sun control and shading devices can dramatically reduce building peak heat gain and cooling requirements. These devices also improve the natural lighting quality of building interiors.

11. How shading devices are classified?

Shading devices is classified in to two types they are

(i) Internal shading devices and

(ii) External shading devices.

12. What is central heating?

A central heating system provides warmth to the whole interior of a building or portion of a building from one point to multiple rooms.

13. What are the components of central heating system?

Common components of a central heating system using water-circulation include:

- A gas supply lines, oil tanks and supply lines or distinct heating supply lines
- A Boiler (or a heat exchanger for district heating) which heats water in the system
- Pump to circulate the water in the closed system
- Radiators which are wall-mounted panels through which the heated water passes in order to release heat into rooms

14. What is ventilation?

The term ventilation is used to mean the free passage of clean air in a structure. In other words, the removal of all vitiated air from a building and its replacement with fresh air is known as ventilation.

15. What are the factors affecting ventilation?

1. Air changes
2. Humidity
3. Quality of air
4. Temperature
5. Use of building

16. What are type of ventilation?

The system of ventilation are classified into the following two types

1. Natural ventilation
2. Mechanical or artificial ventilation

17. What are methods of artificial ventilation?

(i) Exhaust system

(ii) Supply system

(iii) Combination of exhaust and supply systems

(iv) Plenum process

(v) Air-conditioning

18. What is air conditioning?

It is defined as the process of simultaneously controlling and maintaining the properties of air like temperature, humidity, purity, direction of flow etc., in a closed space.

19. What is principle of air conditioning?

An Air- conditioner continuously draws an air from an indoor space to be cooled and cools it by the refrigeration principles and discharges it back into the same indoor space that needs to be cooled.

Such continuous cyclic processes of drawl, cooling and recirculation of the cooled air keeps the indoor space at the required lower temperature for the desired purpose.

20. What is the classification of airconditioning system?

The air-conditioning systems can be classified into two categories

1. Comfort air-conditioning
   (a) Summer air-conditioning
   (b) Winter air-conditioning
   (c) Year round air-conditioning
2. Industrial air-conditioning

21. What is window air-conditioner?

- Window air- conditioner is also known as room air-conditioner
- It is designed to condition the air in a single room or a large scale.
- It is called a window air-conditioner because it is usually installed in a window.

22. What are components of a window air-conditioner?

The main components of a window air-conditioner are:

(i) Compressor
(ii) Condenser
(iii) Air filter
(iv) Evaporator
(v) Motor
(vi) Fans
(vii) Thermostat
(viii) Capillary tube

23. What are the advantages of the window air-conditioner?

- For each unit, an individual temperature control device is provided.
- For air distribution, ducts are not required.

24. What are the disadvantages of the window air-conditioner?

- The unit is installed outside the wall.
- This unit has a fixed air quantity.

25. What is packaged airconditioner?

Packaged air conditioner is a self-contained unit primarily for floor mounting, designed to provide conditioned air to the space to be conditioned.

26. What is chilled water plant?

Chilled water is extensively used as a secondary refrigerant in larger commercial, institutional and industrial premises to make cooling available over a large area.

27. What is meant by cooling load? ***(AU Jan 2017)***

It is defined as the total heat required to be removed from the space in order to bring it to the desired temperature by air conditioning and refrigeration equipment.

28. What are the different airconditioning systems?

1. Central Air conditioner
2. Split Air conditioner
3. Window Air conditioner

4. Portable Air conditioner
5. Hybrid Air conditioner

29. What are common causes of AC fire?

1. Failing to keep the not cleaned properly
2. Storing flammable material near the A.C system
3. Faulty parts and equipment

UNIT-II ACOUSTICS

1. Enumerate the ways in which sound is classified. ***(AU Jan 2014)***

Sound is classified on the basis of frequency

(i) Infrasonic (frequency less than 20 H_Z)

(ii) Audible sound (frequency in between 20 Hz and 20,000 Hz)

(iii) Ultrasonic (frequency greater than 20 kHz)

2. Define intensity of sound. What is its unit? ***(AU April 2015)***

It is the amount of sound energy flowing per second per unit area held normally at the point to the direction of propagation. The unit of intensity is watt metre^{-2} or Wm^{-2}

3. What is loudness? ***(AU Jan 2013)***

It is the degree of sensation produced on the ear and varies from one person to another person. Loudness is different from intensity of sound.

4. State Weber -Fechner law in sound. (or) How is loudness of sound related to intensity of the sound wave? ***(AU Dec 2014, Jan 2016)***

It states that loudness of sound (L) is directly proportional to logarithm of intensity.

$L \propto \log_{10} I$

$L = k \log_{10} I$

where k is a constant which depends on the quality of the sound, sensitivity of the ear and other factors.

5. Distinguish between loudness and intensity of sound. ***(AU Dec 2015)***

S.NO.	Loudness	Intensity
(I)	It is the degree of sensation Produced on the ear and hence It depends upon the listener.	It is the amount of sound energy flowing per unit area per second. Hence, it Depends on the source of sound and does not depend upon the listener.
(ii)	It is not a pure physical quantity. It is subjective in nature.	It is a pure physical quantity.
(iii)	Loudness cannot be measured directly	Intensity is directly measured in Wm^{-2}

6. Define sound intensity level and write its unit. ***(AU Jan 2012, May 2013)***

Sound intensity level is obtained by comparing intensity of the sound I with standard zero level sound intensity I_0. I_0 is taken to be 10^{-12}watt m^{-2} at 1000H_Z.

Unit for sound intensity level is decibel.

Sound intensity level in decibel $= 10 \log_{10}(I/I_o)$

7. What is a decibel? ***(AU Jan 2011)***

A decibel (dB) is the unit of sound intensity level of a sound. Sound intensity level is measured in decibel scale (or) logarithmic scale because the response of human ear to sound is found to vary in a logarithmic way with intensity of sound.

