V.S.B ENGINEERING COLLEGE, KARUR

DEPARTMENT OF CIVIL ENGINEERING

CLASS/SEMESTER: IV YEAR/VII SEMESTER B.E., CIVIL ENGINEERING

CE6701 – STRUCTURAL DYNAMICS AND EARTHQUAKE ENGINEERING

UNIT – I

THEORY OF VIBRATION

Two Marks Questions and Answers

1. **What is mean by Frequency?**

Frequency is number of times the motion repeated in the same sense or alternatively. It is the number of cycles made in one second (cps). It is also expressed as Hertz (H_Z) named after the inventor of the term. The circular frequency ω in units of sec^{-1} is given by $2\pi f$.

2. **What is the formula for free vibration response?**

The vibration which persists in a structure after the force causing the motion has been removed. The corresponding equation under free vibration is $mx + kx = 0$

3. **What are the effects of vibration?**
   i. Effect on Human Sensitivity.
   ii. Effect on Structural Damage

4. **Define damping.**

Damping is the resistance to the motion of a vibrating body. Damping is a measure of energy dissipation in a vibrating system. The dissipating mechanism may be of the frictional form or viscous form. Unit of damping is N/m/s.

5. **What do you mean by Dynamic Response?**

The Dynamic may be defined simply as time varying. Dynamic load is therefore any load which varies in its magnitude, direction or both, with time. The structural response (i.e., resulting displacements and stresses) to a dynamic load is also time varying or dynamic in nature. Hence it is called dynamic response.

6. **What is mean by free vibration?**

The vibration which persists in a structure after the force causing the motion has been removed is known free vibration. **Example:** oscillation of a simple pendulum.

7. What is meant by Forced vibrations?

The vibration which is maintained in a structure by steady periodic force acting on the structure is known as forced vibration.

8. Write a short note on Amplitude.

It is the maximum response of the vibrating body from its mean position. Amplitude is generally associated with direction – vertical, horizontal, etc. It can be expressed in the form of displacement (u), velocity ($\dot{u}$) or acceleration ($\ddot{u}$).

9. Define Resonance.

When the frequency of external force is equal to or matches with one of the natural frequencies of the vibrating system, the amplitude of vibration becomes excessively large. This phenomenon is called resonance.

10. What is mean by Degrees of freedom?

The number of degrees of freedom of system equals the minimum number of independent co-ordinates necessary to define the configuration of the system.

11. Define static force.

A push or pull or a load or many loads on any system creates static displacement or deflection depending on whether it is a lumped system or a continues system; there is no excitation and hence there is no vibration.

12. Write a short note on simple Harmonic motion.

Vibration is periodic motion; the simplest form of periodic motion is simple harmonic. More complex forms of periodic motion may be considered to be composed of a number of simple harmonics of various amplitudes and frequencies as specified in Fourier series

13. What is the response for impulsive load or Shock loads?

Impulsive load is that which acts for a relatively short duration. Examples are impact of a hammer on its foundation. Damping is not important in computing response to impulsive loads since the maximum response occurs in a very short time before damping

forces can absorb much energy from the structure. Therefore, only the undamped response to impulsive loads will be considered.

14. Write a short note on single degree of freedom (SDOF) systems.

At any instant of time, the motion of this system can be denoted by single co-ordinate (x in this case). It is represented by a rigid mass, resting on a spring of stiffness 'k' and coupled through a viscous dashpot (representing damping) having constant 'C'. Here, the mass 'm' represents the inertial effects of damping (or energy dissipation) in the system. Using the dynamic equilibrium relation with the inertial force included, according to D'Alembert's principle, it can be written as

F_I +	F_D +	F_S =	P (t)
(Inertia Force)	(Damping force)	(Elastic force)	(Applied force)

This gives $mx + Cx + Kx = P$

x, x, x respectively denote the displacement, velocity and acceleration of the system. P (t) is the time dependent force acting on the mass. The above equation represents the equation of motion of the single degree freedom system subjected to forced vibrations**.**

15. Define Cycle.

The movement of a particle or body from the mean to its extreme position in the direction, then to the mean and then another extreme position and back to the mean is called a Cycle of vibration. Cycles per second are the unit Hz.

16. Write short notes on D'Alembert's principle.

According to Newton's law, **F = ma**

The above equation is in the form of an equation of motion of force equilibrium in which the sum of the number of force terms equal zero. Hence if an imaginary force which is equal to **ma** were applied to system in the direction opposite to the acceleration, the system could then be considered to be in equilibrium under the action of real force **F** and the imaginary force **ma**. This imaginary force **ma** is known as **inertia force** and the position of equilibrium is called **dynamic equilibrium**.

D'Alembert's principle which state that a system may be in dynamic equilibrium by

adding to the external forces, an imaginary force, which is commonly known as the inertia force

17. Write the mathematical equation for springs in parallel and springs in series

Springs in parallel

$$k_e = k_1 k_2$$

k_e is called equivalent stiffness of the system

Springs in series

$$\frac{1}{k_e} = \frac{1}{k_1} + \frac{1}{k_2}$$

18. Define logarithmic decrement method.

Logarithmic decrement is defined as the natural logarithmic value of the ratio of two adjacent peak values of displacement in free vibration. It is a dimensionless parameter. It is denoted by a symbol δ.

19. Write short notes on Half-power Bandwidth method.

Bandwidth is the difference between two frequencies corresponding to the same amplitude. Frequency response curve is used to define the half-power bandwidth. In which, the damping ratio is determined from the frequencies at which the response amplitude is reduced $1/\sqrt{2}$ times the maximum amplitude or resonant amplitude.

20. Define critical damping.

Critical damping is defined as the minimum amount of damping for which the system will not vibrate when disturbed initially, but it will return tot the equilibrium position. This will result in non-periodic motion that is simple decay. The displacement decays to a negligible level after one nature period T.

21. List out the types of damping.

(1) Viscous Damping **(2)** Coulomb Damping, **(3)** Structural Damping, **(4)** Active Damping, **(5)** Passive Damping.

22. What is meant by damping ratio?

The ratio of the actual damping to the critical damping coefficient is called as damping ratio. It is denoted by a symbol ρ and it is dimensionless quantity. It ca be written as

$$\rho = c/c_c$$

23. Define vibration.

Vibration is the motion of a particle or a body or a system of concentrated bodies having been displaced from a position of equilibrium, appearing as an oscillation.

24. What are the types of vibration?

1. Free and forced vibration
2. Linear and non-linear vibration
3. Damped and undamped vibration
4. Deterministic and random vibration
5. Longitudinal, Transverse and torsional vibration.

25. What are the methods to derive equation of motion?

1. Simple harmonic motion method
2. Newton's method
3. Energy method
4. Rayleigh's method
5. D'Alembert's principle.

26. State Newton's second law.

"The rate of change of momentum is proportional of momentum is proportional to the impressed forces and takes place in the direction in which the force acts".

27. What are the methods to measure damping?

1. Logarithmic decrement method.
2. Half power bandwidth method.

28. Define Dynamic Load Factor (DLF) (or) magnification factor.

It is defined as the ratio of dynamic displacement at any time to the displacement produced by static application of load.

$$DLF = X_{dyn} / X_{static}$$

29. What is meant by frequency response curve?

A curve plotted between frequency ratio and magnification factor for a few values of ρ is known as frequency response curve.

30. What is meant by phase lag?

The steady state response is expected to occur at the forcing period of $T = 2\pi/\omega$ but it occurs with a delay (or) with a time difference of $(\Phi/2\pi)$. Thus $(\Phi/2\pi)$ is called phase lag.

31. What are the instruments used for measuring vibration?

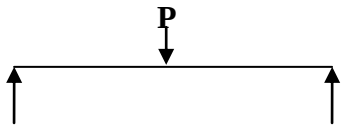
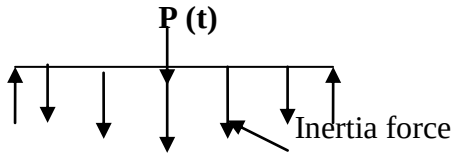
1. Seismometer
2. Accelerometer.

32. Define Transmissibility ratio. (T_R)

Force transmitted to the foundation to the amplitude of the applied forces is known as transmissibility of the support system.

$T_R = F_T/F$

33. Differentiate between static and dynamic loading.

Static Loading	Dynamic loading
1. Load is constant with respect to time. 2. Static problem has only one response i.e., displacement. 3. It has only one solution. 	1. Load and its responses vary with respect to time. 2. It has three responses i.e., displacement, velocity and acceleration. 3. It has an infinite number of solutions. 

34. What are the causes of dynamic effects?

1. Initial conditions
2. Applied forces
3. Support motions.

35. Define mass(m), stiffness(k) and natural period(T)

1. **Mass** is obtained by dividing the weight of the body by the acceleration of gravity. M = w/g. unit is kilograms (kgs).
2. **Stiffness** is defined as the force required to produce unit deformation. Its unit is N/m.
3. **Natural period** is defined as the time required to complete one cycle of free vibration. It is expressed in seconds.

UNIT – II

MULTIPLE DEGREE OF FREEDOM SYSTEM

1. Define degrees of freedom.

The no. of independent displacements required to define the displaced positions of all the masses relative to their original position is called the no. of degrees of freedom for dynamic analysis.

2. Define the fundamental frequency.

The lowest frequency of the vibration is called the fundamental frequency and the corresponding displacement shape of vibration is called first mode of vibration.

3. What is mean by flexibility matrix?

Corresponding to the stiffness (k), there is another structural property known as flexibility which is nothing but the reciprocal of stiffness. The flexibility matrix F is thus the inverse of the stiffness matrix, $[F] = [K]^{-1}$.

4. What is meant by decoupling of equations?

To simplify the response of MDOF system the coupled differential equations must be transformed to independent or uncoupled equations which contain only one dependent variable. This process of uncoupling the coupled differential equation is called decoupling of equations.

5. What are the effects of Damping?

The presence of damping in the system affects the natural frequencies only to a marginal extent. It is conventional therefore to ignore damping in the computations for natural frequencies and mode shapes

6. Write a short note on damping force – Damping force matrix.

If damping is assuming to be of the viscous type, the damping forces may likewise be represented by means of a general damping influence co efficient, C_{ij}. In matrix form this can be represented as

$$\{fD\} = [C]\{Y\}$$

7. What are the steps to be followed to the dynamic analysis of structure?

The dynamic analysis of any structure basically consists of the following steps.

1. Idealize the structure for the purpose of analysis, as an assemblage of discreet

elements which are interconnected at the nodal points.

2. Evaluate the stiffness, inertia and damping property matrices of the elements chosen.
3. By supporting the element property matrices appropriately, formulate the corresponding matrices representing the stiffness, inertia and damping of the whole structure.

8. What are normal modes of vibration?

If in the principal mode of vibration, the amplitude of one of the masses is unity, it is known as normal modes of vibration.

9. Define Shear building.

Shear building is defined as a structure in which no rotation of a horizontal member at the floor level. Since all the horizontal members are restrained against rotation, the structure behaves like a cantilever beam which is deflected only by shear force.

10. What are the assumptions made in shear building idealization?

a. Deformation of structures is not affected by the axial force in the columns.
b. Stiffness due to columns and inertia due to slabs are considered.
c. No joint rotations in the structure.
d. Loads act horizontally so that slabs move parallel to each other.

11. What is mass matrix?

The matrix $\begin{bmatrix} m_1 & 0 \\ 0 & m_2 \end{bmatrix}$ is called mass matrix and it can also be represented as [m]

12. What is stiffness matrix?

The matrix $\begin{bmatrix} k_1 + k_2 & -k_2 \\ -k_2 & k_2 \end{bmatrix}$ is called stiffness matrix and it also denoted by [k]

13. Write short notes on orthogonality principles.

The mode shapes or Eigen vectors are mutually orthogonal with respect to the mass and stiffness matrices. Orthogonality is the important property of the normal modes or Eigen vectors and it used to uncouple the modal mass and stiffness matrices.

$\therefore \{\phi\}_i^T [k] \{\phi\}_j = 0$, this condition is called orthogonality principles.

14. Explain Damped MDOF system.

The response to the damped MDOF system subjected to free vibration is governed by

$$[M]\{\ddot{u}\} + [c]\{\dot{u}\} + [k]\{u\} = 0$$

In which [c] is damping matrix and $\{\dot{u}\}$ is velocity vector.

Generally small amount of damping is always present in real structure and it does not have much influence on the determination of natural frequencies and mode shapes of the system. ∴ The naturally frequencies and mode shapes for the damped system are calculated by using the same procedure adopted for undamped system

15. What is meant by first and second mode of vibration?

The lowest frequency of the vibration is called fundamental frequency and the corresponding displacement shape of the vibration is called **first mode or fundamental mode of vibration**. The displacement shape corresponding to second higher natural frequency is called **second mode of vibration.**

16. Define principal mode of vibration.

When both the masses vibrate at same frequency and in phase, a definite relationship exists between the amplitudes of the two coordinates and the displacement configuration which is called principal mode of vibration.

17. Define normal mode of vibration.

If in the principal mode of vibration the amplitude of one of the masses is unity, it is known as normal mode of vibration.

18. Write the equation of motion for an undamped two degree of freedom system.

$$[m]\{\ddot{u}\} + [k]\{u\} = 0$$

This is called equation of motion for an undamped two degree of freedom system subjected to free vibration.

19. What is meant by two degree of freedom and multi degree of freedom system?

The system which requires two independent coordinates to describe the motion is completely is called **two degree of freedom system**.

In general, a system requires n number of independent coordinates to describe it motion is called **multi degree of freedom system.**

20. Define mode shape and node.

Mode shape is a graphical representation of the relative amplitudes of the two coordinates and their phase angle relationship. The point at which the amplitude changes its sign from positive to negative (or) vice versa is called node.

21. Define normalization.

The normal modes are completely determined by assuming unit values for the amplitude of motion at the first degree of freedom. So that the normal modes of the remaining coordinate are computed relatively. This process of normalizing each mode is called normalization.

22. Write the concept of modal superposition method.

It is used to uncouple the coupled differential equations by means of transformation of coordinates which incorporates the orthogonality principles of the mode shapes.

While decoupling, the response of a MDOF system is reduced to the SDOF system.

23. Write the characteristic equation for free vibration of undamped system.

$$|[k] - \omega^2[m]| = 0$$

This equation is called as characteristic equation or frequency equation.

UNIT – III

ELEMENTS OF SEISMOLOGY

1. Define Seismology and Earthquake

Seismology is the study of the generation, propagation generation and recording of elastic waves in the earth and the sources that produce them.

An **Earthquake** is a sudden tremor or movement of the earth's crust, which originates naturally at or below the surface. About 90% of all earthquakes results from tectonic events, primarily movements on the faults.

2. What are the causes of Earthquake?

Earthquake originates due to various reasons, which may be classified into three categories. Decking waves of seashores, running water descending down waterfalls and movement of heavy vehicles and locomotives, causes feeble tremors these earthquakes are feeble tremors, which don't have disastrous effects.

Contrary to the volcanic earthquake and those due to superficial causes, which can be severe, only locally, the more disastrous earthquakes affecting extensive region are

associated with movements of layers or masses of rocks forming the crust of the earth. Such seismic shocks, which originate due to crustal movements, are termed as tectonic earthquakes.

3. **What is mean by Epicenter and focus?**

The point at which the rupture begins and the first seismic wave originates is called **focus** or **hypocenter**. The point on the ground directly above the focus is called **epicenter.**

4. **What are the sources of earthquakes?**

Earthquake

Natural sources	Manmade sources
1. Tectonic earthquakes	1. Controlled sources
2. Volcanic earthquakes	2. Reserved induced earthquakes
3. Rock faults	3. Mining induced earthquakes

5. **How earth is divided?**

Earth is divided into four main layers

1. The inner core (solid)
2. Outer core (liquid)
3. Mantle (solid but can deform slowly in a plastic manner)
4. Crust

6. **Write a short note on Plate Tectonic Theory**

Tectonic is the study of deformations of earth materials that result from deformation. Plate tectonics refers to deformation on a global scale. The basic hypothesis of plate tectonics is that the surface of the earth consists of a number of large plates. These plates move relative to one another. The present six important plates are namely

1. African plate
2. American plate
3. Antarctic plate
4. Australian – Indian plate
5. Eurasian plate
6. Pacific plate

7. **Write a short note on Seismic waves.**

Large strain energy released during an earthquake travel as seismic waves in all directions through the earth's layers, reflecting at each interface. These waves are of two types,

1. Body waves
    a) primary waves (p-waves)
    b) secondary waves (s-waves)
2. Surface waves.
    a) Love waves
    b) Rayleigh waves

8. Define rock fault.

A fault is a break or fracture in the materials of the earth along which there has been displacement. Fault is a fracture having appreciable movement parallel to the plane of the fracture.

9. What are the types of fault?

1. Dip-slip fault
    a. Normal fault
    b. Reverse fault
2. Strike slip fault
3. Oblique fault.

10. What is meant by Richter scale?

Charles F.Richter, an American seismologist developed a scale of magnitude which is called Richter scale. The logarithmic form of Richter scale is

$$M = \log_{10}A - \log_{10}A_0$$

In Richter scale, the scale number ranges from 0 to 9.

11. Write a short note on Magnitude.

The magnitude of an earthquake is the quantitative measure of the amount of strain energy released during an earthquake. The earthquake scale is devised by Charles F. Richter, an American seismologist be based on the total amount of energy released during an earthquake be called magnitude.

12. What is mean by seismogram?

A seismogram is the graph output by a seismograph. It is a record of ground motion at a measuring station. The energy measured in a seismogram may result from earthquake or from some other source.

13. Write a note on Intensity.

Intensity indicates the intensity of shaking or extent of damage at a given location due to particular earthquake. Thus the intensity of some earthquake will be different at different places. Intensity is a measure earthquake in qualitative way by judging what actually happens on the ground, the damage to the buildings and other structures caused by earthquake waves.

14. What are the commonly used intensity scales?

1. Ten point Rossi Forrel scale
2. Twelve point Modified Mercalli scale.

15. What is Elastic rebound theory?

The concept of possible mode of origin of tectonic earthquakes is known as Elastic Rebound theory.

16. Compare: Magnitude and Intensity of an earthquake.

Sl.No	Magnitude	Intensity
1.	Magnitude measures the energy release at the source of the earthquake. It is determined from measurements on seismographs.	Intensity measures the strength of shaking produced by the earthquake at a certain location. It is determined from the effects on people, structure and natural environment.
2.	Magnitude of an earthquake is a quantitative measure of its size. Thus the magnitude of the earthquake is a single number which does not vary from place to place.	Intensity is a qualitative measure of an earthquake, based on the damage caused by them.
3.	Bhuj earthquake of January 2001 had a magnitude of 7.7 on Richter scale. The earthquake was felt over a large part of the state such as Bhuj, Ahmedabad etc. Magnitude of the earthquake of all the places remains same, i.e. 7.7.	The intensity of the same earthquake at Bhuj is different from the intensity at Ahmedabad vice-versa.

17. How the earthquakes are classified?

Earthquake can be classified into the following types.

(a) According to plate boundaries
(b) According to its depth of focus
(c) According to its origin of the earthquakes
(d) Based on magnitude (M).

18. What is the difference between Inter plate earthquakes and Intra plate earthquakes?

(i) **Inter plate earthquakes:** The earthquake occurring along the boundaries of the tectonic plates are called as inter plate earthquakes.

Example: 1987, Assam Earthquake

(ii) **Intra plate earthquakes:** The earthquakes occurring within a plate are called as intra plate earthquakes.

Example: 1993, Latur Earthquake

19. What are the factors influences the ground motion?

The factors which influence the ground motion are:

(i) Magnitude of earthquake

(ii) Epicentral distance

(iii) Local soil conditions

20. What is the difference between shallow, intermediate and deep focus earthquake?

(i) **Shallow-focus earthquake:** In this case, the seismic shocks originate at a depth of about less than 70 km. Nearly 80% of the world's earthquakes are shallow-focus earthquakes.

(ii) **Intermediate-focus earthquake:** In this case, the seismic waves originate at a depth between 70 km to 300 km.

(iii) **Deep-focus earthquake:** Here, the point of origin of the seismic wave is at a depth of greater than 300 km.

21. What is Seismograph?

Seismograph is an instrument used to recording motions of the earth's surface caused by seismic waves, as a function of time. A modern seismograph includes five basic parts: a clock, a sensor called a seismometer that measures intensity of shaking at the instruments location, a recorder that traces a chart or seismogram, of the seismic arrivals, an electronic amplifier and a data recorder that stores the information for later analysis.

22. What is meant by seismogram?

Seismograms are the records produced by seismographs used to calculate the location and magnitude of an earthquake.

23. Explain volcanic Earthquake?

Earthquakes associated with volcanoes are more localized both in the extent of damage and in the intensity of the waves produced in comparison to those which are associated with

faulting motions. Deep below the centre of volcano, hot magma moves slowly through underground passages under pressure, as its makes it ways towards the earth's surface. As this happens, the surrounding rock is put under pressure as the magma pushes against it. This causes the rock to fracture and small earthquakes to occur.

24. What are the basic difference between Focus and Epicentre?

Focus is the location within the earth where fault rupture actually occurs whereas the epicentre is the location on the surface above the focus.

25. What is Focus (or) hypocenter?

Focus is an exact location within the earth where seismic waves are generated by sudden release of stored elastic building. It is called as hypocenter. The place or the point of origin of an earthquake below the surface of the earth is called focus.

26. Define epicenter.

The place or point on the surface vertically above the focus of a particular earthquake is termed as its epicenter.

27. What is meant by isoseismal line or isoseists?

It is a line joining all points at which the intensity of the earthquake is the same.

28. What are the factors influencing ground motion?

1. Magnitude
2. Epicentral distance
3. Local soil conditions

29. What is accelerogram?

A graph plotted between acceleration of ground and time is called accelerogram. The nature of accelerogram's may vary depending on energy released at focus, type of faults, geology along the fault plane and local soil.

30. Explain Uttarkashi earthquake of 1991?

An earthquake of magnitude 6.6 struck the districts of Uttarkashi, Tehri and Chamoli in the state of Uttar Pradesh on October 20, 1991. About 768 persons lost their lives, with about 5,066 injured. Maximum peak ground acceleration of about 0.31g was record at Uttarkashi. Many four-storey buildings in Uttarkashi with RC frame and infill walls sustained the

earthquake. Howe ever, some of the ordinary RC buildings collapsed.

