TED (15) -6012
(Revision -2015)

**N20-00784**

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DIPLOMA EXAMINATION IN ENGINEERING/TECHNOLOGY/MANAGEMENT/
COMMERCIAL PRACTICE – NOVEMBER -2020.

# ENVIRONMENTAL ENGINEERING

(Maximum Marks:75) [Time: 2.15 hours]

## PART–A

Marks

**I.** Answer **any three** questions in one or two sentences. Each question carries 2 marks.

1. List different types of well according to construction.
2. Differentiate between aquifer and aquiclude.
3. Differentiate between temporary hardness and permanent hardness.
4. Define sullage.
5. Define sludge digestion. (3x2=6)

## PART - B

**II** Answer **any four** of the following questions. Each question carries 6 marks.

1. Describe various purpose for which water is supplied to a modern industrial town.
2. Explain the requirements of a good disinfectant.
3. Describe water meter and explain different types of water meters.
4. List the factors affecting storm water flow.
5. Explain the physical characteristics of sewage.
6. Explain activated sludge process.
7. Explain sewage sickness. [4x6 =24]

## PART - C

(Answer **any of the three units** from the following. Each full question carries 15 marks)

## UNIT I

**III (**a) Explain per capita demand. List any six factors affecting per capita demand. (7)

(b) From the census data given below, estimate the population of city for the Year 2000 A.D by (i) Arithmetical increase method.
(ii)Geometric increase method.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year | 1900 | 1910 | 1920 | 1930 | 1940 | 1950 | 1960 | 1970 |
| Population | 21610 | 28560 | 37640 | 46520 | 55460 | 63710 | 71320 | 79540 |

(8)

**OR**

**IV** (a) Define spring and explain different types of springs. (7)

(b) Explain the construction of socket and spigot joint with a neat sketch. (8)

## UNIT- II

**V** (a) List the points to be considered in the location and layout of treatment plant. (7)

(b) Design a rectangular sedimentation tank to treat 5 MId of average demand
Velocity of flow = 20 cm/min
Detention period = 2 hours
Total depth of tank =4m with a free board of 0.5 m. (8)

**OR**

**VI** (a) Explain the details of water connection taken from water main to the building with a neat sketch. (7)

(b) Explain radial system. List advantages and disadvantages. (8)

## UNIT- III

**VII** (a) Explain the factors affecting dry weather flow. (7)

(b) Explain water carriage system. List advantages and disadvantages. (8)

**OR**

**VIII** (a) List the factors influencing selection of shape of sewers and explain rectangular sewer. (7)

(b) Explain drop manhole with a neat sketch. (8)

## UNIT – IV

**IX** (a) Design a septic tank for a group of houses with a population of 250 persons. The rate of water supply is 100 lpcd. (7)

(b) Explain oxidation ditch with neat sketch. (8)

**OR**

**X** (a) Explain the requirements of good drainage system in buildings. (7)

(b) Explain the construction and working of Janata model biogas plant. (8)

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DIPLOMA EXAMINATION IN ENGINEERING/TECHNOLOGY/MANAGEMENT/
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# ENVIRONMENTAL ENGINEERING

(Maximum Marks:75) **ANSWER KEY** [Time: 2.15 hours]

## PART–A

Marks

**I.** Answer **any three** questions in one or two sentences. Each question carries 2 marks.

1. **List different types of well according to construction.**
   Dug well, sunk well, driven well , bore well

2. **Differentiate between aquifer and aquiclude**. **-** An **aquifer** is an underground layer of water-bearing permeable rock, rock fractures or unconsolidated materials (gravel, sand, or silt). Groundwater from aquifers can be extracted using a water well. aquiclude (or aquifuge), which is a solid, impermeable area underlying or overlying an aquifer, the pressure of which could create a confined aquifer.

3. **Differentiate between temporary hardness and permanent hardness** –

| Temporary Hardness | Permanent Hardness |
|---|---|
| Temporary hardness is due to the presence of bi-carbonates of calcium and magnesium. | It is due to the presence of chlorides of Sulfates of Calcium and Magnesium. |
| Can be removing by boiling. | Can't be removing by boiling. |
| Hardness removal is cheap. | Hardness removal is expensive |

4. **Define sullage**. **- Sullage** is the used **water** resulting from washing clothes and kitchen utensils, shower or bath **water** and other domestic **water** not containing excreta.