Sound intensity level in decibel=10 $\log_{10}(I/I_0)$
Where I_0- threshold of audibility (10^{-12}watt m^{-2})
I-intensity of sound

8. Show that a 26% change in intensity alters the sound intensity level by 1 decibel. ***(AU Dec 2013)***

Sound intensity level, $\beta = 10 \log_{10}(I/I_0)$ decibel

If β is 1 decibel,

$1=10 \log_{10}(I/I_0)$

$\log_{10} I/I_0=1/10$

I/I_0=antilog (1/10)

$I/I_0=1.26$

26% change in intensity alters sound intensity level by 1 dB.

9. What is reverberation? ***(AU Dec 2012)***

The prolongation or persistence of sound inside a room or hall even after the source of sound has stopped producing the sound is called reverberation.

This is due to multiple reflections from the walls, ceiling, floor and other reflecting surfaces of the room.

10. Define reverberation time of an auditorium. (or) What is reverberation time? ***(AU Dec 2011, Jan 2013)***

The time duration for which the sound persists even after the source of sound has stopped producing the sound is known as reverberation time.

11. What is standard reverberation time?(or) What is Sabine's law? ***(AU Dec 2013)***

Sabine's law states that the standard reverberation time is the time taken by the intensity of sound to fall to one-millionth (10^{-6}) of its initial after the source of sound is cut off.

12. Write down Sabine's formula for reverberation time. ***(AU Jan 2016)***

Reverberation time $T = 0.167\ V/\sum as$ second

Where V-volume of the hall in m^3

a-Absorption coefficients of surface areas of different materials in O.W.U.

s-Surface areas of the different materials in m^2

$\sum as$ total absorption of sound in O.W.U.m^2

13. Define absorption co-efficient of a material. What is its unit? ***(AU Dec 2013)***

The absorption co-efficient of a material is defined as the ratio of sound energy absorbed by its surface to that of the total sound energy incident on the surface.

The unit of absorption co-efficient is open window unit (O.W.U).

14. What are the acoustical factors to be considered while we construct any buildings? ***(AU Jan 2013)***

- Reverberation time
- Loudness
- Focussing
- Echoes
- Echelon effect
- Resonance
- Noises

15. Mention any four sound absorbing materials. ***(AU May 2012)***

Carpets, glass, wool, hair, furniture also wood, foam materials, audience

16. How can we control reverberation time? ***(AU Jan 2017)***

- By providing many windows and ventilators.
- Using heavy curtains with folds.

- Covering the walls with sound absorbing materials such as felt, glass, wool, etc,
- By covering the floor with carpets.
- Having a good size of audience.

17. How will you ensure adequate loudness in a hall? ***(AU May 2010)***

- Using large sounding boards behind the speaker
- By providing low ceiling for the reflection of energy towards the audience
- By providing additional energy with the help of equipments like loudspeakers

18. What is focussing? ***(AU Dec 2012)***

The sound waves falling on concave surfaces of buildings after reflection get focussed to a point. Hence, the intensity of sound is maximum at such points and zero at other places. This is called focussing effect.

19. What is echelon effect? ***(AU May 2013)***

Sound produced in front of regular structures like a set of railings or staircase may produce a material note due to regular repetition echoes of the original sound to the listener. This makes original sound to appear confused or unintelligible. Such an effect called echelon effect.

20. What are the requirements for good acoustics? ***(AU Jan 2002)***

- The hall should have optimum reverberation time of about 1.1 to 1.5 second
- The loudness of the sound should be uniform throughout the hall
- Echoes should not be present
- Resonance effect should be avoided
- There should be no echelon effect
- Noise should be reduced

21. What are the characteristics of musical sound?

(i) Pitch or frequency
(ii) Quality or timbre
(iii) Intensity or loudness

22. What is optimum reverberation time?

The reverberation time for a hall should not be too large or short. It should be a satisfactory value and this preferred value of the time of reverberation is called optimum reverberation time.

23. How will you ensure uniform distribution of sound energy in the hall?

By taking care that there are no curved surfaces. If such surfaces are present, they should be covered with sound absorbing materials.

By having low ceiling.

24. What are echoes? How are they avoided?

When a reflecting surface is far away from the source (more than 17 metres) then the sound is reflected back as a distinct repetition of direct sound. The reflected sound is called an echo.

Remedy

- Providing low ceiling
- Echoes can also be avoided by covering walls and ceiling with suitable sound absorbing material.

25. What is resonance? How is it corrected?

Sometimes the window-panes, sections of the wooden portions, and walls lacking in rigidity (loosely fitted) are thrown into vibrations and they create other sounds. Such vibrations are called resonant vibrations.

These resonant vibrations should be suitably damped.

Remedy

This defect can be rectified by hanging a large number of curtains in the hall.

26. What is noise? How is it classified?

Unwanted sound reaching our ears is called the noise

These are three types of noises

- Inside noise
- Airborne noise
- Structure borne noise

27. What is inside noise? Give the remedy to avoid such noise?

The noises produced inside the same room as known as inside noises.

Remedy

- The machineries and any sound producing equipment may be placed over the sound absorbing materials or pad.
- This type of noises can also be reduced by covering the walls, floors and ceilings with suitable sound absorbing materials.

28. What is air borne noise? Mention the ways to avoid such noise.

Nosie from outside through open windows, doors, ventilators is known as air-borne noise.

Remedy

- By allotting proper places for doors and windows.
- By making perfect arrangement for shutting the doors and windows.
- Using heavy glasses in doors, window and ventilators.
- By making the hall air conditioned, this noise may be eliminated.

29. What is structure borne noise?

The noise through the structure of the building is called structure borne noise.

30. What are sound absorbing materials?

The special materials used to increase the absorption of soundwaves or to reduce the reflection of sound waves in a room or hall are known as sound absorbing materials.

31. What are requirement of a good acoustical material.

- It should be durable and should not be liable to the attacked by insects, termites, etc.
- It should be easily available at a reasonable cost.
- It should be efficient over a wide range of frequencies.
- It should be fire resistant.
- It should give pleasing appearance after fixing.
- It should have high co-efficient of absorption.
- It should have sufficient structural strength.

32. What are types of sound absorbing material?

(a) Porous absorbents
(b) Cavity resonators
(c) Resonant absorbing or panel absorbers
(d) Composite type of absorbents.