31. Write any four recent Indian earthquakes.

1. Bihar-Nepal earthquake, 1988
2. Bhuj earthquake, 2001
3. Sumatra earthquake, 2004
4. Sikkim earthquake, 2006

32. Enumerate TSUNAMI.

A tsunami is a wave train or series of waves, generated in a body of water by an impulsive disturbance that vertically displaces the water column. Tsunami is a Japanese word with the English translation, "harbour wave". The term "tsu" means harbour and "nami" means wave. Tsunami can be generated when the sea floor abruptly deforms and vertically displaces the overlaying water. Tectonic earthquakes are a particular kind of earthquakes that are associated with the earth's crustal deformation; when these earthquakes occur beneath the sea, the water above the deformed area is displaced from the equilibrium position. Waves are formed as the displaced water mass, which acts influence of gravity. When large areas of the sea floor elevate or subside, a tsunami can be created.

33. What is Focal depth and Epicentral distance?

(i) **Focal depth:** The distance between the epicentre and the focus is called focal depth.

(ii) **Epicentral distance:** The distance from epicentre to any point of interest is called epicentral distance.

UNIT – IV

RESPONSE OF STRUCTURES TO EARTHQUAKE

1. What do you understand by response spectrum?

A Response spectrum is the plot of the maximum response (maximum displacement, velocity, acceleration or any other quantity of interest) to a specified load function X_a (t) for all possible SDOF systems (having different natural frequencies or time periods T and a constant damping ratio).

2. What are the factors influencing response spectra?

1. Energy release mechanism
2. Epicentral distance
3. Focal depth
4. Soil condition
5. Richter magnitude
6. Damping
7. Time period

3. Define SEDRS.

A smooth curve is plotted by considering the average of a number of elastic response spectrums corresponding to various possible earthquakes at a particular site. It is known as the Smooth Elastic Design Response Spectrum (SEDRS).

4. What are the factors accompanied in design spectrum?

1. Load Factors
2. Damping to be used in the design
3. Method of calculating of natural period.
4. Type of detailing of ductility.

5. Define Liquefaction.

Liquefaction is a phenomenon in which the strength and stiffness of a soil is reduced by earthquake shaking or other rapid loading. The types of liquefaction includes

1. Flow Liquefaction.
2. Cyclic mobility.

6. What is meant by ductility ratio?

The ratio of the ultimate deformation to the deformation at the initial yielding can give the measure of ductility and it is also called ductility ratio.

7. What is meant by local or element ductility and global or structure ductility?

Introducing ductility in individual element is called **local or element ductility.**

If the ductility is referred with respect to the whole building or entire structure, it is called **global or structure ductility.**

8. What is mean by soil liquefaction?

Soil liquefaction during an earthquake is a process that leads to loss of strength or stiffness of the soil. This could result in the settlement of structures, cause landslides,

precipitates failures of earth dams or cause other types of hazards. Soil liquefaction has been observed to occur most often in loose saturated sand deposits.

9. What do you understand by lateral spreading?

Lateral spreading is the movement of surfacial soil layers, which occur there is a loss of shear strength in a subsurface layer due to liquefaction. Lateral spreading usually occurs on very gentle slopes (< 6%). If there is differential lateral under a structure, there could be sufficient tensile stresses developed in the structures that it could literally tear apart. Flexible buildings have been observed to better withstand extensional displacement than more stiff or brittle buildings.

10. What are the methods available on site Modification?

Several site modification methods have been devised and adopted to reduce the potential or susceptibility of the soils beneath a site to liquefy. Some of them include

i. Excavation and Replacement of liquefiable soils
ii. Densification of in – situ soils
iii. In –stu improvement of soils by alteration
iv. Grouting or chemical Stabilization.

11. Write a short note on Soil Alteration?

The third major category of site improvement methods is alteration of the soil to reduce the potential for liquefaction. The soil may be made more resistant by the construction of mixed – in place solidified piles or walls to provide shear resistance which would confine an area of liquefiable soils to prevent flow.

12. What is mean by Grouting?

The fourth category of soil improvement methods is soil grouting or chemical stabilization. These would improve the shear resistance of the soils by injection of particulate matter, resins or chemicals into the voids. Common applications are jet grouting and deep soil mixing.

13. What is mean by Structural Damping?

Damping of structural systems plays a major role in determining the response of the structure for ground motions induced by earthquakes. The actual stiffness of foundation

and damping co – efficient are dependent on the frequency of vibration.

14. What are the effects of Damping on soil – structure interaction?

Simple single degree of freedom (SDOF) system is considered for the analysis. The system is mounted on a rigid, mass-less and L-Shaped foundation which in turn is supported on an elastic foundation.

15. Define Ductility.

The ability of a structure or its components or of the materials used to offer resistance in the inelastic domain of response in described by the term ‘ Ductility”. It includes the ability to sustain large deformations, and a capacity to absorb energy hysteretic behavior.

16. What are the basic concepts for ductile performance structures?

i. Selection of sound structural configuration with a well defined lateral load resisting system.
ii. Systematic placement of stiff elements with a view to minimize increase in member forces due to torsion.
iii. Availability of direct load path for force transfer from superstructure to soil medium.
iv. Proper detailing of members and joints is very much necessary

17. Write a short note on Push over analysis.

Pushover analysis is a static analysis procedure for assessing the capacity of structural members against seismic forces. A number of widely used procedures (FEMA 273, ATC – 40) compare these demands with the recommended values of member capacities varying with the level of the performance objectives employed. Each member is classified as either force based or displacement based, depending on its mode of behavior.

18. Mention the different Variable affecting sectional ductility.

The variables that affect sectional ductility include,

i. Material variables such as the maximum usable compressive strain in concrete and grade of reinforcement.
ii. Geometric variables such as the amount of tension and compression reinforcement and the shape of the section.
iii. Loading variables such as the level of axial load accompanying shear.

19. What do you understand by Response reduction factor (R)?

It is the factor by which the actual base shear force, that would be generated if the structure were to remain elastic during its response to design basis Earthquake shaking, shall be reduced to obtain the design lateral force. Ductile buildings are designed for seismic forces that are R times lower than the elastic behavior would require.

20. Write a Short notes on the Analysis of structural Response Based on Soil properties.

Analysis of soil structure interaction can be either using the direct method or the multiple – step method. In the direct method, finite element model of the soil – foundation system is generated and solved in a single step. Multi – step method of analysis uses the principle of superposition to isolate the two primary causes of soil – structure interaction, a) the inability of the foundation to match free field deformation; b) the effect of dynamic response of foundation – structure system on the movement of the supporting soil.

21. What is zero period acceleration?

Zero period acceleration implies maximum acceleration experienced by a structure having zero natural period (T =0). An infinitely rigid structure has zero natural period (T = 0). It doesn't deform. Thus relative motion between its mass and its base, Mass has same acceleration as of the ground. Hence ZPA is the same as peak ground acceleration.

22. What is a design spectrum?

Response spectrum developed for displacement, pseudo-velocity and pseudo acceleration in a combined manner for elcentro earthquake (1940) for various damping ratios. This type of spectrum called tripartite response spectrum. For design purpose, local peaks and valleys should be ignored, since natural period can't be calculated with accuracy. Hence smooth cure plotted by considering the average number of elastic response spectrums corresponding to various possible earthquakes at particular site. It is known as design spectrum.

23. What is peak ground acceleration (PGA)?

PGA is a measure of earthquake acceleration. Unlike Richter scale, it is not a measure of the total size of the earthquake, but rather how hard the earth shakes in a given geographical area. PGA is what is experienced by a particle on the ground.

24. Enumerate site specific response spectrum.

A site specific response spectrum is plotted by taking the average of each record of site

specific ground motions. This results in smooth means spectrum. The recorded earthquake motions clearly show that response spectrum shape differs for different types of soil profile at the site. Seed, Ugas and Lysmer (1985) plotted the average shape of response of spectrum.

25. What are the methods to reduce liquefaction?

(a) Avoid liquefaction-susceptible soils
(b) Build liquefaction-resistant structures
(c) Shallow foundation aspects
(d) Deep foundation aspect
(e) Improve the soil
(f) Drainage techniques
(g) Verification of improvement

26. List out the effects of liquefaction.

(a) Loss of bearing strength
(b) Lateral spreading
(c) Sand boils
(d) Flow failures
(e) Ground oscillation
(f) Flotation
(g) Settlement.

27. What is pounding?

Pounding is another important issue in the construction of multistory frame in urban areas. That is when two multistory frames are constructed too close to each other; they may pound on each other during strong ground motion which leads to collision. To avoid collection, adjacent buildings should be separated by minimum gab. These factors imply that nowadays there is a need of earthquake resistance architecture in highly seismic areas.

28. Name the four techniques of aseismic design.

The following four techniques of aseismic design or earthquake resistant building are:

(a) Structural configuration
(b) Lateral strength
(c) Good ductility
(d) Light weight mass.

29. Define inertia force.

Inertia forces are equal to the product of mass and acceleration as per the Newton's Second Law F = ma. Where 'a' is the acceleration and 'm' is the mass.

30. What are the causes of failure of RC frame buildings?

The failure are due to mainly lack of good design of beams/columns frame action and foundation. Poor quality of construction inadequate detailing or laying of reinforcement in various components particularly at joints and in columns/ beams for ductility. Inadequate diaphragm action of roof and floors. Inadequate treatment of masonry walls.

31. What are the advantages of steel and reinforced concrete composite structures?

Steel and RC composite structures are composed of steel skeleton and RC and have the dynamic characteristics of both. It is better with respect to fire resistance and safety against buckling as compared to steel skeleton. Whereas compared to RC structures it has better ductility after yielding. As these features are the properties, which are effective for making a building earthquake resistant and are, found to perform better during earthquakes.

32. Write the behavior of prestressed concrete under earthquake loading.

Prestressed concrete has long been accepted in statically loaded structures. In recent years prestressed concrete has been used in seismic resistant structures. Many thousands of structures have been constructed in which prestressed concrete has been incorporated. Large frame structures are constructed in prestressed concrete and these have performed satisfactorily under normal static and wind loading.

33. Define plain concrete.

Plain concrete is a brittle material. During the first cycle the stress strain curve is the same as that obtained from static tests. The decrease in stiffness and strength of plain concrete is due to the formation of cracks. The compressive strength of concrete depends on the rate of loading. As the rate of loading increases, the compressive strength of concrete increases but the strain at the maximum stress decreases. Plain concrete cannot be subjected to repeated tensile loads since its tensile strength is practically zero.

34. Define Bouchinger effect.

If a specimen is highly deformed in one direction and then immediately reloaded in the opposite direction, it began to flow in this direction at a reduced stress. This is called as

Bouchinger effect. This reflects the material deviation from ideal plastic behavior.

35. What are the two stages of Bouchinger effect?

- ✓ The **first stage** consists of the transient Bouchinger deformation, composed by early re-yielding and work hardening stagnation. The work hardening stagnation appears at a certain range of pre strain.
- ✓ The **second stage** is the permanent softening defined by stress offset in a region after transient period.

36. What is pinching effect?

"pinching effect" is the result of steel bar direction deviating from that of the principal stresses. When the steel bars are oriented in the directions of the applied principal stresses, there was no pinching effect. When the steel bars are oriented at an angle of 45° to the applied principal stresses, there is severe pinching effect. It is obvious that the pinching effect is caused by the orientation of the steel bars, rather than the bond slips between the steel bars and the concrete.

UNIT – V

DESIGN METHODOLOGY

1. What is the formula to find the load factors for plastic design of steel structures?

In plastic design of steel structures, the following load combinations shall be accounted for

1. 1.7(DL+IL)
2. 1.7(DL+EL)
3. 1.3(DL+IL+EL)

When Earthquake forces are considered on a structure, these shall be combined as per Load combination for plastic design of steel structures and partial safety factor for limit state deign of RC and PSC structures.

2. What are the methods of improving element level Ductility?

Ductility in element level is generally with reference to the displacement and moment curvature relationship of a section. This can be generally improved by

i. Decreasing the tension steel area, yield stress and strain of the tension steel increasing the ultimate compressive strain of concrete.

ii. Increasing the area of compression steel.

iii. Reduction in the axial compression on the section.

iv. Provision of effective confinement stirrups, hoops or ties such that compressive steel does not buckle and concrete is led into three dimensional state of stress such that its ultimate compressive strain increases.

3. Write the IS 13920 provisions for flexural members.

The provisions apply to frame members resisting earthquake induced forces and designed to resist flexure. These members shall satisfy the following provisions

(a) The factored axial stress on the member under earthquake loading shall not exceed 0.1fck.

(b) The member shall preferable have a width to depth ratio more than 0.3

(c) Width of the member shall not be less than 200mm.

(d) The depth D of the member shall preferably be not more than ¼ of clear span.

4. What is the formula for finding out the Base shear using seismic co efficient method?

$$V_B = A_h W$$

Where, V_B = is base shear, Ah = Design seismic horizontal seismic coefficient

W = Total weight of building

5. Write the methods of dynamic analysis of multistoreyed structure as per Indian Code IS 1893 (1984)

IS 1893 (1984) gives the Necessary criteria for the earthquake resistant design of structures. This code states that structures should withstand without structural damage, moderate earthquakes and withstand without total collapse, heavy earthquakes.

This code specifies two methods of analysis

i. Seismic co-efficient method
ii. Modal analysis or Response Spectrum method.

6. What are the structural protective systems?

Modern protective system is based on (i) Seismic base isolation (ii) Passive energy dissipaters (iii) Semi active and active systems. Passive energy dissipaters are classified as hysteric, design seismic co – efficient design seismic co – efficient Visco – elastic and others based on the devices used. Eg yielding of metals through sliding friction

7. Write a short note on Mechanism of Base isolation.

The Mechanism of base isolation subjected to ground motion. The isolation reduces the fundamental lateral frequency of the structure from its fixed base frequency and thus shifts the position of structure in the spectrum from peak plateau region. Also it brings forth additional damping due to the increased damping introduced at the base level and thus reduction in the spectral acceleration is achieved.

8. Write down the steps to improve Global level Ductility?

(a) Increasing the redundancy of the structure
(b) Weak bam and strong column approach.
(c) Avoiding soft first storey effects
(d) Avoiding Non ductile failure modes like shear, bond & axial compression at the element level.

9. Define lateral load analysis of building system.

Earthquake force is an inertia force which is equal to mass times acceleration. Mass of the building is mainly located at its floors. Transferring the horizontal component of seismic force safely to the ground is the major task in seismic design. The floors should transfer the horizontal force to vertical seismic elements viz., columns, frames, walls and subsequently to the foundation finally to the soil.

10. Write a short note on Indian seismic codes.

The codes ensure safety of buildings under earthquake excitation IS 1893 – 1962, recommendations for earthquake resistant design of structures. IS 1893 – 1984 the country has divided into five zones in which one can reasonably forecast the intensity of earthquake shock which will occur in the event of future earthquake.

11. Define the term DBE, MCE and MMI.

DBE: Design Basics Earthquake

MCE: Maximum Considered Earthquake

MMI: Mercalli Intensity Scale

12. What is the design philosophy adopted for earthquake resistant structure?

The extreme loading condition caused by an earthquake and also the low probability of such an event occurring within the expected life of a structure, the following dual design philosophy is usually adopted

i. The structure is designed to resist the expected intensity of ground motion due to a moderate earthquake so that no significant damage is caused to the basic structure and

ii. The structure should also be able to withstand and resist total collapse in the unlikely event of a severe earthquake occurring during its lifetime. The designer is economically justified in this case to allow some marginal damage but total collapse and loss of life must be avoided.

13. Write down the formula to find out the Magnitude as per the IS code.

The amount of strain energy released at the source is indicated by the magnitude of the earthquake. Magnitude = $\text{Log}_{10}(A_{max})$

Where A is the maximum aptitude in microns (10^{-3}m) recorded by Wood – Anderson seismograph. If E is the energy released, then

$$\text{Log } E = 11.8 + 1.5\ M$$

14. Why is base isolation effective?

The base isolation systems reduce the base shear primarily because the natural vibration period of the isolation mode, providing most of the response, is much longer than the fundamental period of the fixed base structure, leading to a much smaller spectral ordinate. The higher modes are essentially not excited by the ground motion; although their pseudo acceleration is large their modal static responses are very small.

The primary reason for effectiveness of base isolation in reducing earthquake induced forces in a building is the lengthening of the first mode period. The damping is the isolation system and associated energy dissipation is only a secondary factor in reducing structural response.

15. Explain two cases of design horizontal earthquake load.

(a) When the lateral resisting elements are oriented along orthogonal horizontal direction, the structure shall be designed for the effects due to full design earthquake load in one horizontal direction at time.

(b) When the lateral load resisting elements are not oriented along the orthogonal horizontal directions, the structure shall be designed for the effect due to full design earthquake load in one horizontal direction plus 30% of the design earthquake load in the other direction.

16. Write the formula for modal mass (M_k).

The modal mass $\mathbf{M_k}$ of mode k is given by:

$$M_k = \frac{[\sum_{i=1}^{n} W_i \, \phi_{ik}]^2}{g \sum_{i=1}^{n} W_i \, (\phi_{ik})^2}$$

17. Explain design eccentricity.

The design eccentricity, e_{di} to be used at floor I shall be taken as:

$$e_{di} = \begin{Bmatrix} 1.5\, e_{si} + \ 0.05 b_i \\ or\ e_{si} - \ 0.05 b_i \end{Bmatrix}$$

Whichever of these gives the more severe effect in the shear of any frame

Where e_{di} = Static eccentricity

e_{si} = defined as the distance between centre of mass and centre of rigidity

b_i = floor plan dimension of floor

18. What is additive shear?

Additive shear will be super-imposed for a statically applied eccentricity of $\pm 0.05 b_i$ with respect to centre of rigidity.

19. Name types of damper's.

(i) Metallic dampers or yielding dampers

(ii) Friction dampers

(iii) Viscous dampers

20. What is meant by Base isolation technique?

Seismic base isolation is a technique that mitigates the effects of an earthquake by essentially isolating the structure and its contents from potentially dangerous ground motion, especially in the frequency range where the building is most affected.

21. What are the needs for base isolation?

1. Building is located in a high seismic intensity zone.
2. Existing structure is unsafe.
3. Minimize the damage to primary and secondary structural members.
4. Cost economics of the structure with and without isolators.

22. What is meant by seismic dampers?

Dampers can be installed in the structural frame of a building to absorb some of the energy going into the building from the shaking ground during an earthquake.

23. What are the types of seismic dampers?

1. Metallic dampers or yielding dampers.
2. Friction dampers.
3. Viscous dampers.

24. What are the types of earthquake resistant design methods?

1. Lateral strength design
2. Ductility based design
3. Capacity design method
4. Energy based design

25. What are the types of seismic control systems?

1. Passive control system
2. Active control system
3. Hybrid control system
4. Semi-active control system

26. Write short notes on passive control system.

- ✓ It works on energy transformation principle.
- ✓ It is passive in the sense that it does not require any additional energy source to operate and is activated by the earthquake input motion only.
- ✓ **Example:** Isolators, dampers and oscillators.

27. Write the examples of active control system.

Active TMDs, Tuned liquid dampers, active braces systems and active tendon system.

28. What are the factors that contribute the over strength factor?

- ✓ Load factor on seismic and gravity load
- ✓ Material factors
- ✓ Member sizes/reinforcement more than required
- ✓ Special ductile detailing
- ✓ Redundancy
- ✓ Strain hardening in materials
- ✓ Higher material strength under cyclic loads
- ✓ Strength contribution of non structural members

29. Define over strength factor.

It is ratio of yield force or maximum inelastic force in an elasto plastic system and design force.

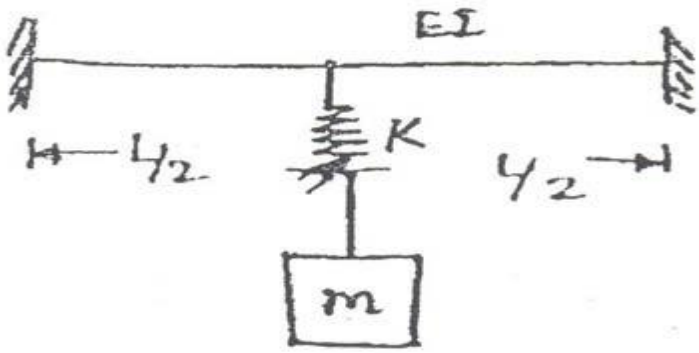
30. What are the factors that govern the architectural configurations?

- ✓ Architectural design
- ✓ Functional requirements
- ✓ Urban design parameters
- ✓ Planning considerations
- ✓ Aesthetic appearance

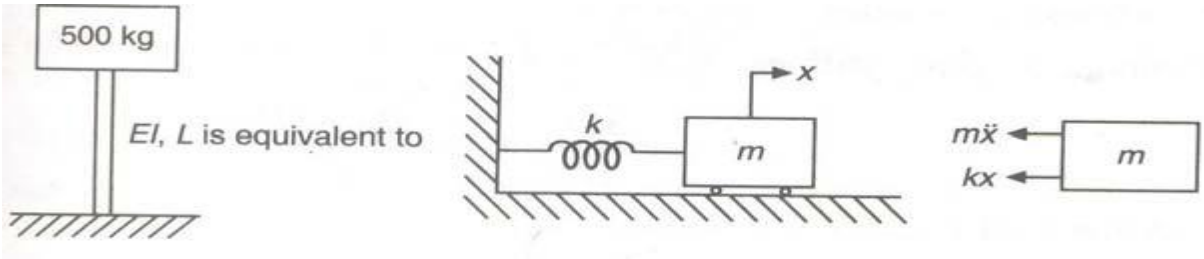
PART-B QUESTIONS (16 MARKS)

UNIT I THEORY OF VIBRATIONS

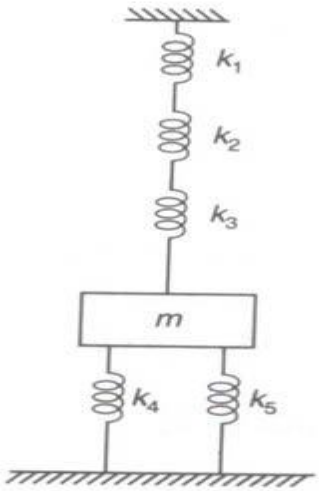
1. Show that the log – decrement is also given by the equation U = 1/n log (U0/ Un) represents the amplitude after n cycles have elapsed.
2. A machine foundation weighs 60 KN. The spring constant is 11000KN/m and dash pot constant (C) = 200KN/s/m. Determine
   a. Whether the system is over damped, under tamped or critically damped.
   b. Logarithmic decrement
   c. Ratio of two successive amplitudes
   d. If the initial displacement is 10mm and initial velocity is zero displacement at t = 0.1s
3. A mass ‘m’ is suspended from a beam shown in figure. The beam is of negligible mass and has a uniform flexural rigidity ‘EI’. Find the natural frequency of the system.



