Important Instructions to examiners:

1) The answer should be examined by keywords and not as word-to-word as given in the model answer scheme.

2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.

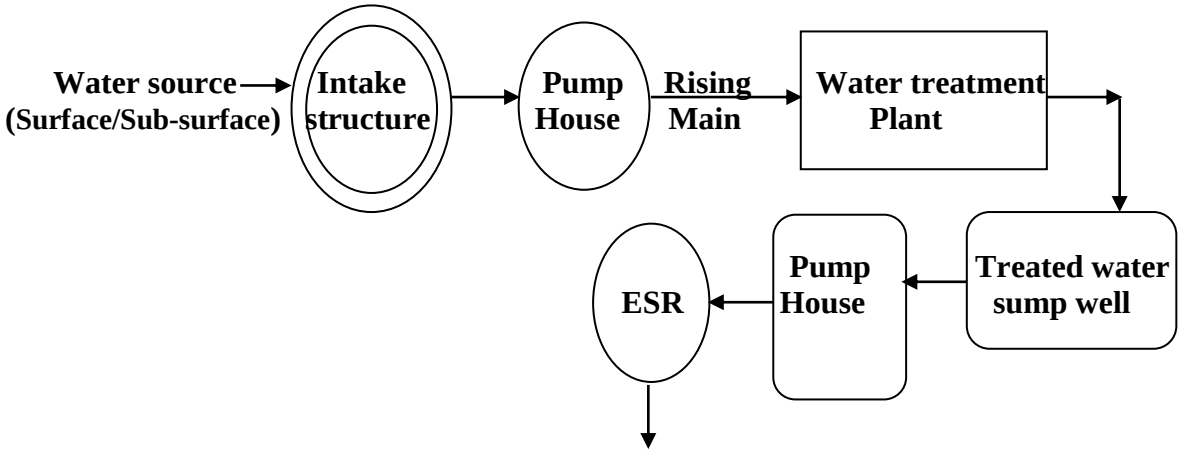
3) The language error such as grammatical, spelling errors should not be given more importance. (Not applicable for subject English and communication skill).

4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figure drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.

5) Credits may be given step wise for numerical problems. In the some cases, the assumed constants values may vary and there may be some difference in the candidates answer and model answer.

6) In case of some questions credit may be given by judgment on part of examiner of relevant answer based on candidates understanding

Question and Model Answers	Marks
Q.1 (A) Attempt any THREE of the following	**12M**
a) State the factors affecting rate of demand (any four)	**4M**
Factors affecting rate of demand- 1. Climatic condition - The per capita consumption of water is more in hot climate than in the cold climate. 2. Living standards of people – Per capita consumption is more for rich people then the poor and middle class people. 3. Size of the community – Water demand of town is more with its size. 4. Industrial and commercial activities- Per capita water consumption increases with industrial and commercial activities in town. 5. Pressure in the distribution system- The water demand increases with increase in the pressure of water in distribution lines. And there will be more loss due to leakage & thefts. 6. System of sanitation- The per capita water demand of town having water carriage will be more than town where it is not used. 7. Cost of water- If the cost of water is more less quantity of water will be used. 8. System of supply- In continuous system of supply, consumption is more than intermittent system. 9. Quality of water- If the quality of water is good water consumption will be more.	**1M (each for any four)**

b) Draw layout of water supply scheme	**4M**
	**2M stating units** **2M Correct sequencing**
c) State the various methods of forecasting of population. Explain any one.	**4M**
Methods of forecasting of population- **1.** Arithmetic Increase method **2.** Geometric Increase method **3.** Incremental increase method **4.** Decrease rate of growth method **5.** Simple graphical method **6.** Comparative graphical method **7.** Master plan or zoning method **8.** Logistic curve method **9.** Apportionment method (National ratio)	**2M (for Any four)**
1. **Arithmetic Increase method**-This method is based on the assumption that the population is increasing at a constant rate**.** The average increase of population for the last three or four decades is worked out and then for each successive future decade, this average is added. This method is used for large old city. $P_n = P_o + n.c$…… Where, P_n = Future population after n^{th} decade Po = Last known decade population c = Average increase in population n= Future no. of decade	**2M (for any one method)**
2. **Geometric Increase method**- The per decade percentage increase is assumed to be constant and increase is compounded over the existing population every decade. $P_n = P_o \times \left(1 + \frac{r}{100}\right)^n$ r = geometric mean	

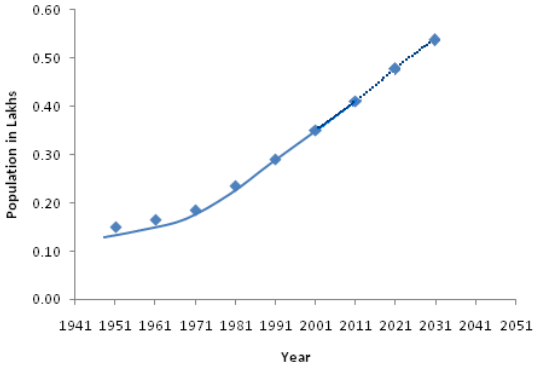
3. **Incremental increase method** – In this method decade growth rate is progressively increasing or decreasing. The population for future decade is worked out by adding the mean arithmetic increase to the last known population as in arithmetic increase method and to this is added the average of the incremental increase, once for the first decade, twice for the second decade and so on.

$$P_n = P_o + n.x + \frac{n.(n+1).y}{2}$$

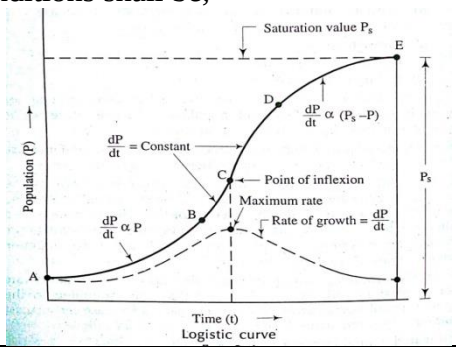
x= Average increase in population

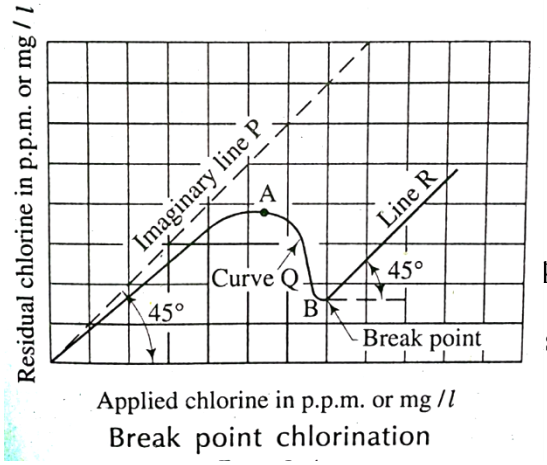
y= Average of incremental increase in population