33. How noises are measured?

Noise meters are the instruments specially designed for noise measurement from low to high frequencies, characteristics of human ear capacity. Noise meters record the dB scale for routine measurement of general noise levels.

Refined noise meters have been developed to take care of peak noise levels, duration of noise exposure quality of noise which are aspects of specified noise situation.

34. What is sound insulation and how it is measured?

The art of preventing the transmission of noise inside or outside the hall or rooms of a building is known as sound insulation.

It is also called sound proofing and it is a measure used to reduce the level of sound when it passes through the insulation is to suppress the noise.
The sound reduction index is used to measure the level of sound insulation provided by a structure such as a wall, window, door, or ventilator.

36. What is a floating floor? Why is it used in buildings? ***(AU Jan 2017)***

A floating floor is a floor that is not fixed to the layer beneath it. Floating floors may be constructed from materials such as timber planks or boards, engineered timber, laminate flooring and some types of tiles. It can be used to help improve the thermal or acoustic insulation of a floor construction.

37. The intensity of sound during heavy traffic is 10^{-4} Wm^{-2}. Calculate intensity level in decibel. ***(AU Jan 2017)***

$\beta = 10 \log_{10}(I/I_0)$
$= 10 \log_{10}(10^{-4}/10^{-12}) = 10 \log_{10}(10^8) = 10x8 = 80$ dB

38. What are main actions which causes impact of noise in multi-storeyed buildings?

1. Speech privacy (will not be there)
2. Background noise(e.g fan, a.c,generator, printer)
3. Sound masking
4. Orientation of buildings.

UNIT-III LIGHTING DESIGN

1. Define Radiant power.

It is defined as the total power or radiation emitted by a lamp, light emitting diode, etc.), transmitted through a surface or impinging upon a surface. Radiant power is measured in watts (w)

2. Define radiant intensity.

Radiant intensity I_e describes the radiant power of a source emitted in a certain direction. The source's (differential) radiant power $d\phi_e$ emitted in the direction of the (differential) solid angle element $d\Omega$ is give by

$$d\phi_e = I_e d\Omega$$

and thus

$$\phi_e = \int_{4\pi} I_e d\Omega$$

In general, radiant intensity depends on spatial direction. The unit of radiant intensity is W/sr.

3. Define radiance.

Radiance Le describes the intensity of optical radiation emitted or reflected from a certain location on an emitting or reflecting surface in a particular direction. The radiant power $d\phi_e$ emitted by a surface element dA in the direction of the solid angle element $d\Omega$ is given by

$$d\phi_e = L_e \cos\theta dA d\Omega$$

4. Define Irradiance.

Irradiance Ee describes the amount of radiant power impinging upon a surface per unit area. In detail, the radiant power $d\phi_e$ upon the surface element dA is given by

$$d\phi_e = E_e dA$$

5. Define radiant exitance.

Radiant exitance M_e quantifies the radiant power per unit area, emitted or reflected from a certain location on a surface.

6. What is spectral radiant power?

It is defined as a source's radiant power per wavelength interval as a function of wavelength internal as function of wavelength. In detail, the source's (differential) radiant power $d\phi_e$ emitted in the (differential) wavelength interval between is given by $d\phi_e = \phi_\lambda(\lambda)d\lambda$

7. What is photometry?

The branch of optics which deals with the measurements of the intensity of light emitted by a source, its illuminating power or intensity of illumination of a surface is called photometry (photo means light, metry means measurement).

8. Define luminous flux.

The light energy emitted per second from a light source (luminous body) is called luminous flux.

It is denoted by ϕ.

Unit: unit of luminous flux is lumen (lm)

9. Define lumen.

Lumen is the luminous flux emitted from a standard candle.

10. Define luminous intensity.

The luminous intensity or illuming power of a source in any direction is defined as the luminous flux emitted per unit solid angle in that direction.

If ϕ is the luminous flux radiated by a source within a solid angle Ω in any particular then luminous intensity is given by

$$I = \phi / \Omega$$

If ϕ is measured in lumens and Ω in steradian

Then I = lumen/steradian or candela

Unit of luminous intensity is candela (cd).

11. Define candela.

It is the unit of luminous intensity of a source. A light has a luminous intensity of 1 candela if it emits 1 lumen (1 lm) per steradian.

12. Define intensity of illumination.

The luminous flux incident normally per unit area of the surface is called illumination on that surface or intensity of illumination.

If ϕ is the total flux falling over an area A, then

Illumination, $E = \phi / A$

If ϕ is measured in lumen and A is in metre^2

E = lumen/metre^2 i.e., lumen per metre^2 or lux.

13. State Lambert's Cosines law. ***(AU Jan 2017)***

It stated that intensity of illumination (illuminance) is

(i) Directly proportional to cosine of the angle of incidence of light radiation on the surface

(ii) Inversely proportional to the square of distance between the surface and source.

14. State inverse square law.

The inverse square law states that the intensity per unit area is inversely proportional to the square of the distance.

15. Define hemispherical reflectance.

It is defined as the ratio of the radiant flux reflected from a surface to the radiant flux incident to it.

16. Define hemispherical transmittance.

It is defined as the radio of the radiant flux transmitted through a surface to the radiant flux incident to it.

17. What are photopic, mesopic and scotopic?

The terms photopic, mesopic and scotopic refer to three ranges of human vision adaptation level. These three differ in anatomical response, spectrum and their effect on visual acuteness. The terms photopic, mesopic and scotopic refer to the primary use of the cones, rods and other light-sensitive cells on the retina of the human eye.

18. What is visual field glare?

Glare is difficulty seeing in the presence of bright light such as sunlight or artificial (car head lamps at night). Because of this, some cars include mirrors with automatic anti-glare functions.

19. What are types of glare?

Glare is generally divided into two types;

I. Discomfort glare and
II. Disability glare.

20. What are the reducing factors of visibility?

Glare can reduce visibility by

- Reduction of brightness of the rest of the scence by constriction of the pupils.
- Reduction in contrast of the rest of the scence by scattering of the bright light within the eye.
- Reduction in contrast by scattering light in particles in the air.
- Bloom surrounding objects in front of glare.
- Reduction in contrast by reflection of bright areas on the surface of a transparent medium or glass, plastic or water.