4. A mass of 10kg is supported by a steel wire 1m in dia and 3m long. The system is made to move upwards with a uniform velocity of 10 cm/sec when the upper end is suddenly stopped. Determine the frequency and the amplitude of the resulting vibrations of the mass and the maximum stress on the wire.
5. A vibrating system consists of a mass of 5kg, spring of stiffness 120 N/m and a damper with a damping co-efficient of 5 N/s/m. determine
    a. Damping factor
    b. Natural frequency of the system
    c. Logarithmic decrement
    d. The ratio of two successive amplitude
    e. The number of cycles after which the initial amplitude reduces to 25%
6. A single degree of freedom system having a mass of 2.5m is set into motion with a viscous damping and allowed to oscillate freely. The frequency of oscillation is found to be 20 Hz, and measure of the amplitude of vibration shows two successive amplitude to be 6mm and 5.5mm. Determine the viscous damping co-efficient.
7. A damper offers resistance 0.08 N at a constant velocity 0.06m/s. the damper is used with a spring of stiffness equal to 12 N/m. Determine the damping ratio and frequency of the system when the mass of the system is 0.3 kg.
8. A harmonic motion has a maximum velocity of 6 m/s and it has a frequency of 12 cps. Determine its period, amplitude and maximum acceleration.
9. A cantilever beam 3m long supports a mass of 500 kg at its upper end. Find the natural period and the frequency. E = 2.1 x 106 kg/cm2 and I = 1300 cm4



10. Consider the system shown in figure. If k1 = 2000 N/m, k2 = 1500 N/m, k3 = 3000 N/m, k4 = k5 = 500 N/m, find the mass if the natural frequency of the system is 10 Hz.



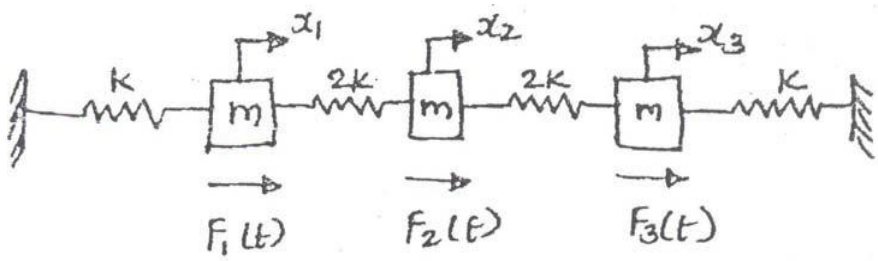
11. Explain duhamel's integral in detail with neat sketches.

UNIT –II MULTIPLE DEGREE OF FREEDOM SYSTEM

1. Determine the natural frequency and mode shapes of a MDF system. The mass and the stiffness matrix of a MDF system is given by

$$[M]=m\begin{bmatrix}1 & 0 & 0\\ 0 & 1 & 0\\ 0 & 0 & 2\end{bmatrix},\ [K]=K\begin{bmatrix}2 & -1 & 0\\ -1 & 3 & -2\\ 0 & -2 & 2\end{bmatrix}.$$

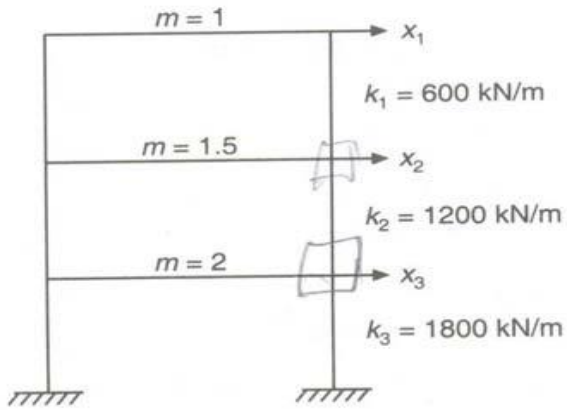
2. A three spring mass system is shown on figure. All the masses are subjected to dynamic forces. Derive the equation of motion in terms of displacements x1, x2, x3 of the masses along the axis of the springs.



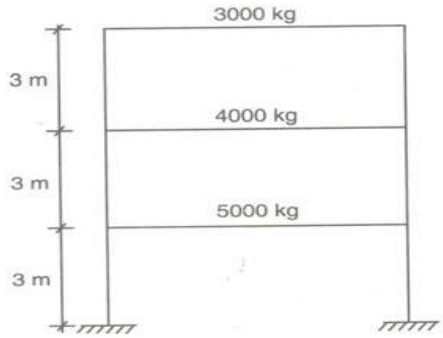
3. State and prove orthogonality property of mode shapes.
4. In a two storey building frame, the mass M1 = M2 = 1000 Kg and stiffness are k1 = k2 = 1 MN/m. If a horizontal force of 20kN is applied ath eht top of ground storey level, determine the displacement of the masses M1, M2. The stiffness and the mass matrix of two degree of freedom system are given.

   K = [200 200 and mass m = [2 0

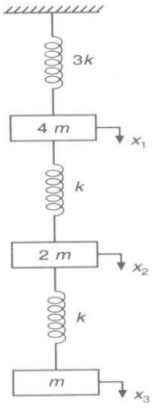
   200 500] 0 3] Determine the natural frequency of the system.
5. Calculate natural frequency and draw the mode shape for the shear building.



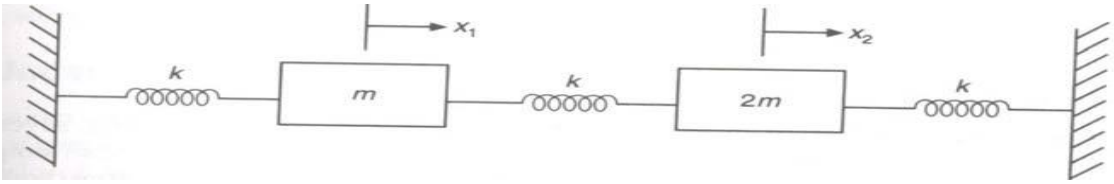
6. Determine the natural frequency and mode shape for the MDOF system. EI = 4.5 x 10^6 N-m^2 for all columns.



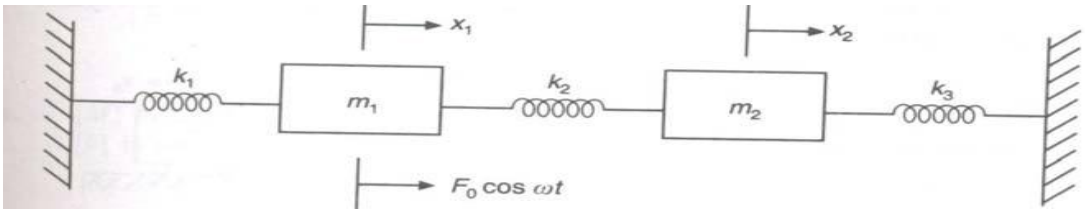
7. Find the natural frequency and mode of the system.



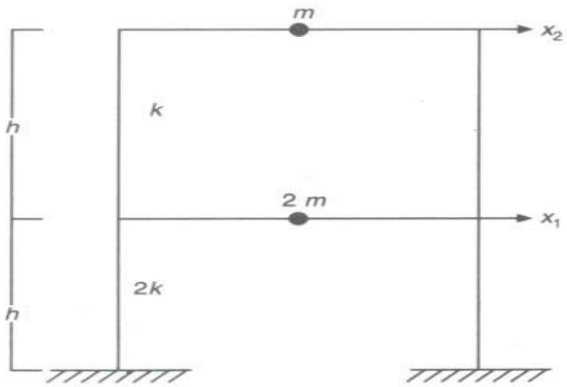
8. Find the natural frequency and mode of vibration for the system shown.



9. Determine the steady state response of the system



10. Determine the natural frequency and mode of vibration of the system



UNIT –III ELEMENTS OF SEISMOLOGY

1. Explain the causes of earthquake and geological faults
2. List out some past disastrous earthquakes
3. Explain the seismic waves with neat sketch

4. Briefly explain plate tectonics and elastic rebound theory.
5. Explain the seismograph and seismogram in detail.
6. Describe the two approaches followed for the prediction of earthquakes.name the major plates of the earth.
7. On what is the assignment of an earthquake magnitude based? is magnitude the same as intensity? Explain.
8. Differentiate magnitude and intensity. How will you measure magnitude and intensity? Explain the methods briefly.
9. Explain about some recent earthquakes and give information on some disastrous earthquakes.
10. What are the types of earthquake explain briefly and discuss about elastic rebound theory.

UNIT –IV RESPONSE OF STRUCTURES TO EARTHQUAKE

1. Explain the effect of soil properties and liquefaction of soils.
2. Explain response behavior and ductility demand in multistoried building with neat sketch.
3. Explain the factors affecting ductility.
4. Define liquefaction of soils. Explain in detail about the factors affecting liquefaction.
5. Briefly explain smooth spectrum and seismic demand diagrams.
6. Explain the Pinching and Bouchinger effect in detail.
7. Explain the behavior of RC steel and prestressed concrete structure under earthquake loading.
8. Define response spectra. Explain the concept and types of response spectra with neat sketch.
9. Why ductility consideration is very important in earthquake resistant design of RC building? Explain the ductile detailing considerations in flexural members as per IS 13920-1993.
10. Define design spectra. Write the concepts of PGA and ZPA.

UNIT –V DESIGN METHODOLOGY

1. What are the effects of base isolation? Explain with suitable examples.
2. What the causes of damage in earthquakes?
3. Explain the planning considerations/architectural concepts as per IS 4326-1993.
4. Briefly explain the salient feature of earthquake resistant provisions as per IS 4326-1993 for RC and masonry structures.

5. What are the methods used to analyses earthquake resistant structures? Explain the procedure of each method as per IS-1893:2002.
6. Why base isolation is effective in earthquake resistant design? Explain the effectiveness in multistory buildings.
7. In what manner is the behavior of soft storey construction likely to be different from a regular construction in the event of an earthquake?
8. Explain about Earthquake design philosophy and also give the main criteria for earthquake resistant measures.
9. Explain in detail about the types of dampers.
10. Write the design procedure for seismic analysis of RC buildings.
11. A three storeyed, symmetrical reinforced concrete school building in zone V with plan dimensions 7m, storey height of 3.5m. Total weight of beams in a storey is 130 kN and total weight of slab in a storey 250kN. Total weight of columns in a storey is 50kN and total weight of walls in a storey 530kN. Live load = 130kN, Weight of terrace floor is 655kN resting on hard rock. Damping = 5%. Determine the base shear and lateral loads at each floor by seismic coefficient method.

CE6702 – PRESTRESSED CONCRETE STRUCTURES

UNIT 1- INTRODUCTION – THEORY AND BEHAVIOUR

1. List out the advantages of prestressed concrete. (AUC Nov/Dec 2011 & 2012)

In case of fully prestressed member, which are free from tensile stresses under working loads, the cross section is more efficiently utilized when compared with a reinforced concrete section which is cracked under working loads.

The flexural member is stiffer under working loads than a reinforced concrete member of the same length.

2. What is meant by pretensioned and post tensioned concrete? (AUC Nov/Dec 2010 & 2011)

Pre tensioning: A method of Pre stressing concrete in which the tendons are tensioned before the concrete is placed. In this method, the prestress is imparted to concrete by bond between steel and concrete.

Post tensioning: A method of pre stressing concrete by tensioning the tendons against hardened concrete. In this method, the prestress is imparted to concrete by bearing.

3. Why is high tensile steel needed for prestressed concrete construction? (AUC Nov/Dec 2012)

High strength concrete is necessary for prestress concrete as the material offers highly resistance in tension, shear bond and bearing. In the zone of anchorage the bearing stresses being hired; high strength concrete is invariably preferred to minimizing the

cost. High strength concrete is less liable to shrinkage cracks and has lighter modulus of elasticity and smaller ultimate creep strain resulting in a smaller loss of prestress in steel. The use of high strength concrete results in a reduction in a cross sectional dimensions of prestress concrete structural element with a reduced dead weight of the material longer span become technically and economically practicable.

Tensile strength of high tensile steel is in the range of 1400 to 2000 N/mm^2 and if initially

stress upto 1400 N/mm^2 their will be still large stress in the high tensile reinforcement after making deduction for loss of prestress. Therefore high tensile steel is made for prestress concrete.

4. What are the various methods of prestressing? (May/June 2013, Apr/May 2010)

- Pre-tensioning
- Post-tensioning

5. What are the systems of prestressing? (AUC May/June 2013)

Pretensioning systems

- Abutment method, Strut and Mould Method

Post tensioning systems

- Freyssinet systems
- Gifford Udall
- Lee-Mccall systems
- Magnel blaton systems

6. List the loss of prestress. (AUC Nov/Dec 2010 & 2013)

- Nature of losses of prestress.
- Loss due to elastic deformation of concrete.
- Loss due to shrinkage of concrete.
- Loss due to creep of concrete.
- Loss due to relaxation of stress in steel.
- Loss of stress due to friction.
- Loss due to anchorage slip.

7. What are the classifications of prestressed concrete structures? (AUC Nov/Dec 2013)

- Externally or internally prestressed
- Pretensioning and post tensioning
- End-Anchored or Non-End Anchored Tendons
- Bonded or unbonded tendons
- Precast, cast-in-place, composite construction
- Partial or full prestressing

8. Define load balancing concept. UC Apr/May 2011 & 2012)

It is possible to select cable profiles in a prestressed concrete member such that the

traverse component of the cable force balances the given type of external loads. This can be readily illustrated by considering the free body of concrete with the tendon replaced by forces acting on the concrete beam.

9. What are the factors influencing deflections? (AUC Apr/May 2011)

- Imposed load and self weight
- Magnitude of the prestressing force
- Cable profile
- Span of the member
- Length of the deflection field
- Spacing between the deflection plate
- Difference of potential between the plates
- Accelerating voltage of the second anode.

10. What are the sources of prestress force? (AUC Apr/May 2012)

- Mechanical
- Hydraulic
- Electrical
- Chemical

11. Define kern distance. (AUC Apr/May 2010)

Kern is the core area of the section in which if the load applied tension will not be induced in the section Kt = Zb / A, Kb = Zt / A,

If the load applied at K_t compressive stress will be the maximum at the top most fiber and zero stress will be at the bottom most fiber. If the load applied at K_b compressive stress will be the maximum at the bottom most fiber and zero stress will be at the top most fiber.

12. What is Relaxation of steel?

When a high tensile steel wire is stretch and maintained at a constant strain the initially force in the wire does not remain constant but decrease with time. The decrease of stress in steel at constant strain is termed relaxation of steel.

13. What is concordant prestressing?

Pre stressing of members in which the cable follow a concordant profile. In case of statically indeterminate structures. It does not cause any changes in support reaction.

14. Define bonded and non bonded prestressing concrete.

Bonded prestressing: Concrete in which prestress is imparted to concrete through bond between the tendons and surrounding concrete. Pre tensioned members belong to this group.

Non-bonded prestressing: A method of construction in which the tendons are not bonded to the surrounding concrete. The tendons may be placed in ducts formed in the concrete members or they may be placed outside the concrete section.

15. Define axial prestressing.

Members in which the entire cross-section of concrete has a uniform compressive prestress. In this type of prestressing, the centroid, of the tendons coincides with that of the concrete section.

16. Define prestressed concrete.

It is basically concrete in which internal stresses of a suitable magnitude and distribution are introduced so that the stresses resulting from external loads (or) counteracted to a desire degree in reinforced concrete member the prestress is commonly introduced by tensioning the steel reinforcement.

17. Define anchorage.

A device generally used to enable the tendon to impart and maintain prestress to the concrete is called anchorage. E.g. Fressinet, BBRV systems, etc.,

18. What are the main factors for concrete used in PSC?

- Ordinary Portland cement-based concrete is used but strength usually greater than 50 N/mm^2;
- A high early strength is required to enable quicker application of prestress; A larger elastic modulus is needed to reduce the shortening of
- the member; A mix that reduces creep of the concrete to minimize
- losses of prestress;

19. What are the uses of prestressed concrete?

- Railway Sleepers;
- Communications poles;
- Pre-tensioned precast “hollow core” slabs;
- Pre-tensioned Precast Double T units - for very long spans (e.g., 16 m span for car parks);
- Pre-tensioned precast inverted T beam for short-span bridges;
- Post-tensioned ribbed slab;
- This is “glued segmental” construction;

20. Define Magnel diagram.

A Magnel Diagram is a plot of the four lines associated with the limits on stress. As can be seen, when these four equations are plotted, a feasible region is found in which points of 1 *P* and *e* simultaneously satisfy all four equations. Any such point then satisfies all four stress limits.

21. What are the advantages of PSC construction?

- In case of fully prestressed member, which are free from tensile stresses under working loads, the cross section is more efficiently utilized when compared with a reinforced concrete section which is cracked under working loads.
- The flexural member is stiffer under working loads than a reinforced concrete member of the same length.

22. What is the principle of post tensioning?

In post tensioning the concrete units are first cast by incorporating ducts or grooves to house the tendons. When the concrete attains sufficient strength, the high tensile wires are tensioned by means of jack bearing on the end face of the members and anchored by wedges or nuts. The forces are transmitted to the concrete by means of the end anchorages and when the cable is curved,

through the radial pressure between the cable and the duct. The space between the tendons and the duct is generally grouted after the tensioning operations.

23. What is chemical prestressing?

It is also called as self stressing of concrete and it was made possible by the development of expanding cement. Generally expanding cements consist of 75 percent Portland cement, 15 percent high alumina cement and 10 percent gypsum, which result in the formation of calcium sulphoaluminate. The linear expansion of cement is about 3 to 4 percent. It is mainly applicable to structural systems and elements in which optimum amount of prestress is relatively low.

24. Enumerate the effect on tendon profile on deflections.

In most of the cases of prestressed beams, tendons are located with eccentricities towards the soffit of beams to counteract the sagging bending moments due to transverse loads. Consequently, the concrete beam deflects upwards on the application or transfer of prestress. Since the bending moment at every section is the product of the prestressing force and eccentricity, the tendon profile itself will represent the shape of the BMD.

25. Write the need for using M35-M40 grade of concrete in prestressed concrete.

Low shrinkage, minimum creep characteristics and a high value of young modulus are necessary for prestressed members. Many desirable properties such as durability, impermeability and abrasion resistance are highly influenced by the strength of concrete like M35 and M40.

26. What are the ways of improving the shear resistance of prestressed concrete beam?

- Horizontal or axial prestressing
- Prestressing by inclined or sloping cables
- Vertical or transverse prestressing

UNIT II DESIGN FOR FLEXURE AND SHEAR

1. What are the different types of flexural failure modes observed in PSC beams?

- Failure of under reinforced sections
- Failure of over reinforced sections
- Failure of sections by other modes
- Fracture of steel in tension

2. What is strain compatibility method?

The method of estimating the flexural strength of prestressed concrete sections is based on the compatibility of strains and equilibrium of forces acting on the section at the stage of failure.

3. What are the assumptions made for strain compatibility method?

- The stress distribution in the compression zone of concrete can be defined by means of coefficients applied to the characteristic compressive strength and the average compressive stress and the position of the centre of compression can be assessed.
- Plane sections normal to the axis remain plane after bending.
- The resistance of concrete in tension is neglected.
- The maximum compressive strain in concrete at failure reaches a particular value.

4. What are the basic assumptions for calculating flexural stressed?

- Plane section remains plane after bending.
- Perfect bond between concrete and prestressing steel for bonded tendons.
- The prestressed concrete section will also behave like a reinforced concrete section only after cracking.
- The tensile stressed are resisted by the steel components namely untensioned reinforcement if and the high tensile steel.
- The theories used for estimating the flexural strength of reinforced concrete section may also use for prestressed concrete sections.

5. List out five factors which influence the ultimate flexural strength of PSC beams.

- The failure mainly a flexural failure, which no effect of shear, bond or anchorage, which might decrease the strength of the section.
- The beams are bonded. Unbounded beams have different ultimate strength than for bonded beams.
- Beams are statically determinate.
- Ultimate loads, obtained are the result of short time static loading. No effect of impact fatigue or long time loading is considered.

6. Explain conventional failure of an over reinforced prestressed concrete beam.

An Over reinforced members fail by the sudden crushing of concrete. The failure being reinforced members fail by the sudden crushing of concrete. The failure being characterized by small deflections and narrow cracks, the area of steel being comparatively large, the stresses developed in steel at failure of the member may not reach the tensile strength.

7. Define degree of prestressing.

A measure of the magnitude of the prestressing force related to the resultant stress occurring in the structural member at working load.

8. Compare the flexure failure of conventional RC beam with PSC beam.

There is no difference in flexural failure of a conventional RC beam and a prestressed concrete beam. Because the prestressed concrete beam will behave as an RC beam, after flexural cracks are formed.

9. What is horizontal shear?

The horizontal shear stress is (normally) maximum at the neutral axis of the beam. This is opposite of the behavior of the bending stress which is maximum at the other edge of the beam, and zero at the neutral axis.

10. What are the three ways of improving the shear resistance of a prestressed concrete beams?

- Horizontal or axial prestressing
- Prestressing by inclined or sloping cables and
- Vertical or transverse prestressing

11. How will you carry out the analysis of the reinforced and prestressed concrete members under shear?

The analysis for axial load and flexure are based on the following principles of mechanics

- Equilibrium of internal and external forces
- Compatibility of strains in concrete and steel
- Constitutive relationship of materials

12. Mention the different types of cracks in a simply supported beam under uniformly distributed load without prestressing.