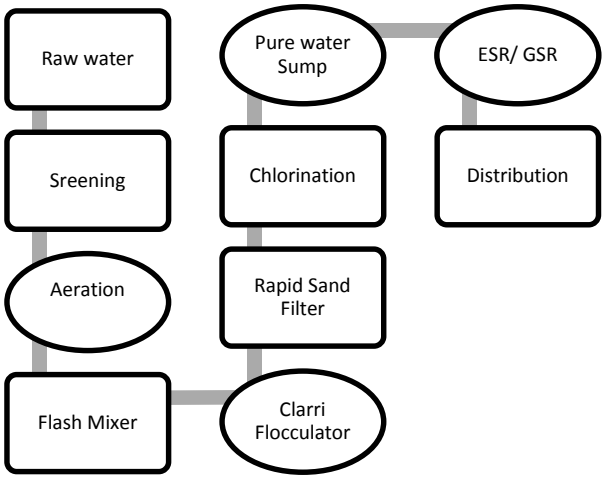
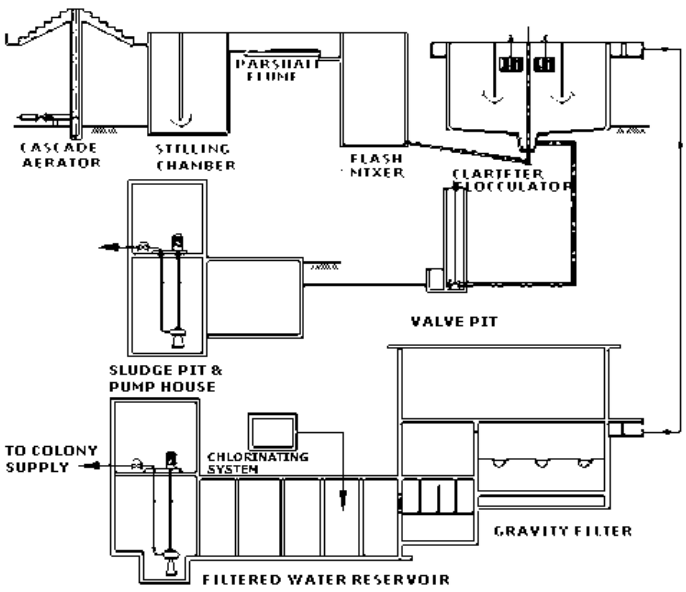
4. **Decrease rate of growth method**- In this method the average decrease in the percentage increase is worked out and is then subtracted from the latest percentage increase for each successive decade.
5. **Simple Graphical method**- In this method the population of last few decades are correctly plotted to a suitable scale on the graph w.r.t. decade. The curve thus obtained is smoothly extended to forecast the future population.



6. **Comparative graph method**- The future population can be predicted by plotting the population of other cities. The curve of past population of the city under consideration is plotted on the same graph. Cities to be compared should be as similar as possible to city being studied. Factors to be considered i) geographical proximity, ii) likeness of economic base, iii) access to similar transportation systems. Population of the city is expected to grow in a similar manner to cities used for comparison.
7. **The Master Plan method-** For the proper development of the cities, their master plans are prepared. The city is divided in various zones such as residential, commercial, industrial, educational, parks & gardens etc. The future expansion of the city is strictly regulated by various bye-laws of corporation and other local bodies according to master plan. The master plans are prepared for 25-30 years.
8. **Logistic Curve method-** If the population of town is plotted w.r.t. time the curve so obtained under normal conditions shall be,



d) State the necessity and Importance of Ground water recharging.	**4M**
Necessity and Importance of Ground water recharging- 1. Increase ground water storage 2. Prevent wastage of water by arresting runoff 3. Safeguard and sustain existing water table. 4. Improve water quality 5. Prevent sea water intrusion and salination of ground water. 6. Prevent soil erosion 7. Mitigates flood 8. To meet the demand for future generation	**½ M each point**
(B) Attempt any ONE of the following	**6M**
a) Decribe Break point chlorination with the help of graph and state importance of residual chlorine.	**6M**
 Break point chlorination The chlorine, when added to the water, performs the function of killing bacteria first and then starts accumulating upto point 'A' as shown in graph. Further addition of chlorine shows sudden decrease in residual chorine upto point 'Q' , this is because of oxidation of organic matter in water. The point 'Q' on graph s called 'Breakpoint' as any chlorine that is a added beyond this point breaks through the water and appears as residual chlorine. **Importance of Residual chlorine-** During the distribution of water through network of pipes there is possibility of contamination, then the residual chlorine present in water is used for killing these bacteria and hence quality of water is maintained for the consumer.	**2M (for Graph)** **2M (Expl.)** **2M**
b) State the factors governing the location of an intake structure.	**6M**
Factors governing the location of an intake structure- 1. The quality of water available at the site should be good. 2. The site of intake should be easily accessible. 3. Intake should not get flooded during floods. 4. Intake works should not be located on curves as far as possible. 5. Power supply should be available and reliable near the site. 6. The intake should not be located near the navigation channel. 7. The site should be such as to permit greater withdrawal of water, if required in future. 8. It must be located at a place from where it can draw water even during the driest period of the year. 9. The intake should be as near the pumping station as possible. 10. Places of rapid current that will endanger the safety of the intake structure should be avoided.	**1M (each for Any six)**

Q.2. Attempt any FOUR of the following	16M
a) State the objects & methods of Aeration	**4M**
Objects of Aeration: 1) To remove the dissolved (like H_2S, CO_2, NO_2) gases from raw water. 2) To increase the dissolved Oxygen content in water. 3) To remove colour, odour considerably. 4) To remove iron and manganese precipitate. **Methods of Aeration:** 1) Cascade aeration 2) Spray Nozzles or fountains 3) Air diffusion 4) Trickling bed or tray	**2M** **2M**
b) Draw & label flow diagram of water treatment plant	**4M**
 **OR**  ***(*Note: Student may draw flow diagram in any manner i.e. either lay out or flow diagram. so give credit 02 marks for naming components and 02 marks for correct sequence of units.)***	**2M stating units** **2M Correct sequencing** **OR** **2M stating units** **2M* Correct sequencing of units.**

c) Define Disinfection. State its objects. — **4M**

Disinfection:
The process of killing the infective or harmful bacteria from water and making it safe for the user is called disinfection. — **2M**

Objects of Disinfection: — **2M (for any two)**

1) To kill harmful bacteria from water at the treatment plant.
2) To prevent the recontamination of water during its transit from the treatment plant to its place of consumption.
3) In case of emergencies when complete treatment of water is not possible, only disinfection is given to water.
4) To give residual sterilizing effect for a long period.
5) To prevent spread of diseases and their epidemics.

d) Describe the theory of filtration — **4M**

Theory of filtration: The filtration process is carried out in following four actions- — **1M (for each step)**

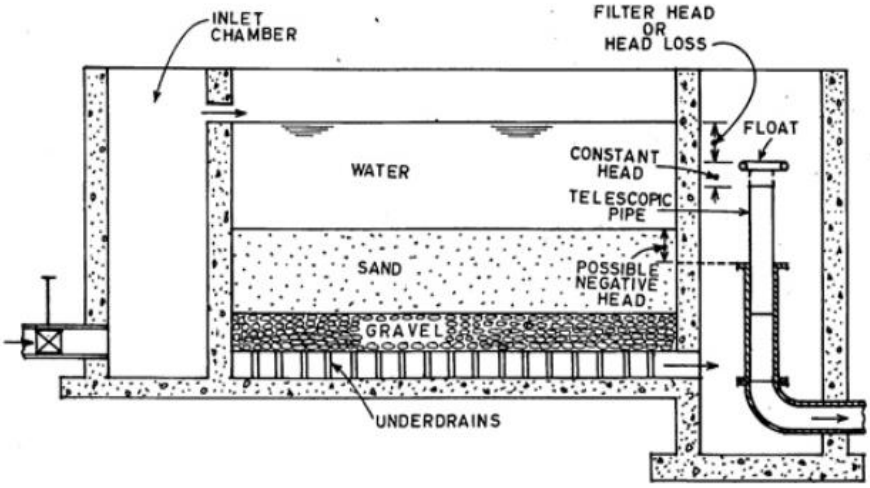
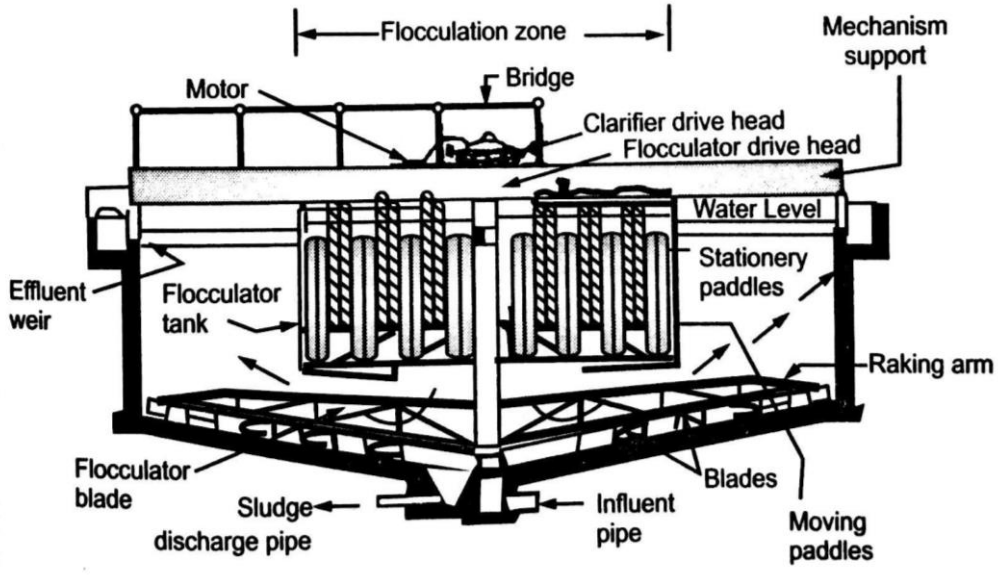
1) **Mechanical Straining:**
   Sand consists of small pores, therefore suspended particles which are larger in size, can not pass through sand bed. Small particles of suspended impurities adhere causing further reduction in pore size. This increase the straining action.
2) **Sedimentation:**
   The voids act as small settling basins. The particles are arrested due to gelatinous film formation and attraction between particles.
3) **Biological Action:**
   Suspended impurities contain some portion of organic impurities like algae, etc. and form a layer. This food consumed by micro organisms with chemical and biological action.
4) **Electrolytic action:**
   Sand particles of filter media carry electrical charges of opposite nature. They therefore attract each other and are neutralized. The characteristics of water are thus changed. Washing of filter media renews the electrical charges.