21. What are methods to reduce glare?

Sunglasses are often worked to reduce glare. The polarized sunglasses are designed to reduce glare caused by light reflected from non-metallic surfaces such as water, glossy printed matter or painted surfaces.

An anti-reflective treatment of eyeglasses reduces the glare at night and glare from inside lights and computer screens.

22. What is day light?

Daylight, or the light of day, is the combination of all direct and indirect sunlight during the day time. Thus includes direct sunlight, diffuse sky radiation, and (often) both of these reflected by the earth and terrestrial objects, (landforms and buildings).

23. What is daylight factor?

The daylight factor is defined as:

$$DF=E_i/E_0 \times 100(\%)$$

where E_i - illuminance due to daylight at a point on the indoors working plane.

E_o - simultaneous outdoor illuminance on a horizontal plane from an unobstructed hemisphere of overcast sky

24. What is the use of models in daylight calculation?

Model studies can be used to predict daylight penetration into any building. This is the only reliable prediction method in the case of unusual situation, complex geometries or heavily obstructed windows.

Model studies can be carried out under outdoor conditions, but the limitations imposed by weather variations can be quite severe.

The artificial sky simulates the standard overcast sky conditions, giving uniform luminance.

25. What are the forms of artificial sky?

There are two basic forms of artificial sky:

(i) Hemispherical and
(ii) Rectangular

26. Mention few artificial light sources.

1. Incandescent Lamp
2. Compact Fluorescent Lamp
3. Fluorescent Tube
4. Discharge Lamps
5. Light Emitting Diode (LED)

27. What is the purpose of supplementary artificial lighting? ***(AU Jan 2017)***

Supplementary Artificial Lighting of interiors is a system of combined artificial lighting and day lighting, which are blended together to provide an even illumination. Parts of the room are permanently lit by artificial light.

UNIT IV NEW ENGINEERING MATERIALS

1. **What are composite materials?**

   Composite materials, are a combination of two or more materials that are different in chemical composition.

   Composite materials can be a combination of various materials, such as plastics, metals, fibers or ceramics.

2. **How composite materials are classified?**

   Based on the reinforcement techniques, composites are classified as:

   (a) Fiber – reinforced
   (b) Structural
   (c) Particle – reinforced

3. **What is the function of matrix materials?**

   In composites, the matrix phase serves important functions. First it binds the reinforcement (fibers) together. It acts as a medium and transmits and distributes the external loads to the fibers.

4. **What are type of composites based on the matrix materials?**

   Based on the matrix materials

   - **Polymer matrix composites**: In this the matrix material is a polymer, reinforced by ceramic.
   - **Metal matrix composites**: in this composite, the matrix is a pure metal, or an alloy and the reinforcement is a ceramic phases.

5. **What are Fibre reinforced plastics and its types?**

   Fibre reinforced plastics consist of fibers in a polymer resin matrix.
   The commonly used fibres are
   (a) Glass Fibre Reinforced Plastics (GFRP)
   (b) Aramid Fibre Reinforced Plastics (AFRP)
   (c) Carbon Fibre Reinforced Plastics (CFRP)

6. **What is fibre reinforced metals?**

   Metal Matrix Composites (MMC) provides high temperature resistance, non – flammability and greater resistance to degradation by organic fluids when composed to polymer matrix composites.

   Fibre reinforced MMCs contain continuous/ discontinuous fibres or whiskers in a ductile metal matrix.

   The ductile matrix materials are aluminium, magnesium, copper, titanium and super alloys. The continuous fibres are graphite, boron, alumina or silicon carbide. The whiskers of silicon carbide and silicon nitride are also used as reinforcement.

7. **What are advantages of composites?**

   • Composite materials exhibit superior mechanical properties such as high strength, toughness, elastic modulus, fairly good fatigue and impact properties.

- As FRP's are light weight materials, the specific strength and modulus is much higher than conventional materials.
- In an aeroplane power to weight ratio is about 16 with composites compared to 5 with conventional materials. This helps in weight reduction and more pay load carrying capacity.
- Fabrication of composites to any desired shape and size can be achieved with case.
- They exhibit good corrosion resistance.

8. What are limitations of composites?

1. Polymeric composites cannot be used for high temperature application.
2. Cost of composites is somewhat higher than may conventional materials.

9. Mention the application of composites?

1. Commercial aircraft
2. Military aircraft
3. Missiles
4. Space hard wares
5. Automobile and trucks

10 . What are metallic glasses?

Generally, glass is an amorphous, brittle and transparent solid. We know that the metals are malleable, ductile and exhibit crystalline properties. The metallic glasses have the properties of both metals and glasses.

It is found that the metallic glasses are strong, ductile, malleable, opaque and brittle. They have good magnetic properties and high corrosion resistance.

11. What are the types of metallic glasses?

Metallic glasses are classified into two types:

(i) Metal – metal metallic glasses

They are combination of metals

	Metal		**Metal**
Example:	Nickel (Ni)	-	Niobium (Nb)
	Magnesium (Mg)	-	Zinc (Zn)
	Copper (Cu)	–	Zirconium (Zr)

(ii) Metal – Metalloid metallic glasses

These are combinations of metals and metalloids.

Example: Metals	: Metalloids
Fe, Co, Ni	B, Si, C, P

12. What are the properties of metallic glasses?

* Metallic glasses have extremely high strength, due to the absence of point defects and dislocation
* They have high elasticity
* They are highly ductile
* Metallic glasses are not work – harden but they are work – soften. (Work hardening is a process of hardening a material by compressing it)
* 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
* The temperature coefficient is zero or negative
* Metallic glasses have both soft and hard magnetic properties
* They are magnetically soft due to their maximum permeabilities. Thus, they can be magnetized and demagnetized very easily.