- Flexural cracks – These cracks form at the bottom near the midspan and propagate upwards.
- Web shear cracks – These cracks form near the neutral axis close to the support and propagate inclined to the beam axis.
- Flexure shear cracks – These cracks form at the bottom due to flexure and propagate due to both flexure and shear.

13. Write the functions of stirrups.

- Stirrups resist part of the applied shear.
- They restrict the growth of diagonal cracks
- The stirrups counteract widening of the diagonal cracks, thus maintaining aggregate interlock to a certain extent
- The splitting of concrete cover is restrained by the stirrups, by reducing dowel forces in the longitudinal bars.

14. Why the stirrups are anchored?

- The stirrups should be anchored to develop the yield stress in the vertical legs.

- The stirrups should be bent close to the compression and tension surfaces, satisfying the minimum cover.
- Each bend of the stirrups should be around a longitudinal bar. The diameter of the longitudinal bar should not be less than the diameter of stirrups.
- The ends of the stirrups should be anchored by standard hooks.
- There should not be any bend in a re – entrant corner. In a re – entrant corner, the stirrups under tension has the possibility to straighten, thus breaking the cover concrete.

15. Differentiate type I, type II and type III structures.

- In a type I member, no tensile stress is allowed under service loads or at transfer.
- In a type II member, tensile stresses are allowed but they should be within the cracking stress.
- For a type III member, the tensile stress can exceed the cracking stress, but still it is limited to a certain value which limits the crack width.

16. What are the variables which influence the moment and shear along the length of the beam?

The types and formation of cracks that depends on the span to depth ratio of the beam and loading influences the moment and shear along the length of the beam.

17. What is meant by unbounded tendons?

For members with unbounded tendons and with the span/depth ratio not exceeding 35, the stress n the tendons is computed by the relation,

$$Fps = (fps+70+(fc/100p_P))$$

18. What are the stages of loading to be considered in design of prestressed concrete section for flexure?

Two stages of loading are to be considered in design of prestressed concrete section for flexure are as,1)Transfer of prestressing force, 2)At working load (service stage)

19. Write the principles of mechanics for the analysis of axial load and flexure in PSC structures.

The analysis for axial load and flexure are based on the flowing principles of mechanics.

- Equilibrium of internal and external forces
- Compatibility of strains in concrete and steel
- Constitutive relationships of materials.

20. List out five factors which influence the ultimate flexural strength of PSC beams.

- The failure mainly a flexural failure, with no effect of shesr, bond or anchorage which might decrease the strength of the section.

- The beams are bonded. Unbonded beams have different ultimate strength than for bonded beams.
- Beams are statically determinate.
- Ultimate loads, obtained is the result of short time loading. No effect of impact fatigue or long time loading is considered.

21. Explain conventional failure of an over reinforced prestressed concrete beam.

(AUC Apr/May 2010)

An Over reinforced members fail by the sudden crushing of concrete. The failure being reinforced members fail by the sudden crushing of concrete. The failure being characterized by small deflections and narrow cracks, the area of steel being comparatively large, the stresses developed in steel at failure of the member may not reach the tensile strength.

22. Define degree of prestressing.

A measure of the magnitude of the prestressing force related to the resultant stress occurring in the structural member at working load.

23. Define Proof stress.

The tensile stress in steel which produces a residual strain of 0.2 percent of the original gauge length on unloading.

24. Define cracking load.

The load on the structural element corresponding to the first visible crack.

25. Define Debonding.

Prevention of bond between the steel wire and the surrounding concrete.

26. Write formula for Moment of resistance in BIS code.

$Mu = A_{pb} A_{ps} (d - d_n)$

UNIT III DEFLECTION AND DESIGN OF ANCHORAGE ZONE

1. **Define partial prestressing.** **(AUC May/June 2013, Nov/Dec 2011)**

The degree of prestress applied to concrete in which tensile stresses to a limited degree are permitted in concrete under working load. In this case, in addition to tensioned steel, a considerable proportion of untensioned reinforcement is generally used to limit the width of cracks developed under service load.

2. **Mention any two functions of end blocks.** **(AUC May/June 2013, Nov/Dec 2013)**

16. Provide Lateral (horizontal) stability from wind and other horizontal (Racking) loads.
17. Provide additional vertical load capacity for the ends of the joists from point loads above.

3. Define anchorage zone. (AUC Nov/Dec 2011)

Prestressed concrete contains tendons which are typically stressed to about 1000 MPa. These tendons need to be anchored at their ends in order to transfer (compressive) force to the concrete. The zone of region is called Anchorage zone.

4. How can PSC beam be considered to carry its own weight? (AUC Nov/Dec 2012)

By providing an external initial stress (the prestress) which compresses the beam. Now they can only separate if the tensile stress induced by the self weight of the beam is greater than the compressive prestress introduced.

5. What is effective reinforcement ratio? (AUC Apr/May 2012)

Ratio of effective area of reinforcement to the effective area of concrete at any section of a structural member is known as effective reinforcement ratio.

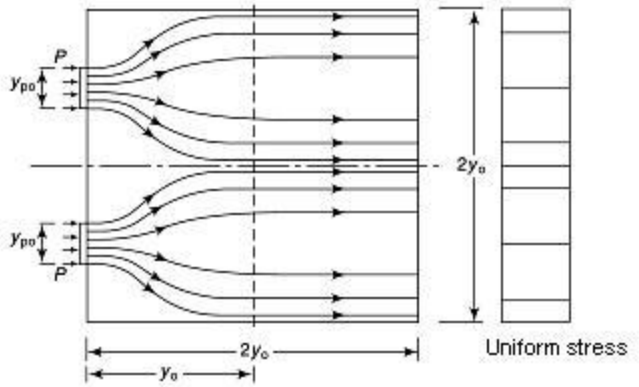
6. At initial stage what forces are considered in prestressed concrete design? (AUC Apr/May 2011)

Prestressing force is considered in prestressed concrete design at initial stage.

7. Why anchorage zone has to be given special attention in design? (AUC Apr/May 2011)

Because the main reinforcement in the anchorage zone should be designed to withstand the bursting tension, which is determined by the traverse stress distribution on the critical axis, usually coinciding with the line of action of the largest individual force.

8. Draw a sketch showing the stress distribution in end block by double anchor plate. (AUC Apr/May 2010)



Double anchor plate

9. What is meant by end block in a post tensioned member? (Nov/Dec 2010)

The zone between the end of the beam and the section where only longitudinal stress exists is generally referred to as the anchorage zone or end block.

10. List any two applications of partial prestressing. (Nov/Dec 2010)

- Used in large diameter concrete pipes

- Used in railway sleepers
- Water tanks
- Precast concrete piles to counter tensile stress during transport and erection.
- Used in bridges construction

11. Define Bursting tension.

The effect of transverse tensile stress is to develop a zone of bursting tension in a direction perpendicular to the anchorage force resulting in horizontal cracking.

12. Mention any four factors affecting the deflection of the prestressed concrete beam?

(i) Imposed load & self weight
(ii) Magnitude of the prestressing force.
(iii) Second moments of area of cross section
(iv) Shrinkage, creep & relaxation of steel stress.
(v) Modulus of elasticity of concrete
(vi) Cable profile
(vii) Span of the member
(viii) Rigidity condition

13. What are the permissible limits for deflection?

(i) The final deflection due to all loads including the effects of temperature, creep & shrinkage should not normally exceed span / 250.

(ii) Deflections including the effects of temperature, creep & span / 350 or 20mm whichever is less

(iii) If finishes are to be applied to prestressed concrete members the total upward deflections should not exceed span.

14. What is meant by primary moment, secondary moment?

- **Primary moment:** The primary moment is the apparent bending moment at a section in a statically indeterminate structure due to the ahead eccentricity of the tendons from the additional moments.
- **Secondary moment**: Secondary moments are additional moments induced at a section due to the redundant reactions developed as a consequence of prestressing the structure.
- **Resultant moment:** The resultant moment at a section of an indeterminate prestressed structure is the sum of primary & secondary moments (i.e) R.M = (P.M + S.M)

15. What is concordant cable?

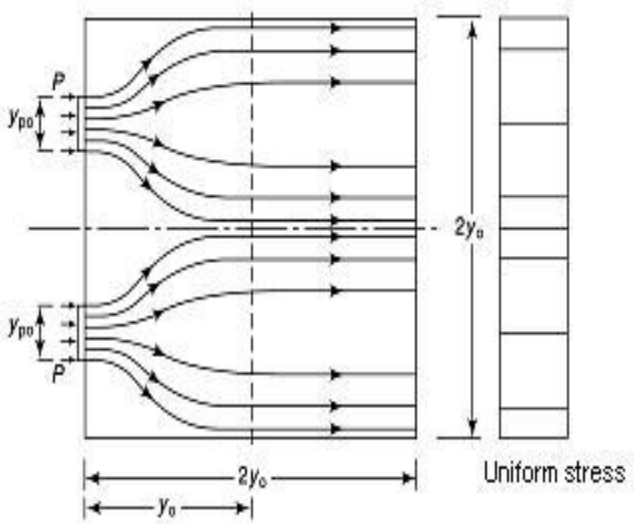
A tendon profile in which the eccentricity is proportional at all cross sections to the bending moment caused by any loading on a rigidity supported statically indeterminate structure is a concordant profile.

16. What is meant by vertical or transverse prestresisng?

Besides the longitudinal prestressing sometimes it may be desirable to provide vertical prestresisng to reduce or eliminate the principal tensile stress. Vertical prestressing is done by providing high tension vertical steel wires of small diameter at suitable pitch & stressed adequately.

17. Enumerate stress distribution in end block.

A physical concept of the state of stress in the transverse direction, that is normal to planes parallel with the top and bottom surfaces of the beam, may be obtained by considering these lines of force as individual fibres acting as curved stuts between end force 2P and the main body of the beam.



Double anchor plate

18. Why reinforcement is necessary in anchorage zone or end block?

In post tensioned members, the prestressing wires are introduced in cables holes or ducts. Pre- formed in the members and then stressed and anchored at the end forces. Large forces concentrated over relatively small areas are applied on the end blocks. It is linearly distributed and develop transverse and shear stressed so that an adequate amount of steel is properly distributed to sustain the transverse tensile stressed.

19. What is meant by transmission length?

In a pretensioned system, when a wire is released, the transmission of prestressing force from

steel to concrete is though a bond comprising of adhesion, friction and shearing resistance. At intermediate points along the length of the beam, the bond stress due to friction and shearing resistance is developed. When the bond stress is zero, and uniform stress distribution is prevalent from the section then the length for achieving this is termed as transmission length.

20. Why anchor block is used in prestressed concrete?

Anchor block having higher discontinuous force applied at the end develop transverse and shear stresses. The distribution of stressed in the anchorage zone, can provide an adequate amount of steel, properly distributed to sustain the transverse tensile stresses.

21. Why anchorage zone has to be given special attention in design?

Large amount of prestressing forces, concentrated over relatively small areas are applied on the end blocks through bearing plates. These forces develop transverse and shear stressed. Generally bursting tensile forces or splitting tensile force and spalling tensile forces are developed while transmitting the prestress to the concrete. These forces are resisted by providing suitable arrangements of reinforcement in the end blocks.

UNIT 4 – COMPOSITE CONSTRUCTION AND CONTINUOUS BEAMS

1. Define propped construction. (AUC May/June 2013, Nov/Dec 2013)

The dead load stress developed in the precast prestressed units can be minimized by propping them while casting the concrete in situ. This method of construction is termed as propped construction.

2. How to achieve compositeness between precast and cast in situ part and show the sketches? (AUC May/June 2013, Nov/Dec 2013)

The composite action between the two components is achieved by roughening the surface of the prestressed unit on to which the concrete is cast in situ, thus giving a better frictional resistance or by stirrups protruding from the prestressed unit into the added concrete or by castellations on the surface of the prestressed unit adjoining the concrete which is cast in situ.

3. What is meant by composite construction of prestressed and in situ concrete? (AUC Nov/Dec & Apr/May 2011)

In a composite construction, precast prestressed members are used in conjunction with the concrete cast in situ, so that the members behave as monolithic unit under service loads. The high strength prestressed units are used in the tension zone while the concrete, which is the cast in situ of relatively lower compressive strength is used in the compression zone of the composite members.

4. How deflections in composite members are computed? (AUC Nov/Dec 2011)

In the case of composite members, deflections are computed by taking into account the different stages of loading as well as the differences in the modulus of elasticity of concrete
in the precast prestressed unit and the in situ cast element.

5. What do you mean by unpropped construction? (AUC Nov/Dec 2012)

If the precast units are not propped while placing the in situ concrete, stresses are developed in the unit due to the self weight of the member and the dead weight of the in situ concrete. This method of construction is referred to as unpropped construction.

6. What are the forces considered in the calculation of deflection of prestressed concrete beams? (AUC Apr/May 2010)

Prestressing force
Self weight of the beam
Dead load of the concrete
Live load acting on the concrete

7. What are the roles played by shear connectors in composite construction? (AUC Apr/May 2010)

It is generally assumed that the natural bond at the interface contributes a part of the required shear resistance depending upon the strength of the in situ cast concrete and the roughness of the precast element. Any extra shear resistance over and above this should be provided by shear connectors.

8. What are the advantages in using precast prestressed units? (AUC Apr/May 2011, Nov/Dec 2010 & 2012)

- Saving in the cost of steel in a composite member compared with a reinforced or prestressed concrete member.
- Sizes of precast prestressed units can be reduced due to the effect of composite action.
- Low ratio of size of the precast unit to that of the whole composite member.
- Composite members are ideally suited for construction bridge decks without the disruption of normal traffic.

9. Name the loadings to be considered for computing initial deflection. (AUC Nov/Dec 2010)

- Prestress
- Self weight of the beam
- Weight of the in situ cast concrete

10. How do you compute the shrinkage and resultant stresses in composite member? (AUC Nov/Dec

2012)

The magnitude of differential shrinkage is influenced by the composition of concrete and the environmental conditions to which the composite member is exposed. In the absence of exact data, a general value of 100 micro strains is provided for computing shrinkage stresses.

11. Distinguish between propped and unpropped construction methods.

(AUC Nov/Dec 2012)

S.No	Propped construction	Unpropped construction
1	The dead load stress developed in the precast prestressed units can be minimized by propping them while casting the concrete in situ. This method of construction is termed as propped construction.	If the precast units are not propped while placing them in situ concrete, stresses are developed in the unit due to the self weight of the member and the dead weight of the in situ concrete. This method of construction is referred to as unpropped construction.
2	If the pretensioned beam supports the weight of the slab while casting.	If the slab is externally supported while casting.

12. What are the assumptions made in stresses developed due to differential shrinkage?

- The shrinkage is uniform over the in situ part of the section.
- Effect of creep and increase in modulus of elasticity with age and the component of shrinkage, which is common to both the units are negligible.

18. Name the loadings to be considered for computing deflection if the beam is propped section.

- Prestress
- Self weight of the beam
- Dead weight of the in situ cast concrete
- Live load of the in situ cast concrete

21. Name the loadings to be considered for computing deflection if the beam is unpropped section.

- Prestress
- Self weight of the beam
- Live load of the in situ cast concrete

15. Sketch the typical cross section of precast prestressed concrete beam.

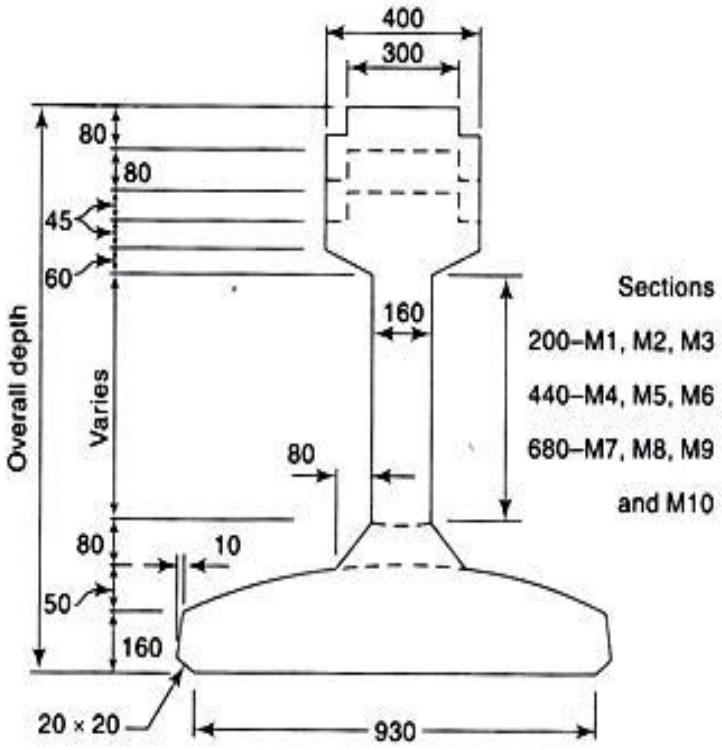


Fig. *Cross-section of Standard C and C.A. Beams*

16. What are the advantages of statically indeterminate prestressed concrete structures?

(i)The bending moments are more evenly distributed between the centre of span and the supports of members.

(ii) Reduction in the sizes of members results in lighter structure.

(iii) The ultimate load carrying capacity in higher than the 01statically determinate structure due to the redistribution of moment

(iv) Continuity of the members in framed by segmental construction using precast units connected by prestressed cables.

(v) In continuous post tensioned guides, the curved cables can be suitably positioned to resist the span & support moments.

17. What are the disadvantages of prestressed continuous beams?

(i)Loss of prestress due to friction is more in long cables.

(ii) Secondary stresses due to prestressing, creep, shrinkage, temperature & settlement of supports may induce very high stresses unless they are controlled.

(iii)Cable positioned to cater for secondary moments are generally no suitable to provide the required ultimate moment under a given system of loads.

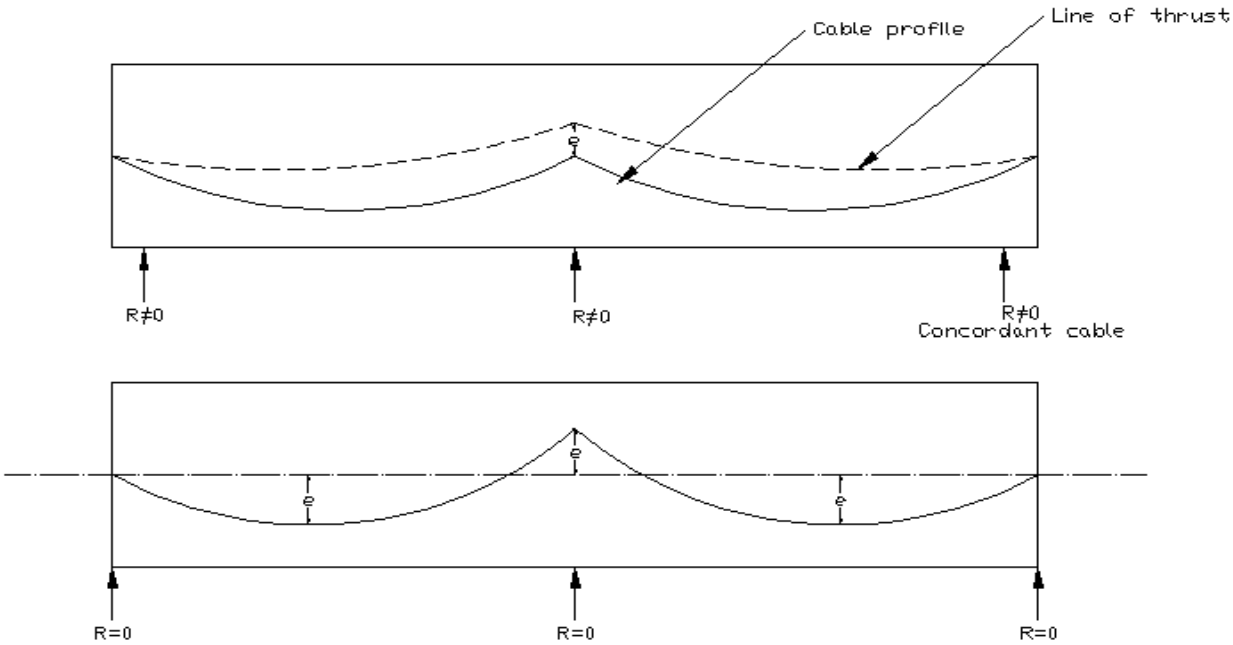
(iv)The computation of collapse (or) ultimate load is influenced by the degree of redistribution of moments.

18. What are the assumptions made for the analysis of secondary moment

(i) The effect of change in length of members due to the prestressing force & external loading in neligible.

(ii) The cable friction is considered to be negligible so that the prestressing force is constant at all points of the cable.

19. Show the resultant thrust line in a two span continuous beam. Prestressed by a parabolic cable with zero eccentricity at all the support



20. What is meant by composite construction is prestressed concrete?

In a composite construction, precast prestressed members are used in conjunction with the concrete cast in site. So that the members behave as a monolithic unit under service loads.

21. What are the advantages of composite constructions?

(i) Appreciable savings in the cost of steel in a composite member compared with a R.C.C. or prestressed concrete members.

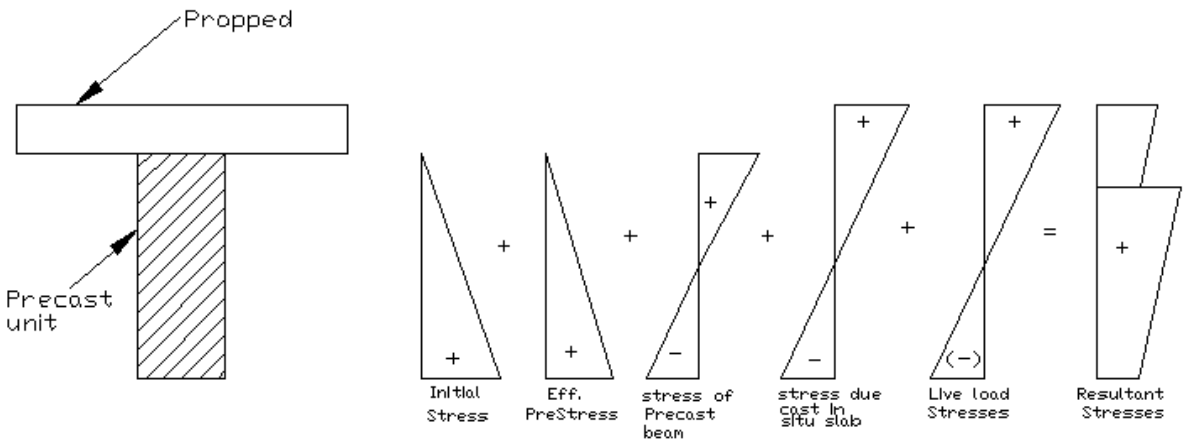
(ii) Sizes of the precast prestressed units can be reduced due to the effect of composite action.