e) Differentiate between dead end system and grid iron system of distribution of water. — **4M**

Dead end system	Grid iron system
1) This system is suitable for cities, developed in haphazard manner.	1) This system is suitable for well planned cities or cities having rectangular layout of roads.
2) One main starts from service reservoir along the main road and sub mains are connected to main form a tree like layout.	2) One main starts from service reservoir along the main road and sub mains, branches are inter connected with each other.
3) Easy determination of pipe diameters, valve sizes, etc.	3) Costly and difficult design of distribution.
4) Fewer valves are required for operating.	4) More valves are required for operating.
5) Limited discharge in the mains for fire fighting.	5) For fighting, more water can be available from all directions.
6) There may be chances of stagnation of water, which in turn cause contamination.	6) No possibility of stagnation of water and water circulates freely.
7) Less manpower required for operating.	7) More manpower required for operating.
8) Formation of dead end causes difficulty in pipe break down and whole locality is affected.	8) During break down, water can be available from other direction.

1M (for any four points)

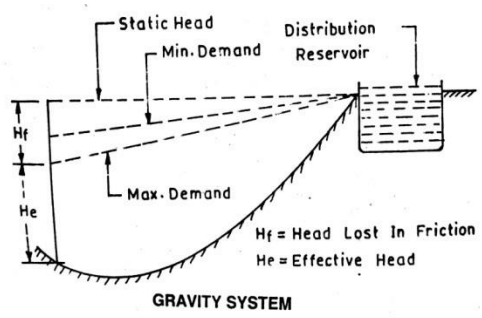
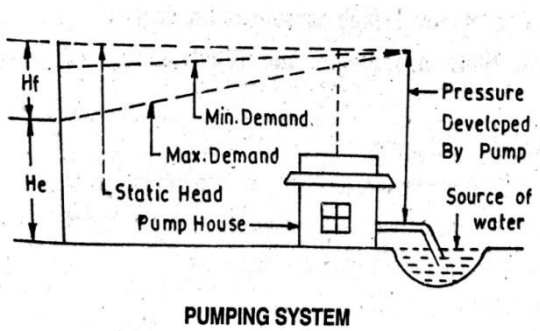
(*Note: Figure is optional here. Give credit 01 mark for both case figure, if drawn.)

f) Explain construction and working of slow sand filter.	**4M**
Construction and working of slow sand filter: 1) These are watertight shallow tanks about 2.5 m to 4 m deep and having surface area 100 m^2 to 2000 m^2 in plan. 2) These tanks contain 60-90cm sand bed and supported on 30-60cm thick gravel bed. Gravel is supported on a bed of concrete, sloping towards central longitudinal drain, connected by open jointed under drains. 3) Water enters through a submersible inlet and uniformly distributed on sand bed. 4) After subsequent filtering the filtering media gets clogged. Therefore 2-3cm sand from top of bed is scrapped and replaced with clean sand.  ***(*Note: Figure is optional here. Student may draw figure to explain the construction, so give credit 02+02 marks. And if figure is missing, give credit 04 marks for expalanation.)***	**2M** **2M***
Q.3 Attempt any FOUR of the following:	**16M**
a) Draw a labeled sketch of clariflocculator	**4M**
 **Clariflocculator**	**2M (for sketch) & 2M (for labeling)**

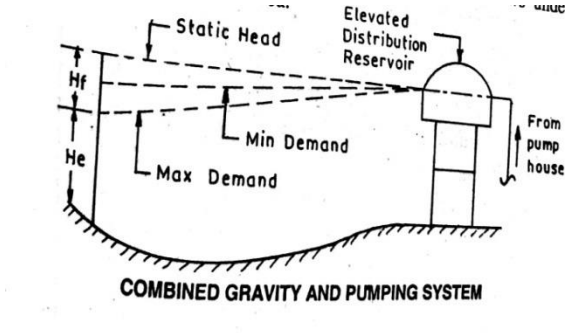
b) Define coagulation and state purpose of using alum as coagulant.	**4M**
Coagulation:- The process of adding certain chemicals in order to form insoluble, and gelatinous precipitation (or floc) which become heavier and finally settle down is known as Coagulation. **Purpose of using alum as coagulant is as follows:** 1) It is Cheap. 2) It does not require skilled supervision. 3) It forms good stable floc. 4) It is easy to handle and non-corrosive. 5) It reduces taste and odour in addition to turbidity.	**2M** **2M** **(Any two points)**
c) Explain the process of prevention of pollution of bores and bore wells.	**4M**
Process for prevention measures of pollution of bores and well waters is as follows:- i) By Galvanizing the bore well materials ii) By using stainless steel pipes iii) By reducing the rate of pumping to reduce corrosion of bore materials iv) By using acid resistant materials screens so that incrassating deposits can be removed v) By providing the mesh or screens which are placed against the water bearing. vi) By preventing washing or defecation in immediate surrounding area of the bore well.	**4M** **(for any four points)**
d) State the types and functions of distribution of water. (one function each)	**4M**