5. **Define sludge digestion**. **-** Process of decomposition of complex organic substances in sludge into simpler stable compounds by bio chemical reactions by the anaerobic bacteria.. (3x2=6)

## PART - B

**II** Answer **any four** of the following questions. Each question carries 6 marks.

**1.Describe various purpose for which water is supplied to a modern industrial town.**

- To provide whole some water to the consumers for drinking purpose.
- To supply adequate quantity to meet at least the minimum needs of the individuals

- To make adequate provisions for emergencies like fire fighting, festivals, meeting etc
- To make provision for future demands due to increase in population, increase in standard of living, storage and conveyance
- To prevent pollution of water at source, storage and conveyance
- To maintain the treatment units and distribution system in good condition with adequate staff and materials
- To design and maintain the system that is economical and dependable

**2. Explain the requirements of a good disinfectant.**

- Should be effective in killing harmful bacteria
- Should be harmless, economical and easily available
- Should not require skilled labor, costly equipment
- Should take only reasonable time in killing harmful pathogenic organisms at normal temperature

**3. Describe water meter and explain different types of water meters**.

WATER METER **-** These are the devices which are installed on the pipes to measure the quantity of water flowing at a particular point along the pipe.

The readings obtained from the meters help in working out the quantity of water supplied and thus the consumers can be charged accordingly.

The water meters are usually installed to supply water to industries, hotels, big institutions etc. metering prevents the wastage of purified water

1. Positive Displacement.
2. Electromagnetic Flow **Meter**. ...
3. Multi-jet Flow **Meter**. ...
4. Turbine Flow **Meter**. ...
5. Ultrasonic Flow **Meter**. ...

**4. List the factors affecting storm water flow.**

1) Rate of water supply

- The quantity of sanitary sewage varies with the rate of water supply.
- The rate of water supply is not constant, but it fluctuates.
- These fluctuations may be seasonal, daily and hourly. The rate of sewage is assumed as equal to the rate of water supply.

2) Population

- The quantity of sanitary sewage directly depends on the population. As the population increases the quantity of sanitary sewage also increases and vice versa.

3) Type of area served

- The quantity of sanitary sewage also depends on the type of area such as residential, industrial or commercial.

4) Infiltration and ex-filtration

- The percolation of subsoil water in the sewer through the defective joints or cracks of sewer is called infiltration.

The leakage of sewage from the sewer into the ground surrounding the sewer is called ex-filtration.

- Infiltration increases the quantity of sewage. On the other hand ex-filtration decreases the quantity of sewage.

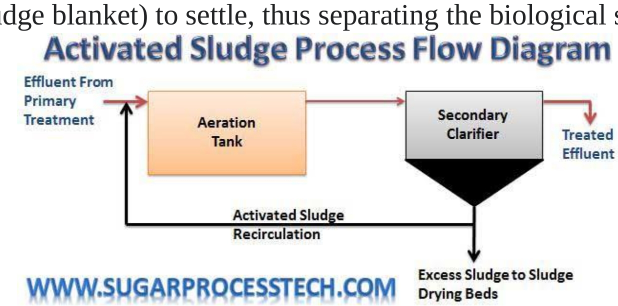
**5. Explain the physical characteristics of sewage.**

**(a) Physical Characteristics of a sewage:**

1. Colour: The sewage has grey or light brown colour. The stale or septic sewage has black or dark brown colour.
2. Odour: Fresh sewage has soapy or oily smell but the stale sewage has offensive odour due to liberation of Hydrogen sulphide.
3. Temperature: Temperature of sewage is slightly higher than that of water supplied.
4. Turbidity: Sewage is normally turbid. **(4x2=8)**

**6. Explain activated sludge process.**

- The activated sludge process is one of the biological method of industrial waste waste treatment.
- Activated sludge process – a biological wastewater treatment process which speeds up waste decomposition.
- Activated sludge is added to wastewater, and the mixture is aerated and agitated.
- After a certain amount of time, the activated sludge is allowed to settle out by sedimentation and is disposed of (wasted) or reused (returned to the aeration tank)
- **Components:** An **aeration tank** where air (or oxygen) is injected in the mixed liquor. This is followed by a **settling tank** ("**secondary settling tank**") to allow the biological flocs (the sludge blanket) to settle, thus separating the biological sludge from the clear treated water.