(iii)Low ratio of size of precast unit to that of the composite member & in many cases precast prestressed units serves as supports & dispenses with the form work for the placing of in situ concrete.

(iv) Composite constructions are indically suited for the constructions of bridge decks without disturb the normal traffic.

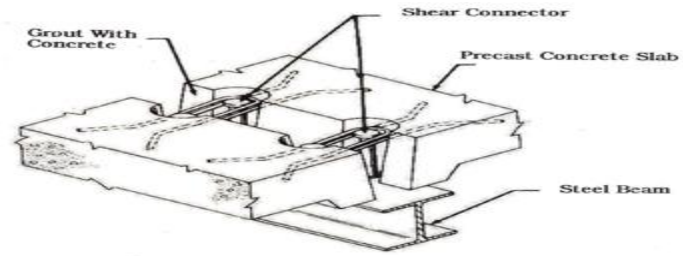
(v) Efficient utilization of materials in a composite section results in reduced dead loads & leading to overall economy.

22. Sketch the stress across the mid span section as various stages of loading in propped composite flexure members.



23. What is meant by shear connectors?

Effective bonding between the two parts of a composite beam may be developed by providing castellation in the precast unit or by projecting reinforcements from the precast unit is known as shear connectors.



UNIT 5 - MISCELLANEOUS STRUCTURES

1. What are the functions of water stopper (water bar) in water tank construction? (AUC May/June 2013)

19. The base slab is subdivided by joints which are sealed by water stops.
20. The reinforcement in the slab should be well distributed to control the cracking of the slab due to shrinkage and temperature.

2. Differentiate prestressed cylinder and non-cylinder pipe. (AUC May/June 2013)

Prestressed cylinder pipe:

22. It is developed by the Lock Joint Company.
23. A welded cylinder of 16 gauge steel is lined with concrete inside and steel pipe wrapped with a highly stressed wire.
24. Tubular fasteners are used for the splices and for end fixing of the wire and pipe is finished with a coating of rich mortar.
25. It is suitable upto 1.2 m diameter.

Prestressed non-cylinder pipe:

- It is developed by Lewiston Pipe Corporation.
- At first concrete is cast over a tensioned longitudinal reinforcement.
- A concrete pipes after curing are circumferentially stressed by means of a spiral wire wound under tension and protected by a coat of mortar.
- The main function of longitudinal prestress is to prevent cracking in concrete during circumferential winding and cracking due to the bending stresses developed during the handling and installation of pipes.

3. Define circular prestressing. (AUC Nov/Dec 2011, 2012, 2013, 2010)

When the prestressed members are curved in the direction of prestressing, the prestressing is called circular prestressing.

For example, circumferential prestressing in pipes, tanks, silos, containment structures and similar structures is a type of circular prestressing.

4. What are the design criteria for prestressed concrete tanks? (AUC Nov/Dec 2011)

14. It is to resist the hoop tension and moments developed are based on the considerations of desirable load factors against cracking and collapse.
15. It is desirable to have at least a minimum load factor of 1.2 against cracking and 2 against ultimate collapse as per IS code.
16. It is desirable to have at least a minimum load factor of 1.25 against cracking and 2.5 against ultimate collapse as per BS code.
17. The principal compressive stress in concrete should not exceed one-third of the characteristic cube strength.
18. When the tank is full, there should be a residual compressive stress of at least 0.7 N/mm^2.

- When the tank is empty, the allowable tensile stress at any point is limited to 1 N/mm^2.
- The maximum flexural stress in the tank walls should be assumed to be numerically equal to 0.3 times the hoop compression.

5. What are the design criteria for prestressed concrete pipes? (AUC Nov/Dec 2012)

- Circumferential prestressing, winding with or without longitudinal prestressing.
- Handling stresses with or without longitudinal prestressing.
- Condition in which a pipe is supported by saddles at extreme points with full water load but zero hydrostatic pressure.
- Full working pressure conforming to the limit state of serviceability.
- The first crack stage corresponding to the limit state of local damage.

6. How are the tanks classified based on the joint? (AUC Nov/Dec 2013)

- Tank wall with fixed base.

- Tank wall with hinged base.
- Tank wall with sliding base.

7. **Define two stage constructions. (Apr/May 2012)**

In the first the concrete is cast over a tensioned longitudinal reinforcement. In the second stage the concrete pipes after curing are circumferentially stressed by means of a spiral wire wound under tension and protected by a coat of mortar.

8. **Write any two general failures of prestressed concrete tanks. (AUC Apr/May 2012)**

- Deformation of the pre-cast concrete units during construction.
- Manufacturing inaccuracies led to out of tolerance units being delivered to the site under investigation.
- It May have affected the ability to achieve a good seal.

9. **What is the stress induced in concrete due to circular prestressing? (AUC Apr/May 2010)**

The circumferential hoop compression stress is induced in concrete by prestressing counterbalances the hoop tension developed due to the internal fluid pressure.

10. **Explain the effect of prestressing force in concrete poles. (AUC Apr/May 2010)**

It should be reduced in proportion to the cross section by the techniques of debonding or dead ending or looping some of the tendons at mid height.

11. **Write the various types of loadings that act on prestressed concrete poles. (AUC Nov/Dec 2010)**

- Bending due to wind load on the cable and on the exposed face.
- Combined bending and torsion due to eccentric snapping of wires.
- Maximum torsion due to skew snapping of wires.
- Bending due to failure of all the wires on one side of the pole.
- Handing and erection stresses.

12. **What are the advantages of prestressing water tanks? (AUC Apr/May 2011)**

- Water storage tanks of large capacity are invariably made of prestressed concrete.
- Square tanks are used for storage in congested urban and industrial sites where land space is a major constraint.
- This shape is considerable reduction in the thickness of concrete shell.
- The efficiency of the shell action of the concrete is combined with the prestressing at the edges.

3. How are sleepers prestressed? (AUC Apr/May 2011)

- Two block sleepers

- Longitudinal sleepers
- Beam type single piece prestressed concrete sleepers.

14. Mention the importance of shrinkage in composite construction?

The time dependent behavior of composite prestressed concrete beams depends upon the presence of differential shrinkage and creep of the concretes of web and deck, in addition to other parameters, such as relaxation of steel, presence of untensioned steel, and compression steel etc.

15. What are the different types of joints used between the slabs of prestressed concrete tanks?

- Movement joint
- Expansion joint
- Construction Joint
- Temporary Open Joints.

16. What are the advantages of partially prestressed concrete poles?

- Resistance to corrosion in humid and temperature climate and to erosion in desert areas.
- Easy handling due to less weight than other poles.
- Easily installed in drilled holes in ground with or without concrete fill.
- Lighter because of reduced cross section when compared with reinforced concrete poles.
- Fire resisting, particularly grassing and pushing fire near ground line.

17. What are the types of prestressed concrete pipes?

- Monolyte construction
- Two stage construction

18. Distinguish between non-cylinder and cylinder pipes. Non-cylinder pipes:

The design principles are used for determining the minimum thickness of concrete required and the pitch of circumferential wire winding on the pipe.

Cylinder pipes:

The design principles of cylinder pipes are similar to those of the non-cylinder pipes except that the required thickness of concrete is computed by considering the equivalent area of the light gauge steel pipe embedded in the concrete.

19. Define the losses of prestress.

Due to elastic deformation of concrete during circumferential wire winding, there is a loss of prestress which depends upon the modular ratio and the reinforcement ratio.

20. What are the advantages of prestressed concrete piles?

- High load and moment carrying capacity.
- Standardization in design for mass production.
- Excellent durability under adverse environmental conditions.
- Crack free characteristics under handling and driving.
- Resistance to tensile loads due to uplift.
- Combined load moment capacity.

21. What are the advantages of prestressed concrete over R.C.C concrete?

(i) The use of high strength concrete and steel in prestressed members results in lighter and slender members than is possible with reinforced concrete.

(ii) The effectiveness of carrying external loads is only by the section above the neutral axis is reinforced concrete but the entire cross section is effective is prestressed concrete.

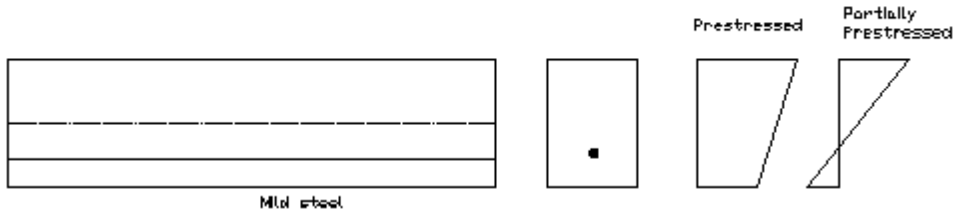
(iii)The reinforced concrete sections are heavy and shear reinforcement is essential where as in prestressed concrete the section is smaller & curved tendons helps to resistance.

(iv) Do the long span structures the prestressed concrete is generally more economical than reinforced concrete & also \prestressed members are decrease in weight reduces the design loads and the cost of construction.

(v) Due to utilization of concrete in the tension zone a savings of 15 to 30% in concrete 60 to 80% savings in steel.

22. Explain partial prestressing.

Under the working load, if the cross section is subjected to no tension after prestressing then it is known as fully prestressed. lll$_{ly}$ under working loads even after the pretsress is apply. If there is some tension. It is known as partial prestressing . Normally the tension portion is reinforced with mild steel reinforcement. This untensioned reinforcement is required so as to resist differential shrinkage temperature effects and handling stresses.



23. Mention the advantages of partial prestressing. (AUC Nov/Dec 2012 & 2013)

26. Limited tensile stresses are permitted in concrete under service loads with controls on the maximum width of cracks and depending upon the type of prestressing and environmental condition.
27. Untensioned reinforcement is required in the cross-section of a prestressed member for various reasons, such as to resist the differential shrinkage, temperature effects and handling stresses.
28. Hence this reinforcement can cater for the serviceability requirements, such as

control of cracking, and partially for the ultimate limit state of collapse which can result in considerable reduction in the costlier high tensile steel.

29. Saving in the cost of overall structure.

PART-B QUESTIONS (16 MARKS)

UNIT-1

INTRODUCTION – THEORY AND BEHAVIOUR

1. A rectangular concrete beam 100mm wide & 250mm deep spanning over 8m is prestressed by a straight cable carrying a effective prestressing force of 250kN located at an eccentricity of 40mm. The beam supports a live load of 1.2 kN/m. a) calculate the resultant stress distribution for the centre of the span cross section of the beam assuming the density of concrete as 24kN/m^2 b) Find the magnitude of prestressing force with an eccentricity of 40mm which can balance the stresses due to dead load & live load at the soffit of the centre span section.

2. A PSC beam of 120mm wide and 300mm deep is used over a span of 6m to support a udl of 4kN/m including its self weight. The beam is prestressed by a straight cable carrying a force of 180kN & located at an eccentricity of 50mm. Determine the location of the thrust line in beam & plot its position at quarter & central span sections.

3. A Prestressed pretensioned beam of 200mm wide and 300mm deep is used over an span of 10m is prestressed with a wires of area 300mm^2 at an eccentricity of 60mm carrying a prestress of 1200 N/mm^2 Find the percentage of loss of stress, E_c= 35 kN/mm^2 Shrinkage of concrete = 300 x 10^{-6} , creep coefficient =1.6

4. A PSC beam of 120mm wide and 300mm deep is used over an span of 6m is prestressed by a straight cable carrying a force of 200 kN & located at an eccentricity of 50mm. Ec= 38 kN/mm^2 . Find the deflection at centre span a) Under prestress + self weight b) Find the magnitude of live load udl which will nullifythe deflection due to prestress & self weight.

5. A PSC beam of 230mm wide and 450mm deep is used over an span of 4m is prestressed by a cable carrying a force of 650kN & located at an eccentricity of 75mm. The beam supports three concentrated loads of 25kN at each quarter span points. Determine the location of the pressure line in beam at centre, quarter & support sections. Neglect the moment due to self weight of the beam.

6. A PSC beam with rectangular section, 150mm wide 300mm deep is prestressed by three cables each carrying a effective prestress of 200kN. The span of the beam is 12m. The first cable

is parabolic with an eccentricity of 50mm below the centroidal axis at the centre of the span and 50mm above the centroidal axis at the supports.The second cable is parabolic with an eccentricity of 50mm at the centre of the span and zero eccentricity at the supports. The third cable is straight with an eccentricity of 50mm below the centroidal axis.If the beam supports an UDL of 6kN/m and Ec=38kN/mm2 Estimate the instantaneous deflection for the following stages i) Prestress + self weight of the beam ii) Prestress + self weight of the beam + live load

7. (i) Explain why high strength concrete and high strength steel are needed for PSC construction
   (ii) State different types of prestressing

8. (i) Explain shrinkage of concrete in PSC members
   (ii) Explain durability, fire resistance and cover requirements for PSC members

9. A PSC beam supports an imposed load of 5kN/mm^2 over a simply supported span of 10m.The beam has an I section with an overall depth of 450mm.Thickness of flange and web are 75mm and 1000mm respectively. The flange width is 230mm. the beam is prestressed with an effective prestressing force of 350kN at a suitable eccentricity such that the resultant stress at the soffit of the beam at mid span is zero. Find the eccentricity required for the force.

10. A PSC beam of section 120mm wide and 300mm deep is used over an effective span of 6m to support an udl of 4kN/m including self weight. The beam is prestressed by a straight cable with a force of 180kN and located at an eccentricity of 50mm. Determine the location of thrust line in the beam and plot its position.

UNIT -2

DESIGN FOR FLEXURE AND SHEAR

1. A pretensioned T section has a flange width of 1200mm and 150mm thick. The width and depth of the rib are 300mm and 1500mm respectively. The high tension steel has an area of 4700mm^2 and is located at an effective depth of 1600mm. If the characteristic cube strength of the concrete and the tensile strength of steel are 40 and 1600Mpa respectively; calculate the flexural strength of the section.

2. A PSC beam of effective span 16m is of rectangular section 400mm wide and 1200mm deep. Atendons consist of 3300mm^2 of strands of characteristic strength 1700 N/mm^2 with an effective prestress of 910 N/mm^2. The strands are located 870mm from the top face of the beam. If f_{cu} =60 N/mm^2, estimate the flexural strength of the section as per BS provisions for the following cases:
(i) Bonded tendons (ii) Unbonded tendons

3. A post tensioned bridge girder with unbonded tendons is of size 1200mm wide by 1800mm deep is of box section with wall thickness of 150mm. The high tensile steel has an area of

4000mm^2 and is located at an effective depth of 1600mm. The effective prestress in steel after loss is 1000 N/mm^2& effective span is 24m. If f_{ck} = 40 N/mm^2, f_p = 1600 N/mm^2 Estimate the flexural strength.

4. The end block of a PSC beam with rectangular cross section is 100mm wide and 200mm deep. The prestressing force of 100kN is transmitted to the concrete by a distribution plate of 100mm x 50mm, concentrically loaded at the ends. Calculate the position and the magnitude of tensile stress on the horizontal section through the centre and edge of the anchor plate. Compute the bursting tension on the horizontal planes.

5. The end block of a post tensioned concrete beam 300mm X 300mm is subjected to a concentric anchorage force of 800kN by a freyssinet anchorage system of area 1100mm^2. Discuss and detail the anchorage reinforcement for the end block.

6. Discuss the advantages and disadvantages of partial prestressing.

7. A symmetrical I section prestressed beam of 300mm wide and 750mm overall depth with flanges and web 100mm thick. The beam is post tensioned with the cables containing 48 wires of 5mm diameter high strength steel wires at an eccentricity of 250mm. The compressive strength of concrete is 40N/mm^2 and the ultimate tensile strength of wire is 1700N/mm^2. Assuming that the grouting of tendons is 100% effective determine the ultimate moment of section as per IS1343:1980.

8. A PSC beam 250mm wide and 650mm deep is subjected to an effective prestressing force of 1360kN along the centroidal axis. The cable is placed symmetrically over the mild steel anchor plate of area 150mm x 350mm. design the end block.Take f_{ck} = 30N/mm^2. Assume initial prestressing force is 1.2 times the effective prestressing force.

9. (i) Discuss the load deflection behavior of under prestressed, partially prestressed and over prestressed members in detail.

(ii) Explain concept of limit states, partial safety factor.

10. a) What is meant by partial prestressing? Discuss the advantages and disadvantages when partial prestressing is done.

b) Explain about the types of flexure failure occurs in prestressed concrete section

UNIT-3

DEFLECTION AND DESIGN OF ANCHORAGE

1. A cylindrical PSC water tank of internal diameter 30m is required to store water over a depth of 7.5m. The permissible compressive stress in concrete at transfer is 13 N/mm^2 and the

minimum compressive stress under working pressure is 1 N/mm^2. The loss ratio is 0.75. Wires of 5mm diameter with an initial stress of 1000 N/mm^2 are available for circumferential winding and Freyssinet cables made up of 12 wires of 8mm diameter stressed to 1200 N/mm^2 are to be used for vertical prestressing. Design the tank walls assuming the base as fixed. The cube strength of concrete is 40 N/mm^2

2. A prestressed cylindrical pipe is to be designed using a steel cylinder of 1000mm diameter and thickness 1.6mm. The circumferential wire winding consist of a 4mm high tensile wire initially tensioned to a stress of 1000 N/mm^2. The ultimate tensile strength of wire is 1600 N/mm^2. The yield stress of the steel cylinder is 280 N/mm^2. f_{ct}=14 N/mm^2, W_w =0.8 N/mm^2. Determine the thickness of concrete lining required. Fmin = 0; modular ratio = 6

3. Design a free edge water tank of diameter 36m to store water for a depth of 5m. Assume ultimate stress in steel = 1500N/mm^2. Stress in steel at transfer = 70% of ultimate stress. Safe stress in concrete = $0.5f_{ck}$. Compressive stress in concrete at service condition= $0.1f_{ck}$. Final stress in steel = 0.8 x stress in steel at transfer. Take modular ratio=5.5 f_{ck} = 45N/mm^2

4. Explain the different types of joints between the walls and floor slab of prestressed concrete tanks.

5. Write the design criteria of PSC pipes in detail

6. Explain the step by step design procedure of circular tanks.

7. Explain the types of PSC pipes with neat sketch

8. A non cylindrical PSC pipe of 1000mm diameter and thickness of concrete shell is 75mm is required to convey water at a working pressure of 1.5 N/mm^2. The length of the pipe is 6m. The loss ratio is 0.8. Determine the circumferential wire winding of using 5mm diameter wires stretched to 1000 N/mm^2. The maximum permissible tensile stress is 11.2 N/mm^2

9. Design a non cylindrical PSC pipe of 600mm internal diameter to withstand a working hydrostatic pressure of 1.05 N/mm^2using 2.5mm HYSD stressed to 1000N/mm^2 at transfer. Permissible maximum and minimum stresses in concrete at transfer and service load are 14 N/mm^2 and 0.7 N/mm^2. The loss ratio is 0.75. E_s = 210kN/mm^2 and E_c = 35kN/mm^2

10. Explain any one method of circumferential wire winding adopted in circular prestressing with a neat sketch

UNIT-4

COMPOSITE BEAMS AND CONTINUOUS BEAMS

1. Explain the design procedure of Prestressed composite section.

2. A precast pretensioned beam of rectangular section has a breadth of 100mm and depth of 200mm. The beam with an effective span of 5m is prestressed by the tendons with their centroids coinciding with the bottom kern. The initial force in the tendons is 150kN. The loss of prestress is 15%. The top flange width is 400mm with the thickness of 40mm.If the composite beam supports a live load of 8kN/m^2 calculate the resultant stresses developed if the section is propped and unpropped.

3. A composite T beam is made up of pretensioned rib of 100mm wide and 200mm deep and a cast insitu slab of 400mm wide and 40mm thick. Having the modulus of elasticity as 28kN/m^2, if the differential shrinkage is 100 x 10^{-6} determine the shrinkage stresses developed in precast and cast insitu units.

4. A composite T-girder of span 5 m is made up of a pre-tensioned rib, 100 mm wide by 200 mm depth, with an in situ cast slab, 400 mm wide and 40 mm thick. The rib is prestressed by a straight cable having an eccentricity of 33.33 mm and carrying initial force of, 150 kN. The loss of prestress is 15%. Check the composite T-beam for the limit state of deflection if its supports an imposed load of 3.2 kN/m for (i) unpropped(ii) propped. Assume modulus of Elasticity of 35 kN/mm^2 for both precast & in situ cast elements.

5. i) Explain the types of composite construction with neat sketch.

(ii) Explain the precast prestressed concrete stresses at serviceability limit state.

6. A PSC beam of cross section 150 mm x 300 mm is SS over a 6pan of 8m and is prestressed by means of symmetric parabolic cables @ a distance of 76 mm from the soffit @ mid span and 125 mm @ top @ support section. If the force in the cable i.e 350 KN. Calculate deflection @ mid span the beam is supporting its own weight The point load which must be applied at mid span to restore the beam to the level of its support.

UNIT-5

MISCELLANEOUS STRUCTURES

1. What are the advantages of prestressed concrete bridges?

2. Explain the pre tensioned and post tensioned bridge decks commonly used in construction of bridges.

3. Write the design procedure for post tensioned prestressed concrete slab bridge deck.

4. Write the design procedure for pre tensioned prestressed concrete slab bridge deck.

5. Write the design procedure for post tensioned PSC T beam slab bridge deck.

6. State the significance of adopting the combination of pre tensioned and post tensioned tendons in bridge construction.