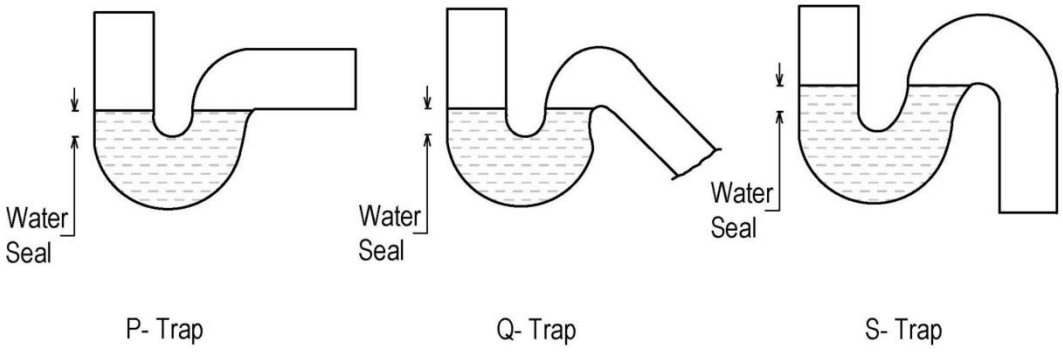
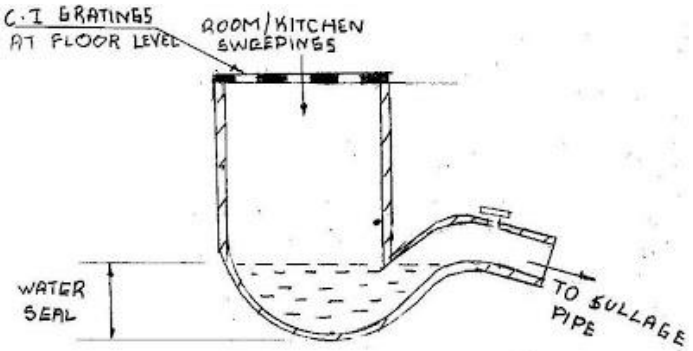
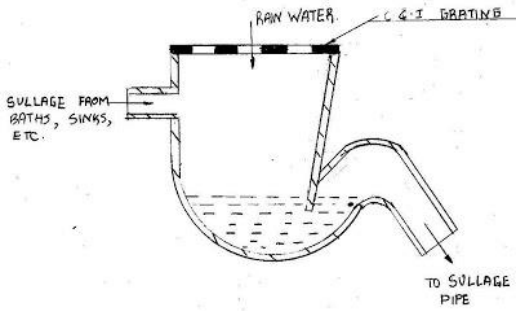
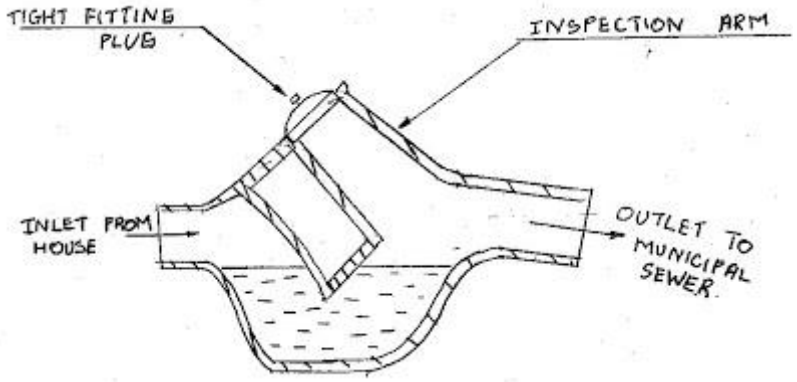
Types and functions of distribution of water:

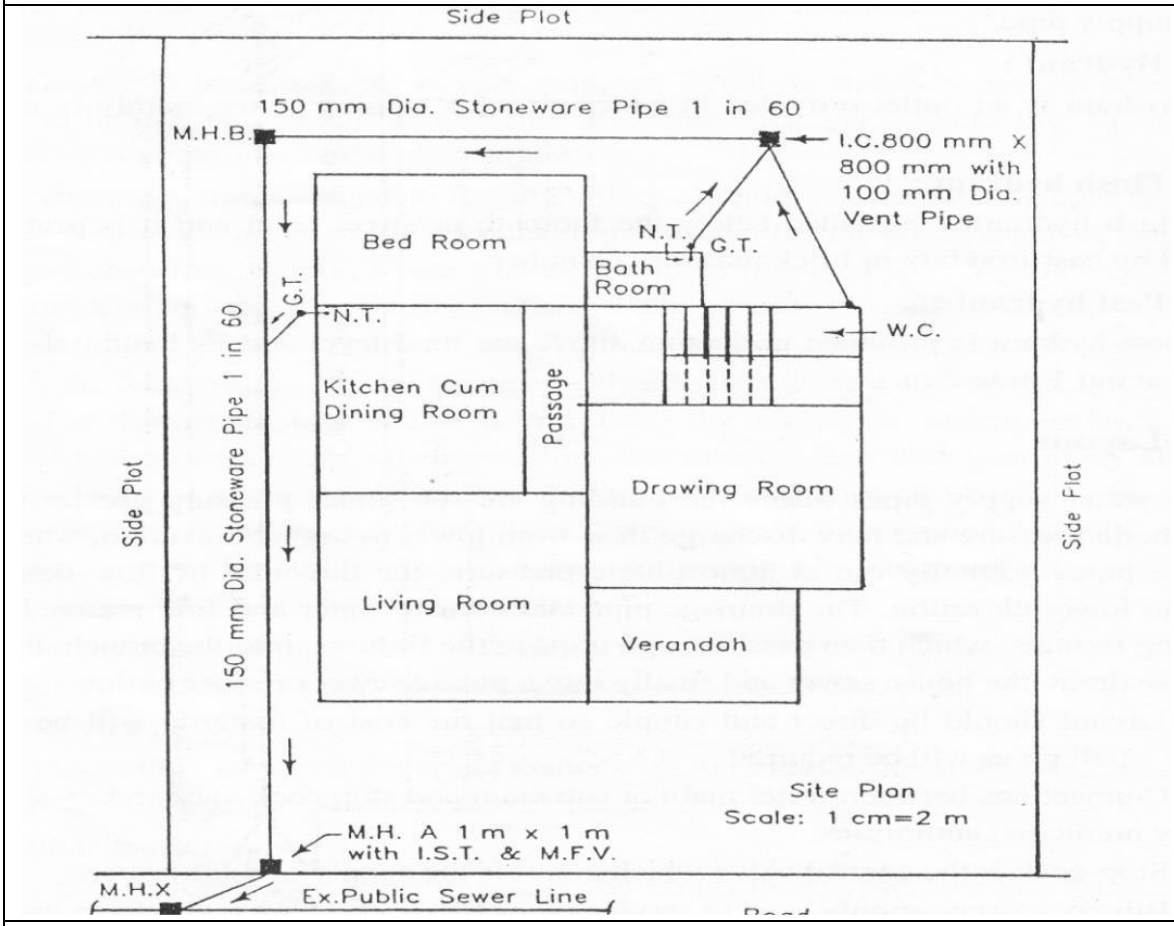
The main function of any type of distribution of water is to distribute the water in sufficient quantity and with due protection of treated water and with sufficient pressure to every consumer.

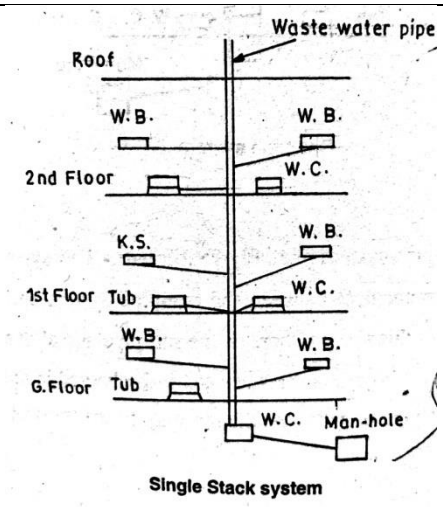
Type of Distribution of Water	Function
i) Gravity System  GRAVITY SYSTEM	In Gravity system, water flows under gravitational force. It is suitable when source is at a higher level than distribution area.
ii) Pumping System  PUMPING SYSTEM	In this system, Water is pumped in the distribution mains for supply to distribution area. It is used when gravity flow is not possible or the source of water is at lower level than the city.