13. List any four application of metallic glasses. ***(AU Jan 2017)***

1. They possess high physical and tensile strength. They are superior to common steels and thus they are very useful as reinforcing elements in concrete, plastic and rubber.
2. Strong ribbons of metallic glasses are used for simple filament winding to reinforce pressure vessels and to construct large fly wheels for energy storage.
3. Due to their good strength, high ductility, rollability and good corrosion resistance, they are used to make razor blades and different kinds of springs.
4. Since metallic glasses have soft magnetic properties, they are used in tape recorder heads, cores of high power transformers and magnetic shields.
5. The use of metallic glasses in motors can reduce core loss very much when compared with conventional crystalline magnets.

14. What are shape memory alloys?

A group of metallic alloys which shows the ability to return to their original shape or size (i.e., alloy appears to have memory) when they are subjected to heating or cooling are called shape memory alloys.

15. What are the types of shape memory alloys?

There are two types of shape memory alloys

(i) One – way shape memory alloy

(ii) Two – way shape memory alloy

A material which exhibits shape memory effect only upon heating is known as one – way shape memory. A material which shows a shape memory effect during both heating and cooling is called two – way shape memory.

16. Give example for shape memory alloys.

Generally, shape memory alloys are intermetallic compounds having super lattice structures and metallic – ionic covalent characteristics. Thus, they have the properties of both metals and ceramics.

- Ni – Ti alloy (Nitinol)
- Cu – Al – Ni alloy

17. Define shape memory effect.

The change in shape of a material at low temperature by loading and regaining of original shape by heating it is known as shape memory effect.

The shape memory effect occurs in alloys due to the change in their crystalline structure with the change in temperature an stress.

- While loading, twinned martensite becomes deformed martensite at low temperature.
- On heating deformed martensite becomes austenite (shape recovery) and upon cooling it gets transformed to twinned martensite.

18. Define pseudo elasticity in shape memory alloys? ***(AU Jan 2017)***

Pseudo – elasticity occurs in shape memory alloys when it is completely is austenite phases (temperature is greater than Af austenite finish temperature.

Unlike the shape memory effect, Pseudo – elasticity occurs due stress induced phases transformation without a change in temperature. The load on the shape memory alloy changes austenite phase into martensite.

As soon as the loading decreases the martensite begins to transform to austenite results in shape recovery.

This phenomenon of deformation of a SMA on application of large stress and regaining of original shape on removal of the load is known as pseudo elasticity. This pseudo elasticity is also known as super elasticity.

19. Mention the application of shape memory alloys.

Shape memory alloys have a wide range of applications.

1. Microvalve (Actuators)

2. Toys and novelties
3. Medical field
   Blood clot filters
   Orthodontic applications
4. Antenna wires
5. Thermostats
6. Cryofit hydraulic couplings
7. Springs, shock absorbers and valves
8. Stepping motors
9. Titanium – aluminium shape memory alloys

20. What are advantages of shape memory alloys?

* They are simple, compact and high safe
* They have good bio – compatibility
* They have diverse applications and offer clean, silent and spark – free working condition
* They have good mechanical properties and strong corrosion – resistance

21. State the disadvantages of shape memory alloys.

* They have poor fatigue properties.
* They are expensive
* They have low energy efficiency

22. What are ceramic materials?

Most of the ceramics are compounds of metallic and non – metallic elements. They crystal structure of ceramics is more complex because at least two elements are involved in making a ceramic compound. Ceramics can be used at low as well as high temperatures.

Ceramic materials are obtained by firing them at high temperatures. Traditional ceramics are clay products like bricks, tiles and porcelain. China ceramics are obtained by firing clay products.

23. What are natural ceramics materials?

Ceramics can be natural or manufactured

Natural ceramics

The most frequently used, naturally occurring ceramics are: Silica (SiO_2), Silicates and Clay minerals.

24. What are traditional ceramic materials?

Traditional ceramics are made from three basic components: clay, silica, and feldspar. Examples of traditional ceramics are glasses, tiles, bricks and porcelain.

25. What are engineering ceramics materials?.

Engineering ceramics are mainly pure compounds or oxides, carbides or nitrides of pure compounds. Some of the important engineering ceramics are alumina (Al_2O_3) silicon nitride (Si_3N_4), Silicon carbide (SiC) and Zirconia (ZrO_2)

26. Give classification of ceramics based on crystal structure.

(i) Crystalline ceramics
(ii) Non – crystalline (Amorphous) Ceramics
(iii) Bonded ceramic

27. What is crystalline ceramics?

These have simple crystal structure, such as aluminium oxide (corundum), magnesium oxide, silicon carbide. Most of the oxides can be considered packing of oxygen ions with the cations occupying the tetrahedral and / or octahedral sites in the structure.

28. What are non – crystalline ceramics?

These are usually regarded super, cooled liquids. Their molecules are not arranged in regular geometric shapes. E.g. amorphous or fused SiO_2 has each Si bonded to four O and each O is bonded to two Si.

This type of ceramics is used for mirrors, optical lenses, reinforcement fibres for GRP and optical fibres for data transmission.

29. What are bonded ceramics?

These ceramics contain crystalline and non – crystalline materials which are bound together by a glassy matrix after firing. This group included the lining and clay products.

Bonded ceramics are used as electrical insulators, refractory for furnace, spark plugs etc.

30. Mention the steps for the processing of ceramic materials.

(i) Raw materials processing,
(ii) Fabrication
(iii) Densification

31. What are the thermal properties of ceramics?

(i) Thermal capacity
* The specific heats of fine clay bricks are 0.25 at 1000°C *and* 0.297 at 1400°C
(ii) Thermal conductivity
*The ceramic materials possess a very low thermal conductivity since they do not have enough free electrons.
(iii) Thermal Shock
"Thermal shock resistance "is the ability of a material to resist cracking or disintegration of the material under sudden changes in temperature".

- Lithium compounds are in many ceramic compounds to reduce thermal expansion and provide excellent thermal shock resistance.

32. What are the mechanical properties of ceramics

Compressive strength: Compressive strength in ceramics in general is many times greater than tensile strength.

Shear strength: High shear strengths and low fracture strengths are generally characteristics of ceramics.

Tensile strength: Tensile strength in ceramics are theoretically high.