7. Write the design procedure for post tensioned bridge girders.

8. Explain the methods involved in utilizing precast pretensioned members in bridge construction.

CE6703 – WATER RESOURCES AND IRRIGATION ENGINEERING

TWO MARKS QUESTION AND ANSWERS

SIXTEEN MARKS QUESTION BANK

UNIT – I

1. Briefly discuss about water resources in India and Tamilnadu.
2. Briefly explain the steps involved in water resources planning.
3. Explain the water requirements for irrigation, hydropower generation, navigation, drinking and disposal of sewage and industrial waste?
4. Discuss about single and multipurpose reservoir with its advantages and disadvantages.
5. Discuss the strategies for reservoir operation.
6. Discuss about levees and flood walls?
7. How will you fix the capacity reservoir?
8. Briefly discuss about the flood control methods.
9. Differentiate between structural and non structural measures for flood control?
10. What are the factors affecting sedimentation and control measures for sedimentation?
11. Briefly discuss about the planning of multipurpose reservoir.

UNIT – II

1. Discuss the salient feature of National Water Policy.
2. What is the importance of water resource survey for the development of the country?
3. Mention the importance of various data required for water resource development and how will you collect them?
4. Briefly discuss about Necessity of National Water Policy.

5. Briefly discuss about economics of water resource planning.

6. Briefly discuss about consumptive use of water and the factors affecting consumptive use of water. How will you measure it?
7. Briefly explain the methods for determination of consumptive use?
8. Explain the water characteristics to be investigated?
9. What is Master Plan in water resources? Explain the scope and aims in detail.
10. Briefly discuss about the contents of Master Plan?
11. Briefly discuss about the concept of basin as a unit for development?
12. What are the different characteristics of water? Briefly discuss about it?

UNIT – III

1. Explain the term duty and delta and derive their relationship?
2. Discuss the need for the irrigation projects in the Indian context?
3. Draw the layout of the canal irrigation system and how duty varies between various location from main canal to field channel. Discuss the methods to improve the duty in that system.
4. List out the various type of irrigation efficiencies and discuss any four?
5. Discuss in detail the planning and the development of irrigation project in the Indian context?
6. What are the methods of improving duty?
7. Define irrigation efficiency, draw irrigation system and define all types of efficiencies using that diagram?
8. Discuss some of the important irrigation projects of our country?
9. Discuss I brief the ill effects of irrigation?

UNIT – IV

1. What is the necessity of river training works?

2. Describe in brief different types of river training works?
3. What is mean by guide banks? What are their functions and effects?
4. State the necessity and location of canal falls?
5. Briefly explain about classification of canals?
6. State the factors to be considered for the choice of a suitable type of cross-drainage work?
7. Explain how canals are classified? Discuss the methods to improve canal irrigation system?
8. Explain canal lining?

UNIT – V

1. Briefly explain about canal irrigation?
2. Briefly explain about lift irrigation?
3. Briefly explain about tank irrigation?
4. Briefly explain about flooding methods?
5. Briefly explain about sprinkler irrigation methods?
6. Briefly explain about drip irrigation?
7. Explain briefly the 'Sprinkler' and 'drip' methods of irrigation systems.
8. State the classification of 'surface irrigation'?
9. Classify the method of irrigation and write the objective of any three irrigation methods.
10. Briefly explain about on-farm-development works?
11. What is the need for water user's association?
12. What is meant by 'participatory irrigation management'? Explain the concept briefly. Highlight the relative merits of 'participatory irrigation management' that of a conventional management approach' adopted in Engineering.

CE 6704 ESTIMATION AND QUANTITY SURVEYING
Two Mark Questions and Answers

Unit-I – Estimate of Buildings

1. Define estimate.

An estimate is a computation or calculation of the quantities required and expenditure likely to be incurred in the construction of a work. The estimate is the probable cost of a work and is determined theoretically by mathematical calculation based on the plans and drawing and current rates.

2. Write the importance of estimate.

- Estimate gives an idea of the cost of the work and hence its feasibility can be determined.
- It gives an idea of time required for the completion of the work.
- It is required to invite tenders and quotations and to arrange contract.
- It is also required to control the expenditure during the execution of the work.

3. What is meant by Quantitysurvey?

- Itisthescheduleofallitemsofworkinabuilding.Thesequantitiesarecalculatedfromthedrawing ofthebuilding.Thusquantitysurveygivesquantitiesofworkdoneincaseofeachitemswhenprice dgivesthetotalcost.
- In short, quantity survey means calculations of quantities of materials required to complete the work concerned.

4. What are the methods of estimates?

- Detailed estimate
- Abstract estimate

5. What are the types of estimate?

- Preliminary Estimate or Rough cost estimate
- Plinth area estimate
- Cube Rate Estimate or Cubical Content Estimate
- Approximate Quantity Method Estimate
- Detailed Estimate or Item Rate Estimate
- Revised Estimate
- Supplementary Estimate and Revised Estimate.
- Annual Repair or Maintenances Estimate
- Supplementary Estimate

6.Briefly explain about preliminary Estimate.

The estimate which prepared using any rough method to get theapproximatecostconstructionanticipatedinaprojectiscalledanapproximateorroughestimate.S incethisestimate is normally prepared in the preliminary estimate.

7. Estimate the quantities of brickwork and plastering required in a wall 4m long, 3mhighand30cmthick.CalculatealsothecostiftherateofbrickworkisRs.32.00percu.mandof plastering is Rs. 8.50 per sq.m.

Quantities of brickwork	= LxBxH
	= 4m x 3m x0.30m
	= 3.6 cu.m
Quantity of plastering (two faces)	= 2 x 4m x 3m
	= 24 sq.m
Cost of brickwork	= 3.6 x320.00
	= Rs.1152.00
Cost of plastering	= 24x8.50
	= Rs.204.00
Total cost	= 1152.00 +204.00
	= Rs.1356.00

8. Define: Detailed estimate.

The estimate, which provides the item wise quantities of works, item wiseunitratesanditemwiseexpenditureanticipatedintheproject/construction, is called a detailed estimate.

9. What are the methods of taking out estimates or methods of detailed estimate?

- Separate wall method or Long wall- short wall method.
- Centre line method
- Crossing method
- Out to Out and in to in method
- Bay method
- Service unit method

10. What are the methods of detailed estimate?

- Plinth area method
- Cube rate method
- Unit cost method.
- Typical bay method.
- Carpet area method.

11. Define: Abstract estimate.

This is the third and final stage in a detailed estimate. The quantities and rates of each item of work, arrived in the first two stages, are now entered in an abstract form. The total cost of each item of work is now calculated by multiplying the quantities and respective rates.

12. Briefly explain about revised estimate.

The estimate, which is prepared when any major change or alteration is made in the plan/ structural arrangement, with or without affecting the estimate cost, and When the estimated cost is likely to exceed by more than 5% during execution, due to increase in the cost of materials and labour or due to increase in the cost of materials and labour or due to

alterations in the items of works to get the revised quantities /rates/amount is called a revised estimate.

13. What is meant by Supplementary estimate?

When the work is in progress, some changes or additional works are found to be necessary in a project, an additional estimate is prepared is called supplementary estimate.

14. Define quantity surveyor

A qualified or experienced person who does the above mentioned works (takingoff, squaring, abstracting and billing) is called a quality surveyor.

15. Write the duties of quantity surveyor.

- Preparing bill of quantities (Taking off, squaring, Abstracting and billing)
- Preparing bills for part payments at intervals during the execution of work.
- Preparingbillofadjustmentinthecaseofvariationsordereddduringtheexecution of work
- Giving legal advice in case of court proceedings.

16. Calculate the quality of brickwork in an arch over a 1.80m span opening. The arch is 40cm. thick and the breath of a wall is 40cm.

Radius of the arch = 1.8m
Thickness of arch = 40cm
The breath of wall = 40cm
Mean diameter = 3.60+0.40 = 4m
Mean length of the arch given =1/6 x (22/7) x 4 = 2.1m
Quantity of brickwork = 2.1 x 0.40 x 0.4 = 0.34 cu.m
No of bricks required = 0.34cu.m @ 550 bricks per cu.m = 187

17. Define Centre line method.

This method is suitable for walls of similar cross sections. Here the total Centre line length is multiplied by breadth and depth of respective item to get the total quantity at a time. When cross walls or partitions or verandah walls join with main wall, the centre line length gets reduced by half of breadth for each junction. Such junction or joints are studied carefully while calculating total centre line length. The estimates prepared by this method are most accurate and quick.

18. Write a note on Long wall – short wall method.

In this method, the wall along the length of room is considered to be long wall while the wall perpendicular to long wall is said to be short wall. To get the length of long wall or short wall, calculate first the centre line lengths of individual walls.

19. Briefly explain about bay method.

This method is useful and is generally followed in case of buildings havingseveralbays. Thecostofthetypicalbayisworkedoutandisthenmultipliedbythenumberofbaysinthatbuilding.Theextracostfortheendwallsanddifferenceinframing, if there is any, should be made, so as to arrive at the correct cost.

20.Write the recommendation for degree of accuracy in measurements.

- Dimensions of works shall be measured to an accuracy of 0.01 m
- Thickness of R.C works shall be measured to an accuracy of 0.0005 m
- Areas of works shall be calculated to the nearest 0.01 m^2
- Volumes of work shall be calculated to the nearest 0.01 m^3
- Volumes of wood shall be calculated to the nearest 0.001 m^3

21. Define: Floor area.

It defined as covered area i.e plinth areas excluding area of walls (generally 10%-15%) sills of the doors are not included in floor area. The floor area of very storey shall be measured separately.

22. Define: Carpet area.

This means area in a building which is useful one i.e area of drawing room, dining room bedroom etc. Areas of kitchens, staircase, stores, verandahs, entrance hall, bathroom, basement etc. are excluded. It is generally 50% to 60% of the plinth area.

23. What is meant by Lineplan?

Line plan is the plan of a particular construction simply showing main features with the help of the single lines of different portions of the constructions. Details of constructions are not generally shown on this plan. This inside and outside dimensions shown on this plan should necessarily be corresponding to actual dimensions.

24. Write a short note on Centre Line Plan.

Thisisactuallyalayoutplandrawntofacilitatethelayingoutoffoundation lines andotherfeatures.Itisgenerallyfixedontheentranceoratexitinthe centralplaceofthecolonyfortheguidanceoftheinhabitantsandoutsiders.

25. Write the unit of measurement of earthwork, foundation, brickwork, plastering, steel work, and painting.

Earthwork	-	cum
Foundation	-	cum
Brickwork	-	cum
Plastering	-	sq.m
Steel work	-	quintal
Painting	-	sq.m

Unit-II – Estimate of Other Structures

1. Define: Culvert.

It is device used to channel water. It may be used to allow water to passunderneath a road, railway, or embankment.

2. What is meant by Load bearing structures?

It is one in which a wall of a structure bears the weight and force resting upon it,conducting the vertical load from the upper structure to the foundation.

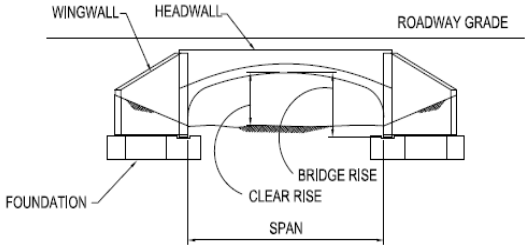
3. What are the main components or parts of culvert?

- Abutments
- Wing walls
- Arch

4. What are the types of culvert?

- Arch culvert
- Slab culvert
- Pipe culvert
- Box culvert

5.Draw differentparts of culvert.



6. What are the methods adopted for the volume calculating?

- From cross-section
- From spot level
- From contours

7. What are factors to be considered in design of septic tank?

- The following factors should be taken into consideration:
- Material should be water proof and corrosion resistant.
- Natural ventilation provided should be adequate
- A manhole should be provided to permit inspection and cleaning.
- Baffles should be limited to one at the inlet and one at the outlet.
- The escape of gas and sludge to effluent pipe should be avoided.

8. Define: Soak pit.

A soak pit, also known as a soak away or leach pit is a covered, porous-walled chamber that allows water to slowly soak into the ground. Pre-settled effluent from a collection and storage/treatment or (semi-) centralized treatment technology is discharged to the underground chamber from which it infiltrates into the surrounding soil.

9. Write the importance of soak pit.

Disposal of effluent from the septic tank may be done by absorption in soil by soak pit; the size and length depend on the number of users and nature of soil.

10. Define lead.

Lead is the crow flying horizontal distance from the centre of borrow pit to the centre of the earth work at site, i.e centre of the area of excavation to the centre of placed earth.

11. Define lift.

Lift is the distance through which the excavated soil is lifted beyond a certain specified depth.

12. How to estimate bituminous and cement concrete road in general.

In both the roads the following steps can be followed.

- Name of the road indicating chainage
- Drawing showing L/S &C/S with all details
- Subgrade soil details
- Design details &intensity of traffic details.
- Life cycle cost that includes cost of construction & maintenance
- Report accompanying the estimate justifying the work to be taken up
- Estimate to be as per the IRC codes.

13. Define: Soling.

Soling is done before laying the foundations and to provide better strength to the foundation as per the specification or requirement at site. It is done by means of stone aggregate of random sizes between 50mm - 150mm.

Types:

Stone flat soling

Brick flat soling

14.Workout the quality of stone metal required for 2Km.Length for wearing coat of a4mwide road. The thickness of the metal road required is 12cmloose.

Quality of metal = 1 X 2 X 1000 X 4 X 0.12 = 960.00cu.m

15. An approach road 2Km.long is to be constructed. Work out the quantity ofmaterials required i.e. stone metal and bricks. Data is given below.

Length = 2Km
Metalled width =3.60m
Soiling of bricks =10cm
Wearing coat of stone metal = 12cmSolution

Solution:

Quantity of bricks = 1 x 2 x 1000 x 3.60 x 0.10 = 720 cu.m
No of bricks = 720.0 x 3.60 x0.12 =3, 60,000
Stone metal = 1 x 2000 x 3.60 x 0.12
= 864cu.m
Bricks = 3, 60,000Nos.

16. A cement concrete road (1:2:3) is to be constructed over the existing waterboundmacadamroad.Thethicknessofslab=10cm.Thelengthoftheroadisonekmandthe width 3.60m.Calculate the quality of cement concrete and the material required,

Solution:

Quality of cement concrete = 1 x 1000 x 3.60 x 0.10 = 360cu.m34.

17. Calculate the quality of earthwork for the construction of an approach road.

Length =1Km
Width of formation = 10 m
Height of embankment = 60cm
Side slope =1:2

Solution

Quantity of earthwork = L ($Bd+Sd^2$)
B=10m; d =0.60m; S =2
Quantity of earthwork = 1000x (10x0.60) +2x0.60x0.60=6720cu.m.

18. List out the various sanitary fittings.

- P trap
- S trap
- Q trap
- Water closet
- Flushing cisterns
- Kitchen sink
- Wash basin, etc

19. Write a short note on Retaining Wall.

It is a structure designed and constructed to resist the lateral pressure of soil when there is a desired change in ground elevation that exceeds the angle of repose of the soil.

20. Write a short note on aqueduct.

It is a water supply or navigable channel (conduit) constructed to convey water. In modern engineering, the term is used for any system of pipes, ditches, canals, tunnels, and other structures used for this purpose

21. Differentiate tube well and open well

Tube well	Open well
A tube well is a type of water well in which a long 100–200 mm (4 to 8 inch) wide stainless steel tube or pipe is bored into an underground aquifer. The lower end is fitted with a strainer, and a pump at the top lifts water for irrigation. The required depth of the well depends on the depth of the water table.	Open wells are almost always water table wells, meaning they are made just deep enough to reach the water table, allowing groundwater to fill the bottom of the well. This type of well commonly has a diameter of at least 3 or 4 feet (0.9-1.2 m), making it big enough for at least one person to stand in the well shaft while it's being constructed, and is usually no deeper than 200 feet (60 m).

22. Write something about Land acquisition.

"Land Acquisition" literally means the acquisition of land for some public purpose by a government agency from individual landowners, as authorised by the law, after paying a government-fixed compensation to cover losses incurred by landowners from surrendering their land to the concerned government agency.

Unit-III – Specification and Tenders

1. Define analysis of rates.

- The determination of rate per unit of a particular item of a work, from the costof quantities of materials, the cost of laborers and other miscellaneous pettyexpenses require for its completion.

2. Define: Schedule of Rates.

In order to determine the rate of a particular item, the factors affecting the rate of thatitem are studied carefully and then finally a rate is decided for that item. This process ofdetermining the rates of an item is termed as analysis of rates or rate analysis.

3. What are the factors affecting Schedule of Rates?

- Specifications of works and material about their quality, proportion and constructional operation method.
- Quantity of materials and their costs.
- Cost of labours and their wages.
- Location of site of work and the distances from source and conveyance charges.
- Overhead and establishment charges
- Profit

4. Define: Owner.

The person of behalf of which work is to be done. He may be an individualorfirm or organization.

5. Define: Drawings.

The section, map, plans etc… which completely define the constructionworkgeometrically is known as drawings

6. Define: Work.

It means the work is to be carried out under thiscontract.

7. Define: Task.

Capacity of doing work by an artisan or skilled lab our in the form of quantity of per day in known as task.

8. What is specification?

Specification is an important document attached with a tender form / contract agreement, which in most cases controls the quality of materials and works.

9.State the different types of specification.

- General or brief specification
- Detailed specification
- Standard specification

10.What are the objects ofspecification?

1. Quality
2. Instruction
3. Aim of the project

11. Describe general specification.

- General specification gives the nature and class of work and materials in general to be used in the various parts of the works, from the foundation to the superstructure.
- General specifications give idea of the whole work or structure and are useful for preparing the estimate.

12. Describe detailed specification

- The detailed specifications form a part of the contract document. The detailed specification of an item of the work specifies the qualities and quantities of materials proportion of mortar workmanship, the method of preparation and execution and method measurement.
- The detailed specifications of different items of work are prepared separately which description what the work should be and how they should execute and constructed.

13. Define:Tender.

Tender is an offer given in writing to execute specified articles or materials at a certain rate, with in a fixed time, under certain conditions of agreement between the contractor and the party, which may be a government department or an individual.

14. What is called Tender Notice?

- The notice inviting tender is called tender notice.
- Tender notice is the publicity of offer to the contractor to quote their ratesforconstructionforconstructionworkosupplied.Sealedtendersareinvited inthemostopen and public manner. It is made public by advisement in leading newspaper, in thegovernment gazette or by notice in English and in the regional languages in public places.

15. Define: Contract and Contractor.

- Contract is merely an agreement being enforceable by law between two persons or parties.
- A person or a firm who undertakes any type of contract is termed as contractor.

16. What are the types of contract?

- Lump-sum contract
- Cost plus percentage of cost contract
- Item rate contract
- Labour contract
- Integrated contracting system

17. Write the essentials requirements of contract.

- The contract language is law full.
- The contract is made by parties competent to contract.
- The contract is made by free consent of the parties.
- The contract is made under valid consideration.
- There shall be a definite proposal and its acceptance.

18. What are the important legal implications of a contract?

- Agreement should not violate the provisions of law.
- It should not have any adverse effect on the morals of the society
- The form of contracts would be in writing and each page of the documents of the contract should be signed by both the parties.
- A contractor who refuses to carry out the work before completion can be used in account of law for breach of contract.

19. What are the types of termination of contract?

- Agreement
- Breach

- Performance
- Impossibility of performance
- Operation of provision of law

20. What are the conditions of contract?

- Conditions relating to documents
- Conditions relating to the execution of work
- Conditions relating to labour and personal

21. What are the types of penalties that are imposed on a contract and why aretheyimposed?

Penalties may be imposed for non-fulfillment of conditions of contract such as not maintaining progress, delay in completion and unsatisfactory work etc. The penalty may be fixed sum per day or a percentage of the estimated cost upto 10%.

22. Why and when the earnest money deposit iscollected?

While submitting a tender, the bidder has to deposit with the departmentanamountequaltoabout2½%oftheestimatedcostoftheworkwhichiscalledearnestmoneydeposit.Thisamountservesasachecktopreventthecontractorfromrefusingtoacceptheworkorrunway,whenhistenderhasbeenaccepted.Incaseofrefusaltotakeup the work his earnest money is forfeited.

23. Why and when the security deposit is collected?

At the time of execution of the contract agreement, the successful tender has to deposit a further sum of 1% of the contract amount to the department. This amount is known as security deposit. This amount is kept as a check so that the contract or fulfils all terms and conditions of the contract. The security deposit will be refunded to the contract on the satisfactory completion of the whole work, after the observation period of 6months.

24. What is a tendernotice?

Tender notice is the publicity of offer to the contractor to quote there ratesforconstructionforconstructionworkorsupplied.Sealedtendersareinvited in the most open and public manner. It is made public by advisement in leading newspaper, in the government gazette or by notice in English and in the regional languages in public places.

25. What information's should a contract document contain?

Contract Documents			
1	Title page	6	General specifications
2	Index page	7	Detailed specification
3	Tender notice and tender forms	8	Schedule of issue of materials
4	Schedule of quantities	9	Conditions of contract.
5	Drawings		

26. Define: Arbitration.

Arbitration is the settlement of a dispute by the decision not of a court or lawbutof one or more persons chosen by the parties themselves involved in the dispute.

27. Define:Arbitrators.

The persons chosen have the right to take decision are called arbitrators.

28. What are the typesofArbitration?

- Arbitration without intervention of court.
- Arbitration with intervention of court and there is no suit pending
- Arbitration is suits.

29. Define: Bar-bending schedule

- Bar bending schedule is a chart which describe the shape of bars, length of bars and total amount of steel is to be used in the specific design.

30. What is meant by contingencies?

Incidental expenses of miscellaneous character which cannot be classifiedapproximately under any distinct sub-head, but is added in the cost ofconstruction necessarily.

31. How will you analyse the rate of a particular item?

Cost of material and cost of labour is analyzed separately. Contractor's profit of 10% is also checked.

Unit-IV- Valuation

1. Define: Valuation.

Valuation is the process of estimating the cost of a property based on itspresentcondition.Thepropertiesmaybeimmovablepropertieslikeland,buildings,mines, trees, quarries etc., and movable properties such as coal, oil, steel, cement, sand etc.

2. Write the objective of valuation.

It is the technique of estimating and determining the fair price or value of a propertysuch as a building, a factory or other engineering structures of various types, land etc.