2M (each for any two types with function)

iii) Combined Gravity & Pumping or Dual System  COMBINED GRAVITY AND PUMPING SYSTEM	In this system, water is pumped to an elevated tank from where it flows under gravity to the distribution area.	
(Note: Figure is optional here. Student may draw figure to explain the distribution, so give credit to figure. And if figure is missing, give credits 04 marks as given in above.)		
e) Define chlorination & state its types.		**4M**
Chlorination:-Chlorination is the process of adding chlorine (Cl_2) or hypochlorite to water. to kill certain bacteria and other microbes in water and thereby preventing the spread of waterborne diseases such as cholera, dysentery, typhoid etc. **Types of Chlorination are:-** 1) Plain Chlorination 2) Pre Chlorination 3) Post Chlorination 4) Double Chlorination 5) Break-Point Chlorination 6) Super Chlorination 7) De-chlorination		**2M** **2M (any four)**
f) State the necessity and importance of sanitation.		**4M**
Necessity and importance of sanitation:- 1) Sanitation generally refers to the provision of facilities and services for the safe disposal of human urine and feces. The word 'sanitation' also refers to the maintenance of hygienic conditions, through services such as garbage collection and wastewater disposal or sewage disposal, after suitable treatment. 2) Sanitation includes collection/containment, conveyance/transport, treatment, disposal or reuse. 3) In addition of this disease, bacteria will breed up in the stagnate water and the health of the public will be in danger. 4) If proper arrangements for the collection, treatment and disposal of all the wastes produced from the town or city are not made, they will go on accumulating and create such a foul condition that the safety of the structures such as buildings, roads will be in danger due to accumulation of spent water in their foundations. 5) Proper sanitation helps in preventing the occurrence of diseases such as typhoid, malaria, tuberculosis, smallpox, chickenpox, etc. 6) It helps in preventing the pollution of natural streams and rivers, also results in protection of groundwater sources. 7) It helps in maintaining good environments for the health of the public. 8) It helps in the general development of the city.		**4M (for any four points)**

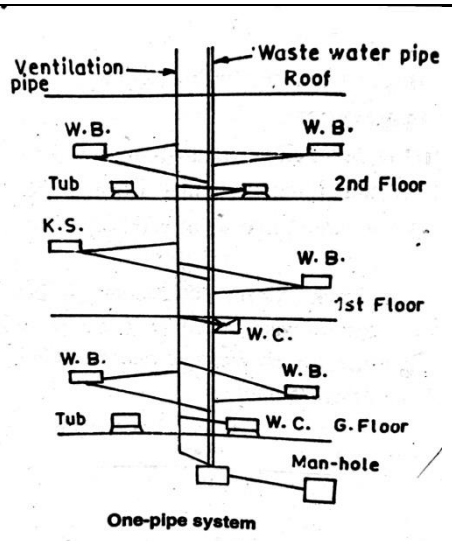
Q.4 Attempt any FOUR of the following:	16M
a) Define sewage and sullage.	**4M**
• **Sewage-** The liquid waste from the community and it includes Sullage, discharge from latrines, urinals, stables and storm water. • **Sullage –** The liquid waste (not foul in nature) collected from wash basin, baths and kitchen sink is called as sullage**.**	**2M** **2M**
b) Define trap and draw the sketch of any two types of Trap.	**4M**
Trap:- The devices used to prevent entry of foul air or gases inside or outside the houses is known as traps. It generally consists of bent tube with consist of water seal between atmosphere and sewer gas. **Types of Trap:**  P- Trap Q- Trap S- Trap  **Floor Trap**  **Gully Trap**  **Intercepting Trap**	**2M** **2M (1M each for any two trap sketch)**

c) Draw the layout drainage plan for building sanitary fittings.	4M
	**2M Plan & 2M labelling**
d) State the various system of plumbing. Explain any one.	**4M**
Systems of plumbing are:- i) Single Stack system ii) One-Pipe system iii) One-Pipe system partially ventilated iv) Two-pipe system	**2M**

System of Plumbing	sketch
i) Single Stack system:- In this system, a single vertical soil pipe is fixed and all the waste matter from baths, kitchens, water closets, etc. is discharged into it. In addition, it also acts as a vent pipe. The single stack system is economical, but it is entirely effective in the depth of water seal only. The traps should, therefore, be filled with water for all the time and the depth of water seal should not be less than 75mm.	 Single Stack system
OR	

2M* any one system

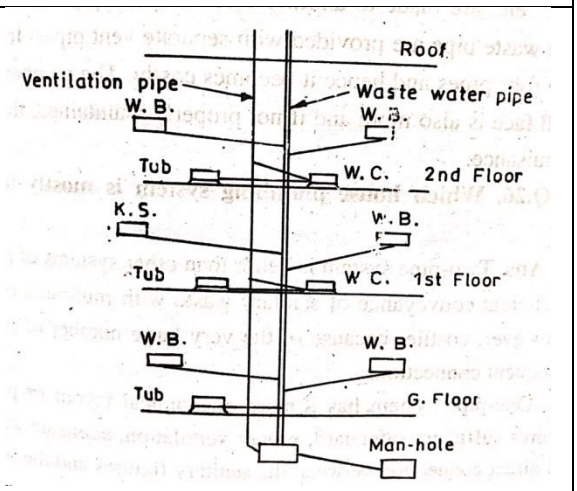
ii) One-Pipe system:- In this system, only one main pipe along with a ventilation pipe is provided which collects both the foul soil waste as well as unfoul waste from the building. The main pipe is directly connected to the drainage system. If this system is provided in multistoried buildings, the lavatory blocks of various floors are so placed one over the other. All the traps of basin, W.C. and sinks are fully ventilated and are connected to ventilation pipe.



One-pipe system

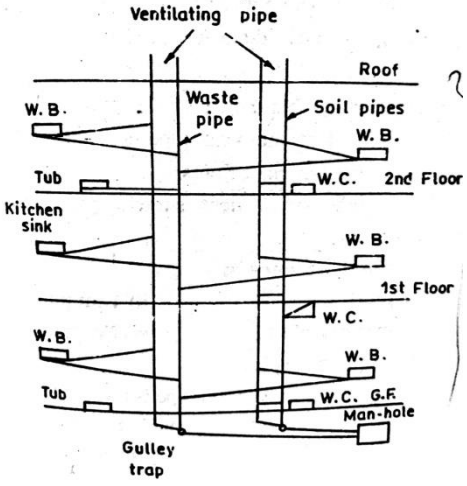
OR

iii) One-Pipe system partially ventilated:- This system is an intermediate arrangement between the one-pipe system and single stack system. In this system, there is one soil pipe and all the waste matter from water closets, baths, sinks etc. is discharged in this pipe. The relief vent pipe provides ventilation only to the traps of water closets.



OR

iv) Two-pipe system:- In this system, two sets of pipes are laid. The soil fixtures such as urinals and water closets are connected to vertical soil pipe. The connections of waste matter from baths, kitchens, etc. are made to another vertical waste pipe. The soil pipe and the waste pipe are provided with separate vent pipes. It will thus require four pipes and hence it becomes costly. The number of pipes on wall face is also more and if not properly maintained, these pipes from nuisance.



(*Note: Figure is optional here. Student may draw figure to explain the distribution, so give credit to figure. And if figure is missing, give credits 04 marks as given in above.)

e) State the types of sewers and mention purpose of each.	**4M**

Types of sewers	Function
1. Main sewer or Trunk sewer	The sewer which carries the whole sewage coming from the branch lines.
2. Branch sewer	The sewer which carries the sewage from the lateral sewers and delivers the same to the main sewer.
3. Combined Sewer	The sewer which carries the domestic sewage and storm water.
4. Intercepting Sewer	The sewer which carries the discharges from a number of main sewers and delivers the same to the point of treatment.
5. Lateral Sewer	The sewer which obtains the sewage directly from the residential building.
6. Relief Sewer	The sewer which carries the excess discharge from an existing sewer.

(*Note: Student may write types based on shape or based on materials, so give credit limited to 2 marks for any four types.)