Torsional strength: Torsional strength is seldom considered as a critical property of ceramics since tensile and cantilever requirements will show the torsional strength of material.

Toughness of Ceramic Materials: Due to presence of covalent – ionic boning, ceramics have low toughness.

33. State the electrical properties of ceramics.

* Ceramics are generally poor conductors of electricity because the electrons associated with the atoms ceramics are shared covalent or ionic bonds.
* Ceramics materials are used in an electrical circuit both as the electrical insulators and as its functional parts.
* Ceramic materials have good dielectric capacity.

34. Mention the chemical proportion of ceramics

* The great majority of ceramic products, are highly resistant to all chemicals except hydrofluoric acid and to some extent, hot caustic solution.
* Organic solvents do not affect the ceramics.
* Oxidic ceramics are completely resistant to oxidation even at very high temperatures.
* Magnesia, zirconia, porcelain, graphite, alumina, etc., are resistant to certain molten metals. They are used for making crucibles and furnace linings.

35. What are ceramic fibers?

They are known as refractory ceramic fibers.

Ceramic fibers comprise a wide range of amorphous or crystalline synthetic mineral fibers characterized by their refractory properties (i.e., stability at high temperatures)

They typically are made of alumina, silica, and other metal oxides or, less commonly, of monoxide materials such as silicon carbide.

Most ceramic fibers are compound of alumina and silica is an approximate 50/50 mixture.

36. What are uses and application of ceramic fibers?

* Ceramic fibers are used as insulation materials, due to their ability to withstand high temperatures. They are used primarily for lining furnaces and kilns.

* The products are in the form of blankets, boards, felts, bulk fibers, vacuum – formed or cast shapes, paper and textiles.

* High – temperature resistant ceramic blankets and boards are used is ship building as insulation to prevent the spread of fire.

37. What are ferro electric ceramics?

Examples for the ferroelectric ceramics are Rochelle salt, $BaTiO_3$, $SiTO_3$, $PbTiO_3$, $LiNbO_3$, $NaNbO_3$, $KNbO_3$, $PbTa2O_3$ etc.

38. What are ferromagnetic ceramics?

The soft magnetic ceramics exhibits similar properties as that of soft magnetic materials (metal counter parts).

The magnetic ceramic materials are classified into three types namely,

- Spinel
- Garnets and
- Hexagonal ferrites

39. What is high alumina ceramics?

High alumina ceramics contains 85% or more by weight of A1 O

- Alumina is nothing but an aluminium oxide (AI2 O3) which is the oldest engineering ceramic.
- Alumina is produced from bauxite (A12 O3 , 2H2 O)

40. What are characteristics of high alumina?

1. Alumina have excellent hardness, wear resistance and chemical inertness properties.

2. They are stiffer than steels.

3. They are stronger in compression than many hardened tool steels.

4. They retain 50% of their room temperature strength at elevated temperature (about 1093□)

5. They possess very good environmental resistance.

6. These are mechanically strong, dense materials, unlike refractories which are usually porous.

7. They have ability to resist, high temperature because they are poor thermal conductors.

41. What are the applications and uses of high alumina?

(i) Alumina is used as a refractory material for high temperature applications.

(ii) Alumina makes an excellent high voltage insulator. Classical applications are for insulators in spark plugs and in insulating substrates to support integrated circuits.

(iii) Alumina based ceramic tools have very high abrasion resistance, hot hardness and are chemically stables than high speed steels. So, they are used in cutting cast irons, and steels to obtain good surface finish.

UNIT V HAZARDS

1. What are the causes of hazards?

Some of the hazards which cause environmental degradation are floods, earth – quakes, cyclones, landslides, drought, famines, etc**.**

2. What are the types are hazards?

Hazards are classified into two categories:

(i) Natural Hazards

(ii) Anthropogenic hazards.

3. What are natural hazards?

* Air – related hazards: Hurricanes, cyclones, storms, etc.
* Water – related hazard: Floods, droughts, etc.
* Earth – related hazards: Earthquakes, landslides, volcanoes, etc.

4. What are anthropogenic hazards?

* Industrial accidents
* War, riots, acts of terrorism, etc.

5. What is earthquake?

An earthquake is caused by a portion of the rigid crust of the earth giving way or getting fractured, some distance below its surface.

6. Define focus and epicentre of earthquake. ***(AU Jan 2017)***

The place where the actual fracture occurs is called the focus of the earthquake. It is not a geometrical point, but an extended region. The point nearest to the focus, on the surface of the earth, is called the **epicentre.**

7. What are the causes of earthquake?

* Sudden movement of hot gases and magma
* Volcanic activities
* Stress, caused by water pressure in dams
* Tectonic stress generated by movement of tectonic plates

8. What are the types of earthquake?

The earthquakes can be also classified into three categories according to its depth of focus. These are

(i) **Shallow focus earthquakes** are earthquakes with depth of focus < 70km. Nearly 80% of total earthquakes are shallow focus earthquakes.

(ii) **Intermediate focus earthquakes** are earthquakes with depth between 70 to300 km.

(iii) **Deep focus earthquakes** are earthquakes having focal depth > 300 km

9. Define intensity of earthquake.

Intensity is a qualitative measure of the strength of an earthquake. It gives a gradation of strength of earthquake using observed damage to structures and/or ground and reaction of humans to the earthquake shaking.

10. Define magnitude of earthquake.

The magnitude is a quantitative of absolute measure of the size of an earthquake. It can be correlated to the amount of wave energy released at the source of an earthquake.

11. What are the effects of earthquake?

1. Ground shaking
2. Liquefaction of ground
3. Ground displacement
4. Land slides
5. Flood
6. Fire

7. Tsunami

12. What are seismic waves?

A number of different types of waves, collectively called seismic waves originate from the focus, (regard as a point). These waves spread on to different points on the surface of the earth and which appears as **'earthquake tremors'**

13. What are types of seismic waves?

(i) Preliminary waves and
(ii) Surface waves.

14. What are primary waves?

These are longitudinal waves, in which the particles of the earth vibrate about their mean position, along the direction of the waves themselves.