3. What is the purpose of valuations?

1. For Buying or Selling Property
2. For assessment of wealth tax, property tax etc
3. For fixation of rent
4. For security of loans or mortgage
5. For insurance, betterment charges etc

6. For compulsory acquisition

4. Write the necessity ofvaluation.

- Rent fixation. It is generally taken as 6% of the valuation of the property
- For buying andselling
- Acquisition of property byGovt.
- To be mortgaged with bank or any other society to raise loan
- For various taxes to be given and fixed, by the Municipal Committee
- Insurance: For taking out on insurancepolicies.

5. What are the methods of valuation?

- Rental Method of Valuation
- Direct Comparisons of the capital value
- Valuation based on the profit
- Valuation based on the cost
- Development method of Valuation
- Depreciation method of Valuation

6. Write a note on Rental Method of Valuation

In this method, the net income by way of rent is found out by deducting all outgoingfrom the gross rent. A suitable rate of interest as prevailing in the market is assumed andYear's purchase is calculated. This net income multiplied by Year's Purchase gives thecapitalized value or valuation of the property. This method is applicable only when the rent is known or probable rent is determined by enquiries.

7. Explain the method of direct comparison with the capital Value.

This method may be adopted when the rental value is not available from the propertyconcerned, but there are evidences of sale price of properties as a whole. In such cases, thecapitalized value of the property is fixed by direct comparison with capitalized value ofsimilar property in the locality.

8. Write a note on Valuation based on profit.

This method of Valuation is suitable for buildings like hotels, cinemas, theatres etc for which the capitalized value depends on the profit. In such cases, the net income is worked outafter deducting gross income; all possible working expense, outgoings, interest on the capitalinvested etc. The net profit is multiplied by Year's Purchase to get the capitalized value. Insuch cases, the valuation may work out to be high in comparison with the cost ofconstruction.

9. Write a note on Valuation based on cost.

In this method, the actual cost incurred in constructing the building or in possessingthe property is taken as basis to determine the value of property. In such cases, necessarydepreciation should be allowed and the points of obsolescence should also be considered.

10. Write a note on Development Method of Valuation.

This method of Valuation is used for the properties which are in the underdevelopedstage or partly developed and partly underdeveloped stage.

11. What is meant by Depreciation Method of Valuation.?

Depreciation is the gradual exhaustion of the usefulness of a property. This may be defined as the decrease or loss in the value of a property due to structural deterioration, life wear and tear, decay and obsolescence.

According to this method of Valuation, the building should be divided into four parts:

- Walls
- Roofs
- Floors
- Doors and Windows

12. What are the methods of depreciation?

1. Straight line Method
2. Constant percentage method or Declining balance method
3. Sinking Fund Method
4. Quantity Survey Method

13. Define: Value.

Value-Present day cost of a engineering structures (saleable value)

14.Define: Scrap Value.

Scrap Value: If a building is to be dismantled after the period its utility is over, some amount can be fetched from the sale of old materials. The amount is known as scrap value of a building. If various from 7% to 10% of the cost of construction according to the availability of the material.

15. Define: Salvage value.

If a property after being discarded at the end of the utility period is sold without being into pieces, the amount thus realized by sale is known as its salvage value.

16.What is meant by capital cost?

Total cost including all the expenditure incurred from beginning tothe completion of a work.

17. Define: Capitalized value.

It is defined as that amount of money whose annual interest at the highest prevailing rate will be equal to the net income received from the property. To calculate the capitalized value, it is necessary to know highest prevailing on such properties and income from the property.

Capitalized Value = Net income x year's purchase

18. Define: Market value.

Market value: The market value of a property is the amount, which can be obtained at any particular time from the open market if the property is put for sale. The market value will differ from time to time according to demand and supply.

19. Define: Book value.

Book value is the amount shown in the account book after allowing necessary depreciations. The book value of a property at a particularly year is the original cost minus the amount of depreciation up to the previous year.

20. What is meant by rate of cost?

The cost per unit of subhead which is arrived at by dividing the up-todatefinal charges on a sub-head by its up-to-date progress.

21. Define: Gross income.

Total amount of the income received from the property during the year, without deducting outgoings.

22. Define: Net income.

An amount left at the end of the year after deducting all useable outgoings

23. Define: Obsolescence.

The value of property decreases if its style and design are outdated i.e rooms not properly set, thick walls, poor ventilation etc. The reason of this is fast changing techniques of construction, design, ideas leading to more comfort etc.

24. Define: Sinking fund.

A fund which is gradually accumulated and set aside to reconstruct the property after the expiry of the period of utility is known as sinking fund. The sinking funds may be found out by taking a sinking fund policy with any insurance company or deposition some amount in the bank. Generally while calculating the sinking fund, life of the building is considered. 90% of the cost of construction is used for calculations 10% is left out as scrap value.

Sinking fund (I) = Si / (1+i) n-1

Where I = Annual installment required

n = Number of year required to create sinking fund

i = Rate of interest expressed in decimal i.e 5% as 0.05S = Sinking fund

25. Define: Annuity.

Annuity is the net instalment of periodical or annual payment of the capital amount invested in a property for a certain specified period. Annuity is paid either in the beginning or at the end of each project.

26. What are the types of annuity?

1. Annuity certain
2. Annuity due
3. Perpetual certain
4. Deferred annuity.

27. Write a short note on mortgage and lease.

- Advancing money against any form of security is called mortgage.
- The Property given no rent for a definite period under terms and conditions is said to be on lease.

28. What are the types of lease?

- Building lease
- Occupation lease
- Sub-lease
- Life lease
- Perceptual lease

29.What is meant by Standard rent?

Standard rent is the rent fixed under the Rent Control Act or even a provision made for the fixation of rent under the Act.

30. What are the important factors influencing the value of building?

1.Type of the building
2.Location of the building
3.Expected life of the building
4.Size and shape of the building
5.The Present condition of the building
6.Legal control of the building

Unit-V Report Preparation

1. **Define: Report.**

   Report describing the various features of the work, is accompanied with estimate. The report should be written in clear language. It should be written in such a way that while studying it one can able to get an idea about the whole work.

2. **What are the points included in the report preparation?**

   The following points are considered in the report,

   1. Brief history of the work
   2. Object necessity and unity of the project with reasons.
   3. Selection of site

4. Surveying
5. General specification and basis of design and calculation.
6. Availability of materials
7. Labour amenities and temporary accommodation for staff.
8. Total cost and financing
9. Return on revenue if any

3. What are the essential qualifications of a good report?

- A report must meet the needs of the readers and answer the questions in their minds
- A report must be at the right level for the readers. Some readers have an in-depth knowledge of the subject while others may be decision-makers without specialized, technical knowledge
- A report must have a clear, logical structure-with clear signposting to show where the ideas are leading
- A report must give a good first impression.
- A report must not make assumptions about the readers' understanding.
- Reports must be written in good English.
- Reports should have a time reference

4. What are the Steps to follow for prepare a Good and Effective Report?

- Define your aim
- Collect your ideas
- Select the material and decide how to show the significance of your facts
- Structure your ideas
- Start on report writing

5. Write the basic structure of technical report.

Report Structure			
1	Cover Page	**9**	Results
2	Title page	**10**	Discussion
3	Table of Contents	**11**	Conclusion
4	Acknowledgments	**12**	Implications
5	Executive Summary	**13**	Recommendations
6	Introduction	**14**	Further development
7	Objectives	**15**	Extension and Adoption
8	Method	**16**	Project coverage

6. Write down the basic principles of report writing?

1. Need for the project
2. Investigation and design carried out
3. Details of proposals
4. Schedule of rates
5. Cost

7. Write a report on a residential building.

1.Types and location of building
2. Types of soil and foundation
3. Details of Structure element
   - Super structure
   - Lintel cum sunshade
   - Beams and Columns
   - Slab
4. Joinery detail
5. Plumbing details
6. Estimate cost of the project

8.Write a report on the construction of a culvert.

1. Types and location of building
2. Types of soil and foundation
3. Catchment area detail
4. Loading classification
5. Details of structural Element
   - Abutment
   - Slab
   - Parapet wall
6. Estimated cost of the project

9. Write a report on the road construction.

1. Location and class of the road
2. Type of soil, subgrade and sub-base
3. Alignment of road
4. Plane table survey
5. Loading classification
6. HFL details
7. Details of culverts across the road if any
8. Estimate cost of a project.

10. Give the estimate for the sanitary installation.

Sanitary works usually consist of providing flush type latrines and connecting with sewer lines of septic tank. For estimating the numbers of different fittings are found out and rates

are taken per number for supply and fixing in position.

11. Give the estimate for the water supply.

The water supply works mainly consist of pipe lines the connection with water mains should be enumerated stating size and length of pipe from the water main up to the boundary of the property together with the charge of water and local authorities.

12. What are the types of Report?

- Information only report
- Research report
- Case-study and analysis report

PART-B Sixteen Mark Questions

Unit-I – Estimate of Buildings

1. Explain the types of estimates and differentiate detailed estimate from revised estimate.
2. What are the difference between preliminary estimates, detailed estimates, supplementary estimates and revised estimates? Under what circumstances each one is prepared and what statements and drawings are to be attached with each one them.
3. Explainthefollowinggeneralitemsofworkinvolvedintheestimationforabuilding along with the process of calculations.
    a. Earthwork in excavation.
    b. Earthwork infilling.
    c. Brick at soling.
    d. Cement concrete in foundation.
    e. Masonry work in foundation.
    f. Damp proof course.
    g. Masonry work in superstructure.
    h. 10 cm thick brickwork.
4. Enumerate different methods for estimating building works along with a suitable example.
5. List and explain any four approximate methods of estimating for buildings.
6. Explain the following area of measurements.
    a. Plinth area
    b. Floor area
    c. Circulation area

d. Carpet area

7. The plan and sectional elevation of a building are given in figure .Estimate he quantities of the following of items of work of the

   (i) Doors and windows

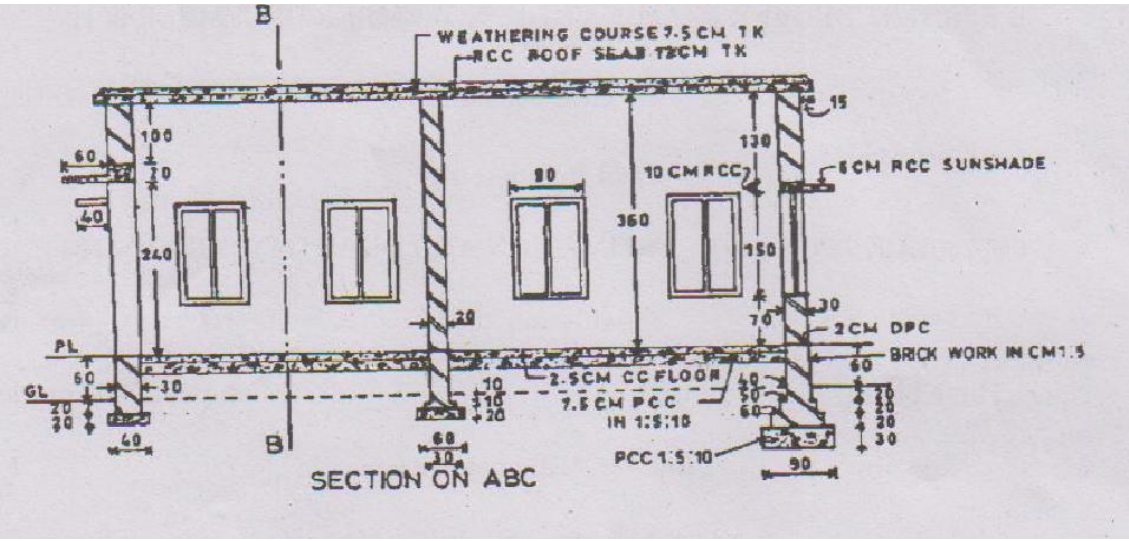
   (ii) R.C.C work in roof slabs, lintels and sunshades

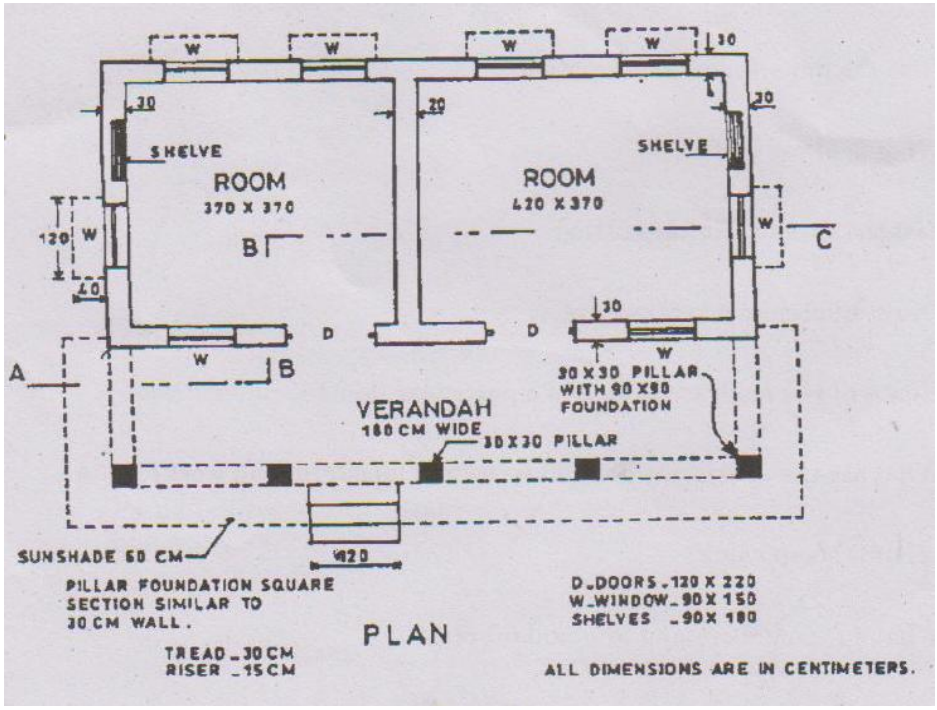
   (iii) Plastering internal

   (iv) First class brick work in C.M. 1:6 in super structure.

   (v) P.C.C. in fou4dation

   (vi) Ceiling plastering.



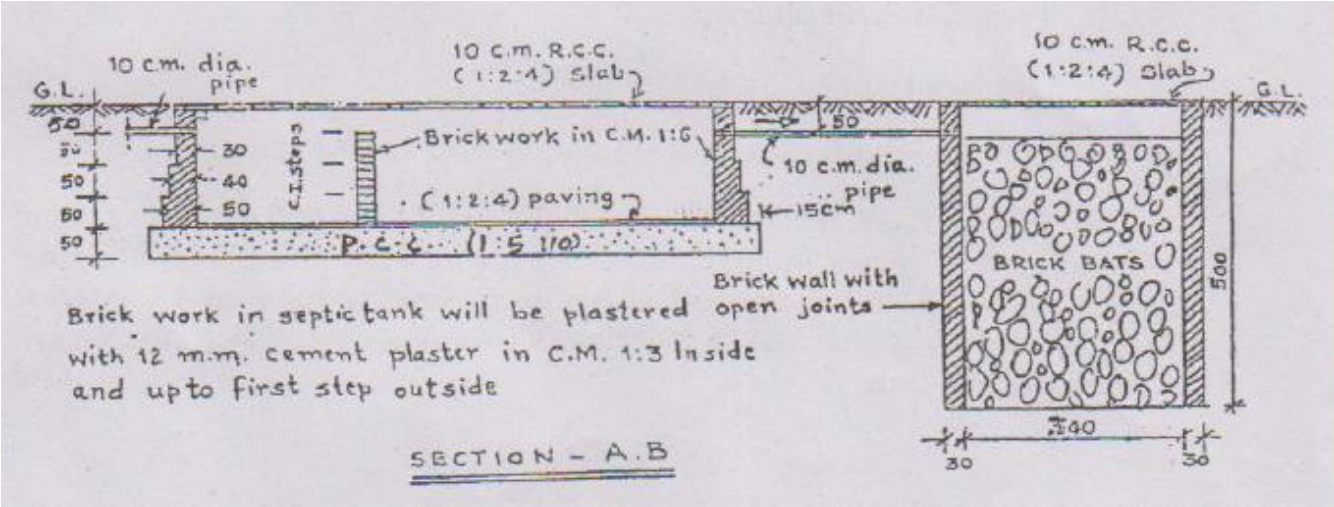


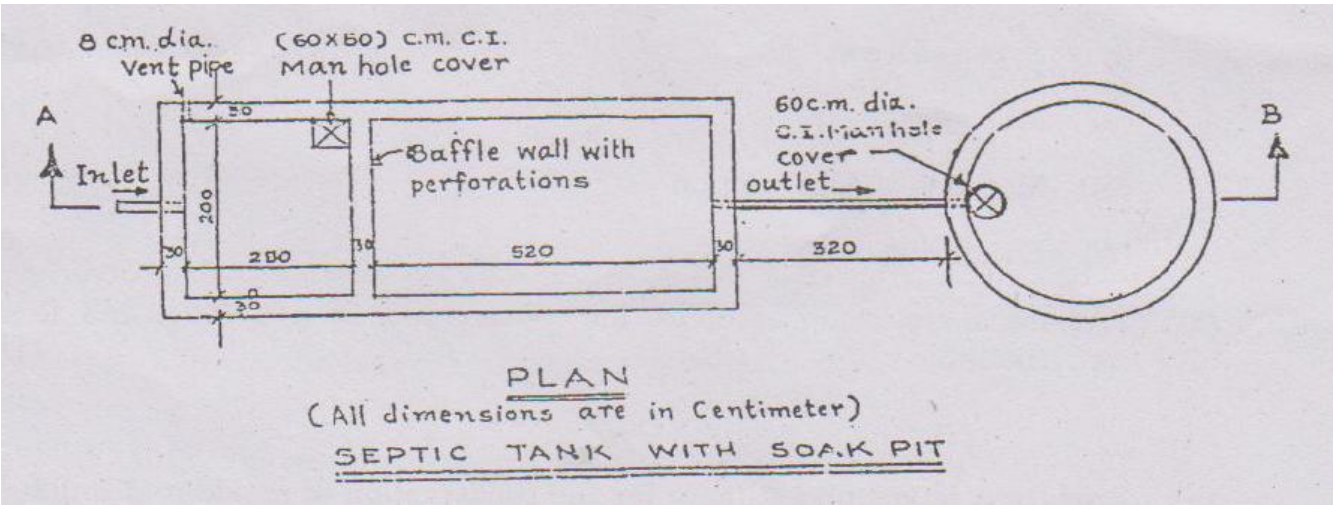
8. Enumerate different methods for estimating building works along with a suitable example.

9. Distinguish clearly between
    a. Rough cost estimate and detailed estimate
    b. Revised estimate and supplementary estimate
    c. Dismantling and demolition
    d. Administrative approval and technical sanction
    e. Sundries and supervision charges
10. Write down the units of measurement and units of payments in respect of the following
    a. Earthwork
    b. Supply of W.S.pipe
    c. Gusset plate
    d. Painting of doors and windows
    e. Holdfast
    f. L.C. in roof terracing
    g. Tar felting
    h. Pre cost jelly works
    i. Mosaic flooring
    j. Doorframes

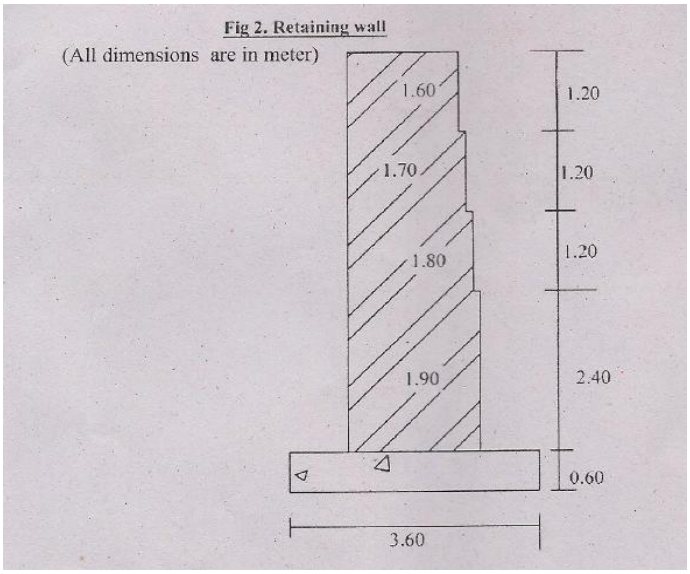
Unit-II – Estimate of Other Structures

1. Estimate the quantity of following items of Septic tank fig.
    (i) Earth work excavation
    (ii) P.C.C. 1:5:10
    (iii) Brick Bats in soak pit.
    (iv) Internal Plastering
    (v) Brick work in C.M. 1:6 in septic tank
    (vi) R.C.C cover slab for septic tank and soak pit.

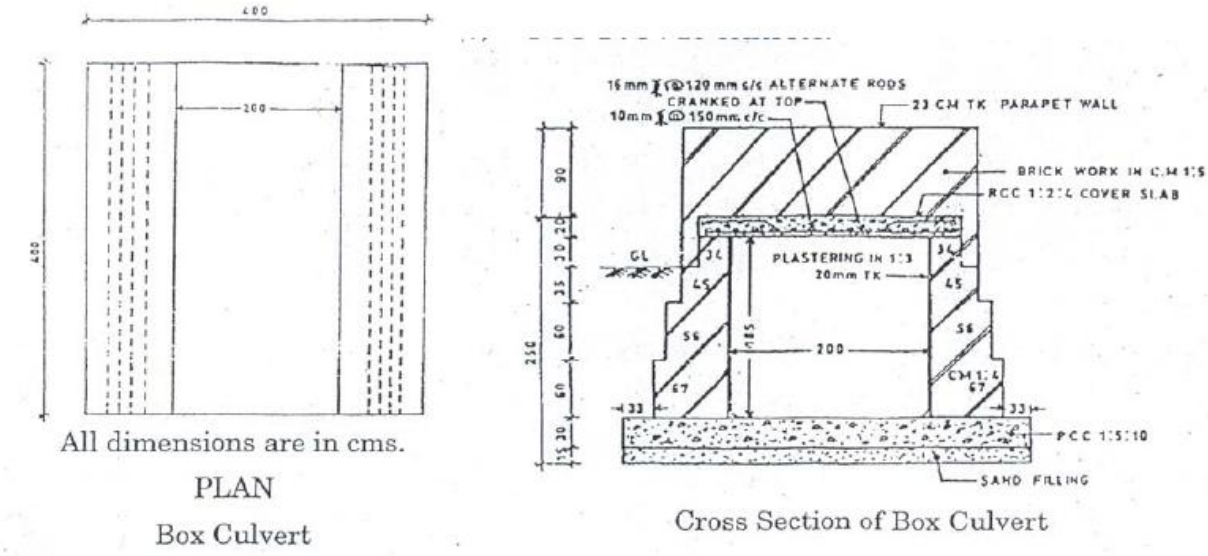




2. Prepare the detailed estimate of the quantities for the following items for a 100 m length of retaining wall shown in fig.
    1. Brick work in CM 1:4
    2. Plain cement concrete 1:4:8
    3. Number of bricks
    4. Number of cement bags.