2M* for any four Types and 2M* for any two functions

f) Define B.O.D. and state its significance in sewage treatment.	**4M**
B.O.D.:- The Biochemical oxygen demand is the quantity of oxygen required for the biochemical oxidation of the biodegradable organic matter at specified temperature and within the specified time.	**2M**
Significance Of B.O.D.:- 1) Biochemical Oxygen Demand is an important water quality parameter because it provides an index to assess the effect discharged wastewater will have on the receiving environment. 2) The higher the BOD value, the greater the amount of organic matter or "food" available for oxygen consuming bacteria. So it is used as a measure for determining the strength of sewage. 3) BOD is also used extensively for wastewater treatment, as decomposition of organic waste by microorganisms is commonly used for treatment. 4) From BOD of the influent and effluent discharged, the efficiency of the treatment plant can be judged. 5) BOD is used in studies to measure the self purification capacity of streams.	**2M (for any two points)**
Q.5. (A) Attempt any THREE of the following	**12M**
(a) Describe the process of Sludge digestion.	**4M**
Process of Sludge digestion- The term sludge digestion is stabilization of sludge by biological decomposition of organic solids and converts it to more simplified and harmless end products.	**1M**
The sludge digestion can be done in both ways- 1) Anaerobic Digestion 2) Aerobic Digestion	**1M**

1. **<u>Anaerobic Digestion</u>**- It is most commonly used process of sludge digestion. The principal function of anaerobic Digestion is to convert most of sludge to liquid and gases and producing very little residual biomass in absence of free oxygen.

The volume of sludge is reduced by 60-75% due to gases escaped and liquification. The acid forming bacteria convert complex organic matter into simple organic acids. In second stage, methane forming bacteria converts the acids into methane & Carbon di-oxide. BOD of the sludge is reduced.

2M (Any one method)

$$4H_2 + CO_2 = CH_4\uparrow + 2H_2O$$

The end product includes 65-70% Methane and 25-30% CO_2 and trace amount of other gases. Solid Retention time is 30-90 days. Process achieves reducing odor, pathogens, and mass reduction.

<u>OR</u>

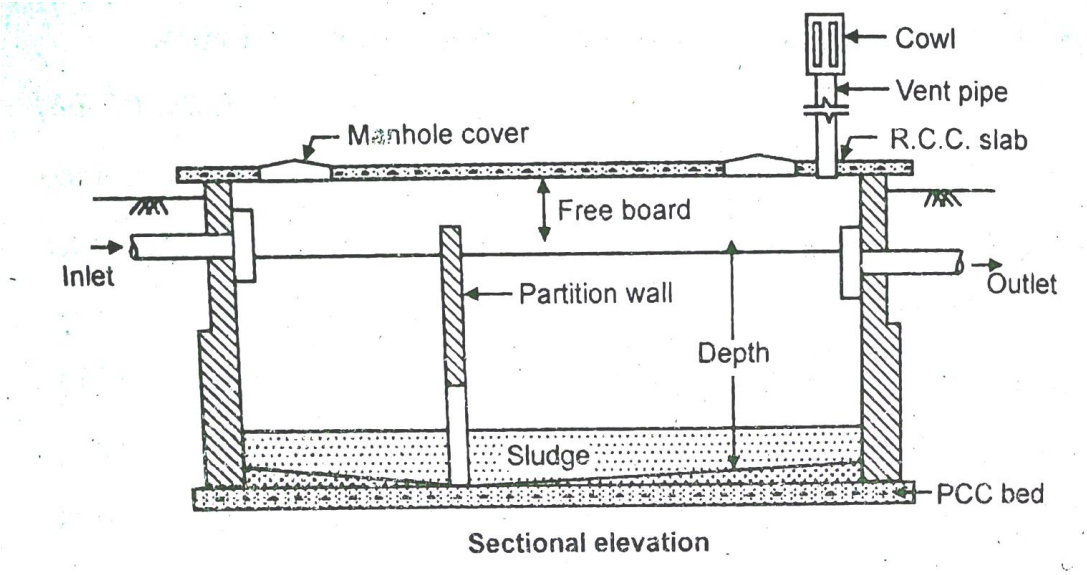
2. **<u>Aerobic Digestion</u>**- This process is essentially a continuation of aeration process, with the volume being reduced by thickening in the secondary clarifier and sludge thickener. This process is an endogenous respiration process in which the organisms are forced to metabolize their own protoplasm. This process requires energy and digested sludge is inert. The end products are CO_2, water, and inert solid. Retention time – 15-20 days.

(b) Describe the working of septic tank with its L-section. **4M**

Working of Septic Tank- Septic tank is closed water tight chamber where combined sedimentation and digestion of sludge are carried out under anaerobic conditions.

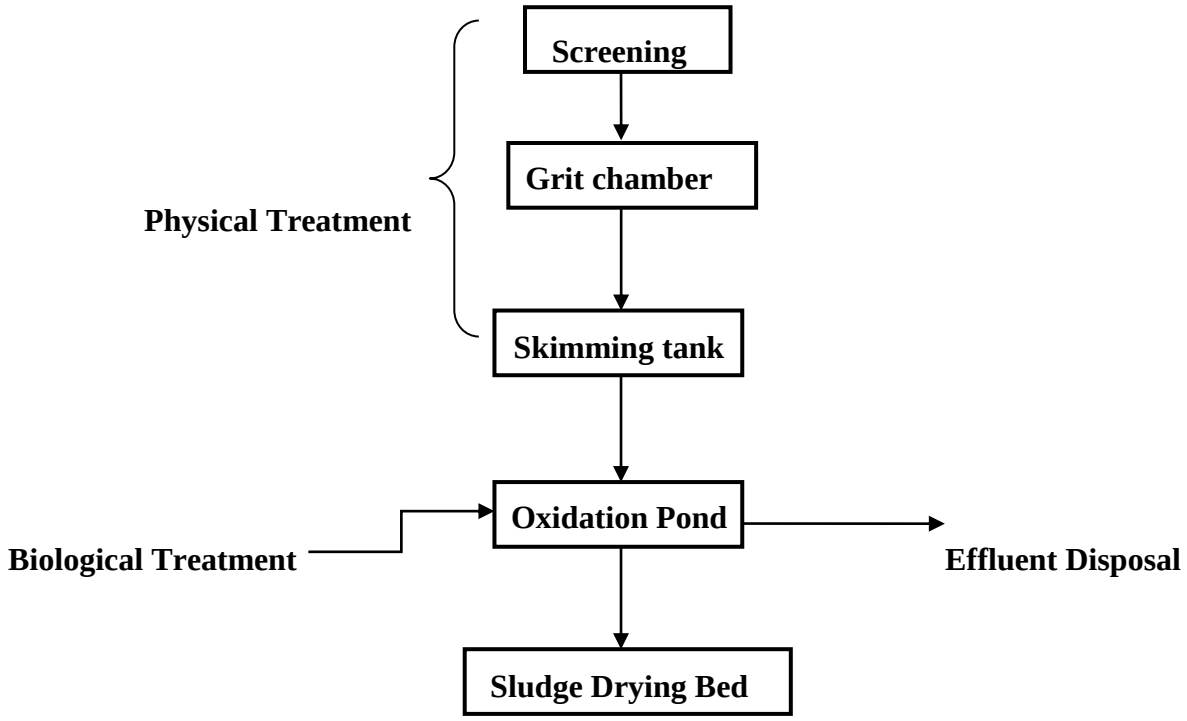
The sewage is detained for some period (12-36 Hrs.) when suspended solids are settled down which are treated by anaerobic digestion and results in reduction of volume and release of CH_4, CO_2, H_2S gases. The foul gases are escaped through vent pipe and the offensive effluent is disposed off into the ground through soak pit. The digested sludge is periodically removed once in year or twice.