If the earth is regarded to be a homogenous sphere, these waves, starting from the focus, travel along the chord of huge circle of the earth.

15. What are secondary waves?

These are transverse waves i.e., the particles of the earth vibrate at right angles to the direction of propagation of the waves.

Starting from the focus, these waves also travel along a chord of a huge circle of the earth.

16.what are the types surface waves

(a) Rayleigh waves
(b) Love waves.

17. Define Rayleighwaves.

These waves are found to remain confined to a comparatively thin layer in the close vicinity if the earth's surface.

Unlike the P and S Waves, they start from the epicenter and arrive at the observing station along a huge circle of the earth

The displacement of the particles is being in the vertical plane containing their direction of propagation.

18. Define love waves.

The heterogeneity of the layers of the earth is also responsible for another type of surface waves, known as Love waves.

In this wave, the displacement of the earth is horizontal, but transverse to the direction on their propagation.

19. What is seismology?

The study of the seismic waves constitutes the science of seismology. It deals with earthquakes and seismic waves that move through and around the earth.

20. What are the applications of seismology?

(i) Investigation of the nature of the interior of the earth.
(ii) Prospecting for oils and minerals.
(iii) Construction of quake – proof buildings
(iv) Forecasting of the occurrence of earthquakes.

21. What is seismic hazard?

Seismic hazard is defined as any physical phenomenon, such as ground shaking or ground failure, which is associated with an earthquake and that, may produce adverse effects on human activities.

22. What is seismic hazard analysis?

Seismic hazard analysis involves the quantitative estimation of ground shaking hazards at a particular area.

23. Mention the most important factors affecting seismic hazard at a location.

1. Earthquake magnitude

2. Source-to-site distance
3. Earthquake rate of occurrence (return period)
4. Duration of ground shaking

24. What are types of seismic hazard analysis?

Seismic hazard is analyzed in two ways

(i) Deterministically (as when a particular earthquake scenario is assumed),

(ii) Probabilistically (in which uncertainties in earthquake size, location, and time of occurrence are explicitly considered).

25. What is deterministic seismic hazard analysis?

- It is done for a particular earthquake, either assumed or realistic.
- DSHA approach uses the known seismic sources sufficiently near the site and available historical seismic and geological data. These data are used to generate discrete, single-valued events or models of ground motion at the site.

26. What are steps in DSHA?

1. Identification and characterization of all sources
2. Selection of source-site distance parameter
3. Selection of the "controlling earthquake"
4. Definition of hazard using controlling earthquake

27. What is probabilistic seismic hazard analysis?

Probabilistic seismic hazard analysis (PSHA) provides a framework in which these uncertainties can be identified, quantified, and combined in a rational manner to provide a more complex picture of the seismic hazard.

28. What are four steps in PSHA?

1. Identification and characterization of earthquake sources.
2. Characterization of temporal distribution of earthquake recurrence.
3. Determination of grand motion.
4. Computation of probability of earthquake.

29. What are cyclones? ***(AU Jan 2017)***

Cyclones are violent winds rotating round a central area.

30. What is a storm surge?

A storm surge is an abnormal rise of sea level near the coast due to which sea water low-lying areas of coastal region causing damage to human life and property.

31. How cyclones are classified?

They are classified as

1. Extra tropical cyclones (temperature cyclones) and
2. Tropical cyclones.

32. What are the categories of cyclone based on wind speeds their capacity to cause damage.

Cyclones are classified in to five different levels on the basis of wind speed. They are further subdivided into the following categories according to their to their capacity to cause damage.

Cyclone category	Wind speed in km/hr	Damage capacity
01	120-150	minimal
02	150-180	moderate
03	180-210	extensive
04	210-250	extreme
05	250and above	catastrophic

33. What are the effects of cyclones?

- Cyclones are associated with high pressure gradients and consequent strong winds, which in turn, generate storm surges. This causes sea water to inundate low-lying area of coastal regions drowning human beings and livestock.
- This erodes beaches and embankments.
- It also destroys vegetation and reduces soil fertility.
- Very strong winds associated with cyclones may damage installations, dwellings, communication systems, trees, etc., resulting in loss of life and property.

34. What are preventive measures of cyclone?

- Some long term deference measures can help to protect us from devastation. Such measures include planting more trees on the coastal belt, construction of dams. Strom shelter, wind breaks, proper drainage and wide roads for quick evacuation.

Forecasting and warning

- Forecasting a cyclonic event is the best measure of minimizing the losses due to a cyclone. Advanced systems of cyclone forecasting are now available to almost all the developed nations of the world.

Construction

- Special care should be taken while constructing houses, bridges, rods, and communication networks in cyclone-sensitive areas.

35. What is flood hazard?

The accumulation of large of water at a place or the presence of more water than what can be handled by the drainage of the area is known as flood. Floor refers to the inundation of normally dry land with water.

36. What are types of floods?

There are 3 types floods.

1. Flash flood
2. River flood
3. Coastal flood

37. What are the causes of floods?

Causes of floods

1. Heavy rain for a very short period results in floods.
2. River can overflow their banks to cause flooding, as it flows downstream to the adjacent low lying areas, there is a burst and water gets into the land.
3. Sea water can be carried by massive winds &hurricanes on to dry costal lands and cause flooding.

38. State the effect flood hazards.

Floods can have devastating consequences and can have effects on the economy environment and people.

Primary hazards are the effects of floods due to direct contact with the flood waters.

39. Mention the methods of flood prevention.

The intensity of flood can be minimized using the following measures:

- Plantation on slopes
- Drainage management
- Flood-plain zoning
- Forecasting

40. What are fire hazards?

Fire hazards include all types of live flames, causes of sparks, hot objects and chemicals that are potential for ignition, or that can aggravate a fire to become large and uncontrolled.

41. What are types of fire hazards?

1. Exposure hazard
2. Internal hazard
3. Personal hazard

42. Mention the causes and effects of fire.

- Improper storage of inflammable materials in and around the premises.
- Heating sources are often causes of fire -space heaters, electric heaters and fireplaces should be used with caution.
- Cooking accidents.
- Smoking
- Electrical wiring.
- Rubbish and waste materials.
- Combustible materials such as glues, solvents, packing materials, flammable liquids or gases stored near or around the factory premises can be major causes of a fire.