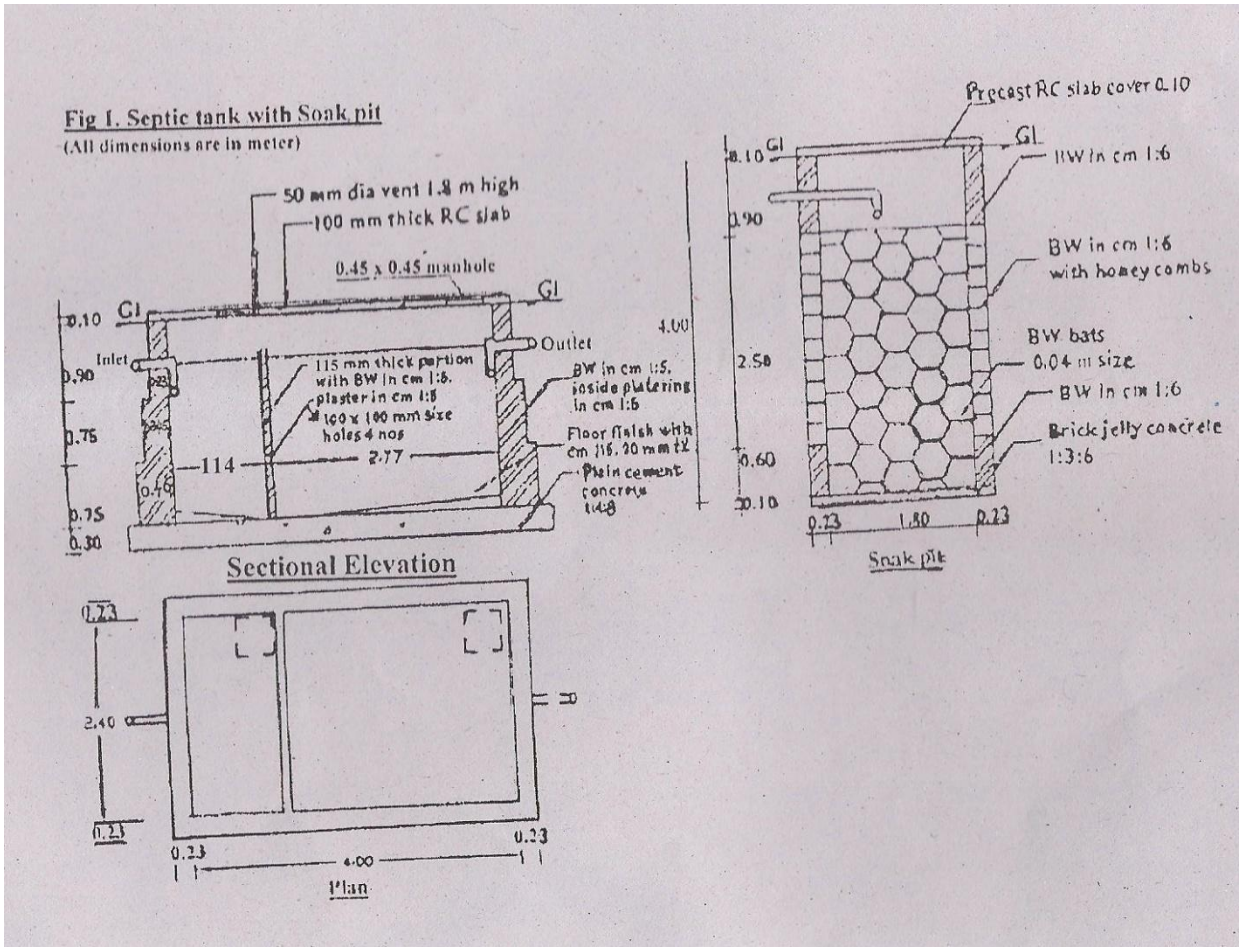


3. Estimate the following quantity for the below figure?
   (i) Earth work excavation
   (ii) PCC
   (iii) Brickwork above & below Ground level
   (iv) RCC work



4. What are the methods of estimation of roads?
5. Draw the different types of sanitary fittings?
6. Explain in detail about septic tank and dispersion trench?
7. Details of a R.C.C retaining wall 25m long. Prepare a detail estimate for the work.
8. Determine the quantities of following works in the septic tank & soak pit shown in fog.
   1. Earthwork excavation

2. Plain cement concrete
3. Brickwork in CM 1:5 in septic tank.
4. RCC 1:2:4 in cover slab of septic tank.



9. Prepare a detailed estimate of a septic tank with soak pit for 25 users.
10. Prepare a detailed estimate for an open well assuming suitable data.
11. Prepare a detailed estimate for a tube well assuming suitable data.
12. Explain the quantities of different items of work for an abutment with wing wall for a culvert.

Unit-III – Specification and Tenders

1. Explain the contents of a typical tender notice.
2. Write down the general specification of modern road.
3. Explain the contents of a typical contract documents.
4. Discuss the necessity of specification in detail.
5. Using current schedule of rates for materials and labours, prepare data for the following items of work:

(i) Half brick with CM 1:1, for $1m^3$,

(ii) Plain cement concrete 1:5:10 for $1m^3$

6. Briefly explain the following items.

   (i) Tender

   (ii) Contract document

   (iii) Termination of contract

   (iv) Over head cost in analysis of rates.

7. Write down the specifications of the following

   1. Cement concrete in foundation
   2. Plastering in cement mortar 1:6.

8. (i) Explain the sequential procedure of opening of tenders.

   (ii) Discuss about three forms of contractors.

9. Explain various types of contract.
10. Explain in detail about the penalties to contractors.
11. Explain in details about arbitration.
12. What is schedule of rates? What information does it give? Explain in detail.
13. Analyses the rate of Reinforced cement concrete beam and column.
14. Analyses the rate of cement concrete of ratio 1:2:4 and 1:3:6.
15. Explain the procedure of opening the tenders, acceptance of tenders and the execution of agreement for carrying out a work.

Unit-VI – Valuation

1. Explain different methods of valuation.
2. Explain in detail about the four methods of calculation of depreciation.
3. Discuss the importance of valuation.
4. Discuss purpose of valuation in detail.
5. Explain the steps involved in the calculation of standard rent for buildings.
6. Calculate the Standard rent of a building with following data:

   Cost of land: Rs. 7, 00,000.00, cost of building 16, 00,000, Expected life of building = 65 years- Returns expected 5% on land and 8% on building. Annual repair 1% on the cost of building. Sinking fund on 4% interest basis on 90% of the cost of building. Other out going 30% of the return from the building.

7. Explain the following:

   (i) Types of lease

(ii) Mortgage

(iii) Methods of depreciation

(iv) Escalation

8. Explain the following

1. Scrap value
2. Salvage value
3. Market value
4. Book value.
5. Capitalised value
6. Sinking fund

9. Calculate the annual rent of a building with the following data.

Cost of land = Rs.20000/-

Cost of building = Rs.80000/-

Estimate life = 80years

Return expected = 5% on land 6% on building

13. A newly constructed building stands are a plot costing Rs. 60,000. The construction cost of the building is Rs.20, 000. And the estimated life of the building is 66 years. The investor's desires to have 8% return on the construction cost and 5% return on the land cost. Assuming annual repairs to be at 0.50% of the cost of construction and other outgoing at 30% of the gross rent, Calculate the annual rent that will have to be changed for the building. The annual instalment of the sinking fund for a life of 66 years of the building at 3% may be taken as 0.2 paise per rupee.
14. A machinery was purchased for rs.20,000 in the year 1970. Salvage value of the machine after 7 year is 6000. Calculate depreciation and value for each year.
15. A construction machinery was purchased for Rs.50, 000. The salvage value of machinery after 5 years is Rs.15, 000. Find the book value at the end of the 3 years.

    1. Straight line method
    2. Constant percentage method.

Unit-V – Report Preparation

1. Briefly explain the principle for the preparation of report of water supply scheme?
2. Prepare a report on estimate for construction of a Culvert and Road construction.
3. Prepare a report estimate for the construction of residential building and water supply and sanitary installation.

4. Write a report to accompanying an estimate for a village water supply scheme.
5. Explain in detail how you will work out standard rent of a government building.
6. What are the points to be considered in the report writing and explain the residential building report?
7. Prepare the report on the estimate for the construction of road.
8. Explain the report on estimation for construction of Tube well?
9. Explain the report on estimation for construction of open well?
10. Explain the report on estimation for construction of water supply & sanitary works?

CE 6023 – INDUSTRIAL WASTE MANAGEMNT

TWO MARKS

UNIT – 1 INTRODUCTION

1. Define the term Population Equivalent.

Population Equivalent is the term which indicates the strength of the industrial waste waters for estimating the treatment required at the municipal sewage treatment plant. , it is define as the ratio of standard BOD's of industrial sewage to the standard BOD of domestic sewage per person per day.

Population Equivalent = Standard DOD of industrial sewage/standard BOD of domestic sewage.

2. What is Hazardous waste?

Hazardous waste is the waste which by their nature and quality may be potentially detrimental to human health and or the environmental and which require special treatment and disposal.

3. What is mean by sewage sickness?

When sewage is continuously applied on a piece of land the pores or void in the soil gets clogged and the free circulation of air will be prevented .This is known as sewage sickness.

4. What are the characteristics of industrial waste water?

P^H, BOD, Turbidity, Colour, COD, Suspended solids, Dissolved solids, Settle able solids.

5. What is the Process of treatment of industrial waste?

Preliminary treatment, Primary treatment, Secondary treatment, Tertiary treatment.

6. What is biodegradable organic matter?

The organic matter which is decomposed by bacteria ,under biological action, is called biodegradable organic matter.

7. The method used to dispose radioactive hazardous wastes?

- Diluted and Disperse method
- Delay and decay method
- Concentrate and contain method
- Reclamation method

8. Distinguish between sewage and sewerage?

SEWAGE: The society's wastes are mixed with sufficient quantity of water and carried through closed conduits under the condition of gravity flow. This mixtures of water and waste products, popularly called sewage.

SEWERAGE: The art of collecting, treating and finally disposing of sewage is known as sewerage.

9. What is a Bioassay study?

- Determination of the strength or biological activity of a substance, such as a drug, by comparing its effects with those of a standard preparation on a test organism.
- A test used to determine such strength or activity

10. What is percapita water demand?

It is the annual average amount of daily water required by one person, and includes the domestic use, industrial and commercial use, public use, wastes, thefts etc.

11. What is called Chronic & Acute?

Chronic:

It estimates longer term effects that measures the ability of an organism to reproduce growth or behave normally.

Acute:

It estimates the short term effects it expresses the concentration of the organism.

12. What are the major types of pollutants?

Carbon monoxide, sulfur dioxide, Nitrous oxide, Hydrogen sulphate, Photochemical smog.

13. What are the objectives of waste water treatment?

- To remove the pollutants from the waste water
- Reducing undesirable effect to receiving streams or lands.
- To remove the pathogens and microorganism in the waste water.

14. What are the causes of industrial pollution?

- Lack of control pollution
- Use of out dated technologies

- Unplanned industrial growth
- Limitation of money for treatment process

15. Classification of industries based on its effects

- Red: Sugar industries, Paper and pulp industries, Tanneries industry, Pharmaceuticals industry.
- Orange: Cotton and spinning industry, Hotel, Crushers, Pesticides.
- Green : Mineralized water, Ice cream industries, Furniture industry, Gold, Handloom, Carpet.

UNIT – 2

CLEANER PRODUCTION

1. What are the 3R Concept?

Reduce, Reuse, Recycle

2. Define cleaner production.

Cleaner production is a preventive, company-specific environmental protection initiative. It is intended to minimize waste and emissions and maximize product output.

3. What are the waste minimization techniques?

Inventory management, Equipment modification, Process modification, Byproduct recovery, Reduce, Recycle, reuse.

4. What is meant by waste audit?

A waste audit is an analysis of your facility's waste stream. It can identify what types of recyclable materials and waste your facility generates and how much of each category is recovered for recycling or discarded.

5. What are the steps involved in waste audit?

- Pre – audit process
- Activity at site
- Post audit activates

6. What is the process involved in volume reduction?

Segregation, Conservation, Product modification, Recycle, Reuse and Reduce.

7. How will you reduce the strength of waste?

Process modification, Equipment modification, Equalization waste, Byproduct recovery, proportioning waste.

8. Write the application of byproduct recovery.

Ammonia liquor is recovered from steel plant caustic soda is recovered from the paper mills.

9. What is called segregation of waste?

Segregation of waste is the process of segregating the concentrated waste water from the diluted waste water.

10. What is called process change?

Process change is the method of change the raw materials or manufacturing process in order to reduce the pollution.

11 What is called equipment modification?

Equipment modification is the process of changing or altering the equipment in order to reduce the pollution.

12. What is meant by end of pipe technique?

Methods used to remove already formed contaminants from a stream of air, water, waste, product or similar. These techniques are called 'end-of-pipe' as they are normally implemented as a last stage of a process before the stream is disposed of or delivered.

13. Example for reuse and recycle

- <u>Reuse</u>
- Save and reuse scrap paper for writing notes and always try to write on both sides of paper.
- Use refillable containers (like Tupperware or reusable mugs) and rechargeable batteries.
- Wash and reuse plastic food storage bags and heavy aluminum.
- Donate unwanted clothing to charities or second-hand clothing stores.
- <u>Recycle</u>
- Donate clothing, furniture, appliances, and electronics to not-for-profit organizations.
- Hold a yard sale to recycle unwanted items. One man's garbage is another man's treasure.
- Place all recyclable items in the blue box for weekly collection.

14. What is meant by Hazardous waste water?

A substance is chemically reactive when it is unstable or could react when exposed to another compound. The waste water having the hazardous characteristics and its pH varies from ≤ 2 and ≥ 12.5 is called Hazardous waste water.

Ex: NaoH, Vehicle batteries, Plating water.

UNIT - 3

POLLUTION FROM MAJOR INDUSTRIES

1. What are the pollution characteristics of sugar industrial waste?

- P^H = 4.6 - 7.1
- BOD = 600 - 4300 ppm
- COD/BOD = 1.3 - 2.0

2. What is called waste water reclamation?

The concept of the reclamation of water is for sustainability and water conservation rather than discharging waste in river, land and ocean.

3. What are the effects of tannery waste on receiving waters and sewers?

Streams will get Odour, color change increasing of chemical contents, aquatic organisms will get affect, ground water get pollute,

Sewer will get eroded, corrosion, presence of solid particles will clog the sewer and damaging of sewer.

4. What are the sources of liquid effluent from sugar mill?

Mill House, Waste Water from Boiling House, Waste Water from Boiler Blow-down, Condenser cooling water, Soda and Acid Wastes.

5. What is the major waste water generating unit in textile industry?

Cleaning, Bleaching and Dyeing.

6. State any two uses of studying manufacturing process of an industry in managing its sewage.

To reduce the waste generation from the industry, reduce the environmental pollution from the industry and to increase the production of the product.

7. State the effluent sources of a thermal power plant.

Coal, burning of fossil fuels, waste water from boiler.

8. Define black liquor in distilleries.

A distilled beverage, spirit, liquor, hard liquor or hard alcohol is an alcoholic beverage produced by distillation of a mixture produced from alcoholic fermentation. This process purifies it and removes diluting components like water, for the purpose of increasing its proportion of alcohol content (commonly expressed as alcohol by volume, ABV).

As examples, this term does not include beverages such as beer, wine, and cider, as they are fermented but not distilled. These all have relatively low alcohol content, typically less than 15%.

9. What are the industries under red categories?

Red: Sugar industries, Paper and pulp industries, Tanneries industry, Pharmaceuticals industry.

10. Name the two waste water reclamation techniques.

Disinfection and Reverse osmosis.

UNIT- 4

TREATMENT TECHNOLOGIES

1) What is called equalization or aim of equalization?

Equalization is a process of making the effluent discharge is fairly uniform in its characteristics like pH,color,turbidity,BOD,COD,etc..,

2) Equalization process or equalization types?

Wall baffle, mechanical agitation, Aeration, combination of these.

3) Purpose of injecting air in equalization tank?

Better mixing, chemical oxidation, biological oxidation, to prevent the settling of solids.

4) What is called neutralization?

Neutralization is the process of converting the acidic or alkaline waste water into neutral by treating with suitable acid or base.

5) How do you acidic waste into neutral?

By treating the acidic waste with Passing the acidic waste into beds of the limestone Lime slurry Caustic soda treatment

6) How do you convert alkaline waste water in neutral?

The over alkaline of waste water is treated by Blowing waste boiler flue gas Adding compressed CO_2 to alkaline waste Producing CO_2 in alkaline waste Adding sulphuric acid

7) What are the methods to remove the suspended solids?

Chemical coagulation , filteration bed like contact bed , trickling filter , intermediate sand filter,microscreenig , ultrafilteration.

8) Define coagulation

Coagulation is the process of settling the suspended solids in the waste water by adding the flocc foming chemical.

9) What are the chemicals added in coagulation ?

Aluminium sulphate, ferrous sulphate , lime , ferric chloride, ferric sulphate

10) Advantages of coagulation process.

Chemical coagulation is found to be more economical than plain sedimentation Less space is enough for operation . This process is simple in operation

11) what are the methods for removal of dissolved organic solids ?

- Adsorption method:
- Activated carbon treatment
- Granular carbon treatment
- Powdered activated carbon treatment
- Chemical oxidation method :
- Ozone treatment
- Chlorination
- UV rays treatment

12) Methods of removal of dissolved inorganics?

The operations in the removal of the inorganic dissolved substances are,

- Chemical precipitation
- Ion exchangers
- Ultrafilteration
- RO
- Electrolysis

13) Define dewatering of sludge.

It is a physical unit operation used to reduce the moisture content of the sludge.

14) Write dewatering methods?

Sludge drying methods, sludge lagooning , vaccum filters , mechanical sludge thickener.

15) What is the purpose of dewatering?

- To reduce the cost
- Easy to handle
- To make sludge odourless
- To treat the sludge in Safeway

16) What are the methods of disposal sludge?

Spreading on farm land , dumping , land filling , sludge lagooning , disposing in sea or river.

17) What is meant by combined treatment of industrial and municipal waste?

In this method industrial waste is discharged in municipal waste with suitable proportion and the treatment is carried out in municipal waste water treatment unit.

18) What are the advantages of combined treatment of industrial & municipal waste?

Cost economy, To improve the quality of treated water

19) Define proportioning Proportioning means discharge of the industrial waste in proportion to the flow of municipal sewage in the sewer.

UNIT – 5

HAZARDOUS WASTE MANAGEMENT

1) What is meant by hazardous waste?

It is a waste , which posses major threats to public health or environment

2) What are the characteristics of hazardous waste ?

Ignitability , reactivity , corrosivity , toxicity.

3) What is called hazardous waste management?

Hazardous waste management is the process of collection ,treatment and disposal of waste material which when improperly handled can cause severe harm to health or environment.

4) What is meant by secure landfills?

Landfilling of hazardous solids waste is regulated more strictly than municipal waste landfilling

5) What are the types of landfills?

Dilute and disperse landfill, containment landfill, dedicated landfill.

6) What are the classifications of hazardous waste for landfilling.

Type A : those wastes unsuitable for landfilling

Type B: wastes which could be suitable for dedicated landfills

Type C: those wastes which may be appropriate for co disposal with normal municipal refuse.

7) What is meant by solidification?

It is the process of convert the liquid waste into solid form by adding selected absorbents.

8) What are the aims for solidification ?

- The liquids waste is convenient to dispose.
- Eco friendly

- Economically

9) Define the term incineration ?

It is the process of burnt the hazardous waste and solid waste at a high temperature which are not suitable for treatment process

10) What are all the hazardous waste incinerators?

- Rotary kilns
- Fluidized bed units
- Liquidized injection tanks

11) What are the method involved in incinerator?

- Rotary kilns
- Fluidized bed units
- Liquidized injection tanks
- Fixed hearth units

12) What is called landfill?

Landfill is the process of disposing the waste by alternate layers of waste and soil in under the soil.

PART B (16 MARKS)

UNIT I INTRODUCTION

1. What is the effect of stream in industrial waste?
2. Explain process modification?
3. Write brief note on environmental legislation?
4. Explain by product recovery with example?
5. Explain waste strength reduction methodology?

UNIT II CLEANER PRODUCTION

1. Lit it method of reducing waste strength explain them with example?
2. Discus the waste volume reduction technique?
3. What is meant by ate audit? Explain with methodology?
4. How change and housekeeping proceed can lead to waste minimization?
5. What are the different waste management approaches?

UNIT III POLLUTION FROM MAJOR INDUSTRIES

1. What is the necessary of dewatering?
2. Explain the various methods of land treatment?
3. What do you mean by auditing?

4. How could strength reduction calculated?

5. List the advantages of common effluent treatment plant?

UNIT IV TREATMENT TECHNOLOGIES

1. With a neat flow diagram explain the treatment methodology for a pulp and paper mill?
2. What are the various sources a distillery unit?
3. Discuss the problems associated with refinery effluent?
4. Discuss the pollution aspects of thermal power?
5. Illustrate the steps involved in textile?

UNIT V HAZARDOUS WASTE MANAGEMENT

1. Define characteristics of hazardous ate?
2. Define physical chemical and biological treatment of hw?
3. Describe the method of land filling?
4. What are the wastes incinerated?
5. What is meant by solidification?

CE6007- HOUSING PLANNING AND MANAGEMENT