2M



2M

L-section of Septic Tank

(c) Write the procedure of laying of sewer.	**4M**
Procedure of laying of sewer is as below- **1) Marking centre lines of sewers and locating the position of sewers appurtenances-** The centre lines of sewers are marked on the stresses and roads from the plans starting from the lowest point of the main proceeding upwards. The setting out of work is done by means of chain and theodolite or compass. **2) Excavation of trenches:-** After marking the layout of sewers lines on the ground the first step is the removal of pavement. After removal of pavement the excavation of trenches is started the excavation is done manually or by means of machinery **3) Sheeting, bracing and dewatering of trenches:-** In case of soft soils the trench side required shoring and strutting to prevent their collapse till the sewers are laid and tested. When sewers lines are to be lead below the ground water table. The ground water enters the trench and causes much difficulty. Therefore the de watering of tranches is compulsory. **4) Laying of pipe sewers and their jointing :-** The sewers pipes are not laid directly on the soil in the tranches. Before actual laying the concreting is done. The centre line of se**wers** and their grades are trans ford from the ground dimension of sight rail and boning rod. Smaller size pipes can be laid by the pipe- layers by hand only but larger size pipes are lowered in the trenches by passing rope around them and supporting through a hook .Then jointing of sewers is done by usual method. **5) Testing of sewers lines.-** The testing of the sewers is done with the help of water test or air test by usual method. **6) Back filling of trenches:-** After testing and removing defects of pipe line the tranches are back-filled with earth generally the Excavated soil of trench is used for back filling. Back filling is done step by step.	**4M** **(For correct procedure with or without steps)** ***Note- Student may write only steps, give credit limited to 2M. Give 2M for explaining any two steps.**
(d) Draw a flow diagram of suitable sewage treatment process for Rural area.	**4M**
 ***(Note- student may write septic tank along with soak pit colony wise or oxidation pond or biogas plant as sewage treatment. So give credit accordingly.)***	**1M** **1M** **1M** **1M**

(B) Attempt any ONE of the following	06
(a) Describe rainwater and sewage collection system for residential building.	**6M**

Rainwater and sewage collection system for residential building:

An efficient rainwater and sewage collection system is important for any residential building. This can be achieved in following ways-

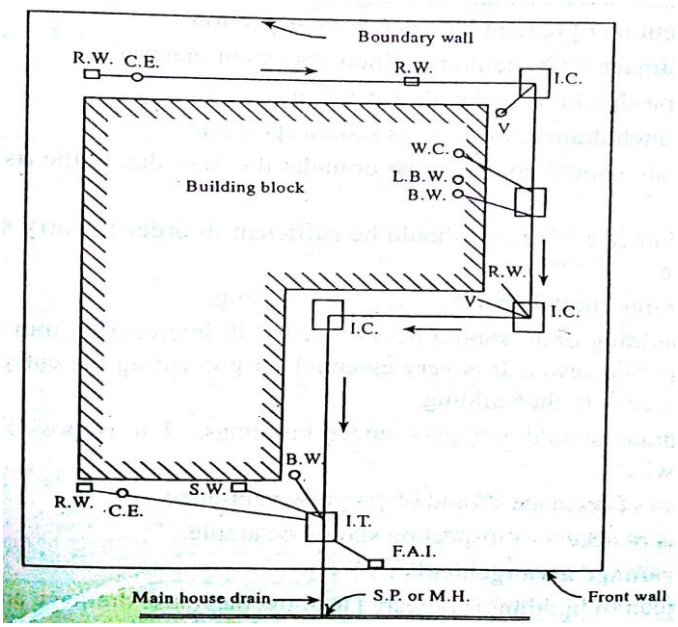
1) The house sewers should be laid by side of the building rather than below the building.
2) The drains should be laid straight between inspection chambers.
3) The entire system should be properly ventilated.
4) The drains should be laid with sufficient slope and grade to achieve self cleaning velocity.
5) The house sewer should be connected to public sewer at sufficiently higher level than the public sewer water level.
6) The house sewer should be connected to public sewer through intercepting trap.
7) The house drainage system should be of non absorbent material and the size should be taken for maximum discharge.
8) The rain water from houses is collected from roofs and is allowed to flow freely on the road for catch basins or inlets of sewer. Sufficient slope shall be provided to roof top for easy flow and collection of rain water.

6M* (For any six points)

OR

OR

Typical drainage system for residential building :



4M* (for plan)

R.W.- Rain water pipe	B.W.- Bath waste
C.E.- Cleaning eye	I.C.- Intercepting chamber
S.W. Sink waste	I.T.- Intercepting trap
V- Vent pipe	F.A.I.- Fresh Air Inlet
W.C.- Water closet	S.P.- Saddle point
L.B.W.- Lavotary basin waste	M.H.- Manhole

2M* (for labeling)

(*Note: Student may draw figure with explanation also. Give credit accordingly.)

(b) Design a circular sewer using the following data: **Population=30,000 souls Rate of water supply-135 lpcd** **N=0.015 Max. Flow=2 x Average flow**	**6M**
Ans. i) Average rate of water supply = $\frac{(30000 \times 135)}{24 \times 60 \times 60 \times 1000}$ = **0.046875 m^3/sec** ii) Average Sewage Flow= 80% of Average rate of water supply =0.8x0.046875 = **0.0375 m^3/sec** iii) Max discharge of sewage produced = Peak factor x Avg. flow **Q =** 2 X 0.0375 = **0.075 m^3/sec** iv) Max. Discharge Q = A x V Where A= $[\frac{\pi}{4} \times D^2]$ and V= $[\frac{1}{N} \times (R)^{2/3} \times (i)^{1/2}]$ by Manning's Formula **Assumed sewer slope** i=1/400 **When Sewer Running Full (R=D/4)** $0.075 = [\frac{\pi}{4} \times D^2] \times [\frac{1}{0.015} \times (D/4)^{2/3} \times (1/400)^{1/2}]$ .... $D^{2.67} = 0.0725$ **D = 0.374 m = say 400 mm dia. sewer pipe** ***(Note-: Student may assume different sewer Gradient (i) value, so give credit accordingly.)***	**1 M** **1 M** **1M** **1M** **1M** **1 M**
Q.6. Attempt any FOUR of the following	**16M**
(a) State the objects of sewage treatment.	**4M**
Object of Sewage Treatment- 1. To remove organic content from the sewage. 2. To remove colour and odour. 3. To remove substances which are toxic or hazardous to aquatic life. 4. To bring the quality of effluent to a desired standard for its disposal. 5. To preserve the quality of natural resources like water, land. 6. To protect the natural aquatic ecosystem. 7. To kill pathogenic bacteria 8. To prevent from the diseases 9. To make healthy environment.	**1M each for Any four**

(b) State the norms suggested by Maharashtra Pollution Control Board for the discharge of treated sewage. (any four)	4M