43. What is fire protection?

Fire protection is the study and practice of mitigating the unwanted effects of potentially destructive fires.

- It involves the study of the behaviour, compartmentalization (Divide a structure into "fadminire compartments" which may certain single or multiple rooms, for the purpose of limiting the spread of fire, smoke and flue gases in order to enable fire protection), suppression and investigation of fire and its related emergencies.

44. What are types of fires based on the kind of combustible material?

(a) class A: Ordinary material e.g. wood, paper, textile and rubbish.
(b) class B: Flammable liquids e.g. oils and greases.
(c) class C: Live electrical equipment.

45. Define fire proofing.

Fire proofing is something resistant to fire or incombustible or material for use in making anything fire proof.

46. Mention few fires proofing material.

The fire resisting properties of common building materials such as stone, brick, timber, cast-iron, glass, steel and concrete

47. What is fire fighting?

Fire fighting is the act of attempting to prevent the spread of and extinguish unwanted fires in buildings, vehicles, wood land etc.

48. What are fire safety regulations?

All buildings shall satisfy certain requirements which contribute, individually and collectively, to the safety of life from fire, smoke, fumes and panic arising from these or similar causes. There are, however, certain general principles and common requirements which are applicable to all or most of the occupancies.

PART – B QUESTIONS
UNIT 1

1. Describe the factors with example components that affect thermal performance of buildings.

(AU Jan 2017)

2. Explain window air conditioner system in detail with neat diagram. Mention its advantages and disadvantages.
3. Explain heat transfer through fenestration.
4. Write a short note on central heating system and chilled water plant.
5. Discuss the common causes of AC fires? What are the steps to be taken to prevent fires?
6. Explain about thermal indices of comfort.
7. Explain in detail the different types of shading devices.
8. What in natural ventilation? Give its purpose. Explain the principles behind wind driven and stack ventilation mechanisms. ***(AU Jan 2017)***
9. Describe the principle, construction and working of a Window Air Conditioner.
10. Discuss the different air conditioner systems for buildings.
11. Explain about the climate and design of solar radiation.
12. What is thermal insulation? Give its importance. Name any two thermal insulators. ***(AU Jan 2017)***
13. Describe the construction and working of fan coil unit.

UNIT II

1. Derive an Expression for the amount of Sound energy absorbed by a wall per second in hall of volume V. ***(AU April 2015)***
2. Define reverberation time. Derive Sabine's formula for reverberation time using Growth and Decay method. ***(AU Jan 2017)***
3. What is absorption coefficient in terms of open window unit? Describe a method of measuring the absorption coefficient of the material. ***(AU April 2013)***
4. Classify the various sound absorbing materials.
5. What are the various factors affecting acoustics of buildings and their remedies?
6. Explain about the impact of noise in multi storied buildings.
7. What are the various methods of sound insulation?
8. i) Write short notes on porous absorbers. Give two examples. ***(AU Jan 2017)***
   ii) Describe airborne sound and impact sound insulation measurements.

UNIT III

1. Derive Cosines law and inverse square law in photometry.
2. Describe the principles of artificial lighting and supplementary artificial lighting.
3. Explain day light design of windows in detail with neat diagrams.
4. Write a note on models and artificial skies.
5. Write short notes on (i) Visual field glare (ii) Day light Calculation
6. i) Write note on Photopic, Mesopic and Scotopic vision. ***(AU Jan 2017)***
   ii) What is glare? How do you reduce it?
7. Describe the various photometric and radiometric quantities.
8. List any four artificial light sources and discuss about ambient, task and accent lighting in

buildings. ***(AU Jan 2017)***

9. How will you calculate the day light in buildings.
10. Explain supplementary artificial lighting with an example in detail.

UNIT IV

1. What are composites? Explain in detail about the structure and applications of Fibre Reinforced Plastics (FRP) and Fibre Reinforced Metals (FRM). ***(AU Jan 2017)***
2. Explain in detail the preparation, properties and applications of Fibre reinforced plastics.
3. Explain in detail the preparation and the properties of metallic glasses.
4. How are metallic glasses prepared? Explain how the melt spinner device can be used to produce met glasses.
5. What are shape memory alloys? How are they prepared? Explain with neat diagram their characteristics. List any four applications of shape memory alloy.
6. Discuss in detail the manufacturing process of ceramics and its applications.
7. Discuss the various properties and applications of ceramic materials in construction engineering.
8. Discuss the classification of ceramics.
9. Describe slip casting process in detail and mention different ceramic forming processes.
10. What are ceramics? With a neat diagram, explain the slip casting, Isostatic pressing and gas pressure bonding manufacturing processes. ***(AU Jan 2017)***
11. Explain thermal, mechanical, electrical and chemical properties of ceramic materials.
12. Discuss in detail the manufacturing process of ceramics and its applications.
13. Write note on i) Ferroelectric ceramics ii) Ferro magnetic iii) High aluminium ceramics.

UNIT V

1. Discuss the various earthquake hazards and explain the disaster mitigation after earthquake.
2. Discuss earthquake ground motion with types, intensity and magnitude.
3. Describe the earthquake in terms of p-waves, s-waves and explain various parameters.
4. Explain Deterministic seismic hazard analysis and probabilistic seismic hazard analysis.
5. Discuss the Deterministic seismic hazard analysis.
6. Explain in detail how the cyclone is formed. What are the different types?
7. Discuss in detail the cyclone and the flood hazards. What are the safety measures?
8. Discuss in detail about fire hazards and guidance on preventive measure. ***(AU Jan 2017)***
9. Describe fire proofing materials.

10. Explain in detail the operation of different types of fire extinguishers equipments.
11. Explain in detail the fire safety regulations and fire fighting equipments.
12. With neat diagrams, explain different types of body waves and surface waves in seismology. ***(AU Jan 2017)***

Prepared By | Approved By

Dr. S. Nirmala | **HOD - Physics**