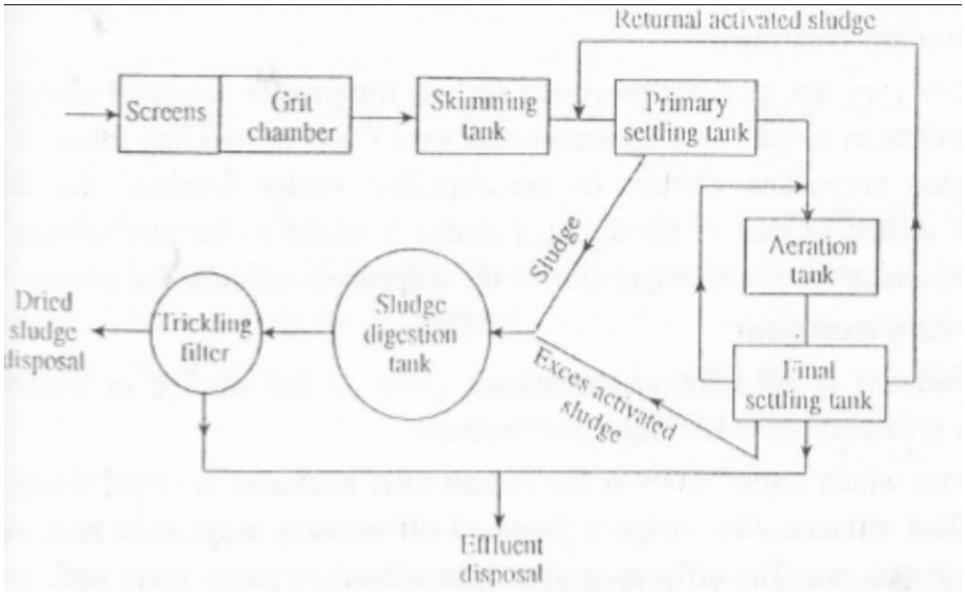
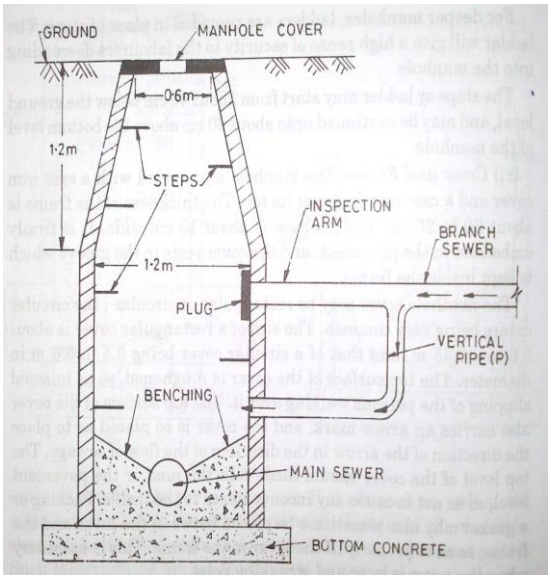
Norms suggested by Maharashtra Pollution Control Board for the discharge of treated sewage:

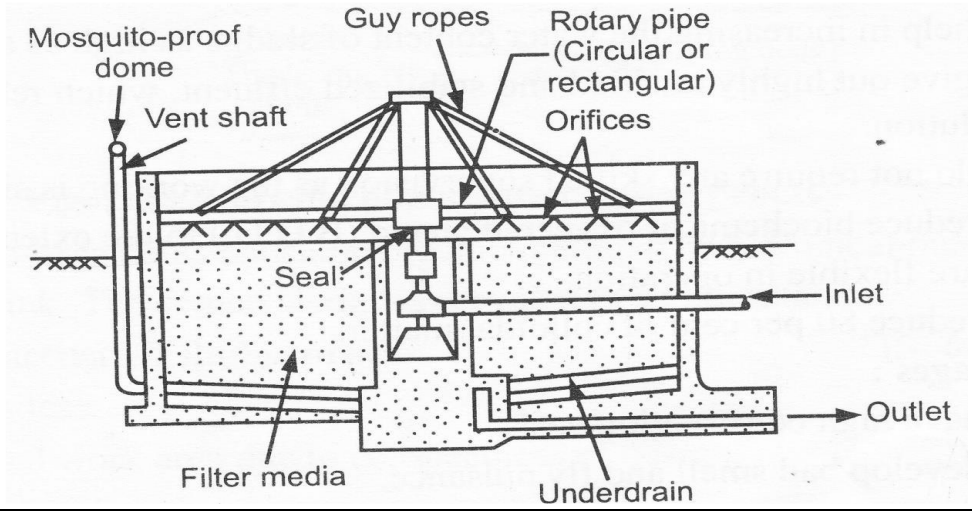
Characteristics of effluent	Tolerance limit for sewage effluents discharged into inland surface water (I)	Tolerance limits for indusrialefluents discharged into		Tolerance limits for inland surface water, when used as raw for public water for supplies and bathing ghats (IV)
		Inland surface water (II)	Public sewers (III)	
B.O.D. (mg/l)	20	30	500	3
C.O.D. (mg/l)	-	250	-	-
pH	-	5.5-9.0	5.5-9.0	6.0-9.0
Total Suspended Solids (mg/l)	30	100	600	-
Temperature	-	40	45	-
oil and greese (mg/l)	-	10	100	0.1
Phenolic compound (mg/l)	-	1	5	0.005
Cynides (mg/l)	-	0.2	2	0.01
Sulphides (mg/l)	-	2	-	-
fluorides (mg/l)	-	2	-	1.5
total residual chlorine (mg/l)	-	1	-	-
Insecticides ,mg/l	-	0	-	0
Arsenic (mg/l)	-	0.2	-	0.2
Cadmium ,mg/l	-	2	-	-
Chromium ,mg/l	-	0.1	2	0.05
Sulphates, mg/l	-	-	-	1000
Copper,mg/l	-	3	3	-
lead,mg/l	-	0.1	1	0.1
Mercury,mg/l	-	0.01	-	-
Nickel,mg/l	-	3	2	-
Zinc,mg/l	-	5	15	-
Chlorides ,mg/l	-	-	600	600

Note:- Students can write any four points from any of the columns (I), (II), (III), (IV).

2.Student may write only characteristic without limit value, give credit accordingly, limited to 2M

1M each for any four (i.e. ½ M for writing characteristic and ½ M for writing correct value)

(c) Draw the General layout and Flow diagram of sewage treatment plant.	**4M**
	**2M stating units** **2M Correct sequencing of units.**
(d) Explain the component parts of Manholes and Drop Manhole.	**4M**
Component parts of a manhole- i) **Working chamber –** It is lower portion of manhole provides working space for labours to carry out maintenance and cleaning operation. ii) **Access shaft -** The upper portion of manhole, which provides access to working chamber. iii) **Cover and Frame-** Manhole is provided with cover and frame at its top flush with road top or ground level. iv) **Steps-** Cast iron/M.S. steps in staggered manner for easy access are provided. v) **Walls-** Walls are made of brick-work/stone work/concrete. vi) In drop manhole, all other components are same as above, except a **vertical drop pipe** from higher to the lower sewer is provided as shown in fig.  ***Note- student may draw only sketch of manhole/drop manhole, then also give full credit as follows.*** **2M-sketch** **2M-Labeling**	**1M** **½ M** **½ M** **½ M** **½ M** **1M**

(e) Define Self Cleansing velocity, vent pipe, water closet & C.O.D.	**4M**
Self Cleansing velocity- The minimum velocity which will prevent the silting or deposition of particles of solid matter in sewers is known as self cleaning velocity. **OR** The minimum velocity at which no solids get deposited in the invert of the sewer is called self cleaning velocity. **Vent Pipe-** A pipe line which is installed for providing flow of air to or from a drainage system to protect trap seals from siphon action and prevent back flow. **OR** The pipe installed for the free circulation of air (i.e. ventilation) within the drainage system is called vent pipe. **Water closet-** It is a sanitary appliance to receive the human excreta directly and is connected to the soil pipe by means of trap. **C.O.D.-** The term Chemical Oxygen Demand can be defined as the quantity of oxygen required for carrying out oxidation of both biodegradable and non-biodegradable organic matter (Total Organic matter) by using a strong oxidizing agent under acidic condition.	**1M** **1M** **1M** **1M**
(f) Explain the working of Tricking Filter with a neat sketch.	**4M**
Working - Trickling filter consists of RCC rectangular or circular tank provided with filter media (stones or broken bricks material) and under drainage system to collect the effluent. Revolving distributor having four arms. Sewage is distributed or sprays by distribution arms through which it trickles to the under drains. As sewage trickles through the filter media, a biological slime layer consisting of aerobic bacteria build up around the media surfaces in two weeks makes the filter ready for use. Organic matter in sewage is absorbed by bacteria in slime layer. It removes 80% colloidal matter, reduces B.O.D. up to 75%. It gives highly nitrified and stabilized effluent and flexibility in operation.  	**2M** **2M**