**7. Explain sewage sickness.** [4x6 =24]

If sewage is applied continuously on a piece of land, pores or voids of soil are filled up or clogged. Free circulation of air is thereby prevented and anaerobic conditions develop. At this stage, the land is unable to take any further sewage load. Organic matter decomposes and foul smelling gases are produced. The phenomena of soil are known as sewage sickness of land.

**Preventive measures:**

In order to prevent sewage sickness of land, the following preventive measures may be adopted

• Alternative arrangement: There should be ample provision of extra land so that land with sewage sickness can be given the desired rest. Alternatively, sewage should be disposed of by some other method when sewage farms are taking rest.

• Depth of sewage: If sewage is applied in excess, the chances of sewage sickness are increased. The land is unable to receive the excess sewage in a satisfactory way and it ultimately clogs up. Depth of sewage on land should be carefully decided by keeping in view the climatic conditions, drainage facilities, nature of crops and characteristics of soil.

• Drainage of soil: Subsoil drain pipes should be laid in sufficient number to collect the percolated effluent

• Intermittent application: Sewage should be applied on land at intervals. The period between successive applications depends on general working of sewage farm and the permeability of soil. Depending on the nature of the soil, this period between successive applications varies from few hours to few weeks.

• Pre-treatment of sewage: sewage should be given some pre-treatment before it is applied on land.

## PART - C

(Answer **any of the three units** from the following. Each full question carries 15 marks)

### UNIT I

**III (**a) **Explain per capita demand. List any six factors affecting per capita demand.** (7)

- It is the annual average amount of daily water required by one person .
- **FACTORS**
- 1. Size and type of city
- 2. Climatic conditions
- 3. Living standard of the people
- 4. Quality of water
- 5. Pressure in the distribution system
- 6. System of sanitation
- 7. System of supply
- 8. Policy of metering system
- 9. Cost of water
- 10. Development of sewerage facilities
-

(b) **From the census data given below, estimate the population of city for the Year 2000 A.D by (i) Arithmetical increase method. (ii)Geometric increase method**.

| Year | 1900 | 1910 | 1920 | 1930 | 1940 | 1950 | 1960 | 1970 |
|---|---|---|---|---|---|---|---|---|
| Population | 21610 | 28560 | 37640 | 46520 | 55460 | 63710 | 71320 | 79540 |

ARITHMETIC INCREASE METHOD

## SOLUTION

| YEAR | POPULATION | INCREASE IN POPULATION $\bar{x}$ |
|---|---|---|
| 1900 | 21610 | ----- |
| 1910 | 28560 | 6950 |
| 1920 | 37640 | 9080 |
| 1930 | 46520 | 8880 |
| 1940 | 55460 | 8940 |
| 1950 | 63710 | 8250 |
| 1960 | 71320 | 7610 |
| 1970 | 79540 | 8220 |
| TOTAL | | 57930 |
| AVERAGE INCREASE PER DECADE | | $\bar{x}$ = 57930/7 = 8276 |

Population in year 2000 is, P2000 = P0 + n.$\bar{x}$ = 79540+ 3 X 8276 = 104368

GEOMETRIC INCREASE METHOD (8)

| YEAR | POPULATION | INCREASE IN POPULATION | Percentage increase in population ( growth rate,r) = $\frac{\text{increase in population}}{\text{original population}}$ x 100 |
|---|---|---|---|
| 1900 | 21610 | ----- | |
| 1910 | 28560 | 6950 | 6950/21610*100 = 32.16 |
| 1920 | 37640 | 9080 | 31.79 |
| 1930 | 46520 | 8880 | 23.59 |
| 1940 | 55460 | 8940 | 19.21 |
| 1950 | 63710 | 8250 | 14.87 |
| 1960 | 71320 | 7610 | 11.94 |
| 1970 | 79540 | 8220 | 11.52 |

- The geometric mean of growth rates (r)= $\sqrt[t]{r1.r2.r3\ldots\ldots.rt}$ = (32.16*31.79*23.59*19.21*14.87*11.94*11.52)^ (1/7) = 19.15 %

The population after 3 decade, ie: for the year 2000,

$$Pn = P0\,[1+\frac{r}{100}]^n$$

Given:

n= 3

r = 19.15 %

P0 = 79540

$$P\,2000 = 79540\,[1+\frac{19.15}{100}]^3 = 134545$$

**OR**

**IV (a) Define spring and explain different types of springs.** (7)

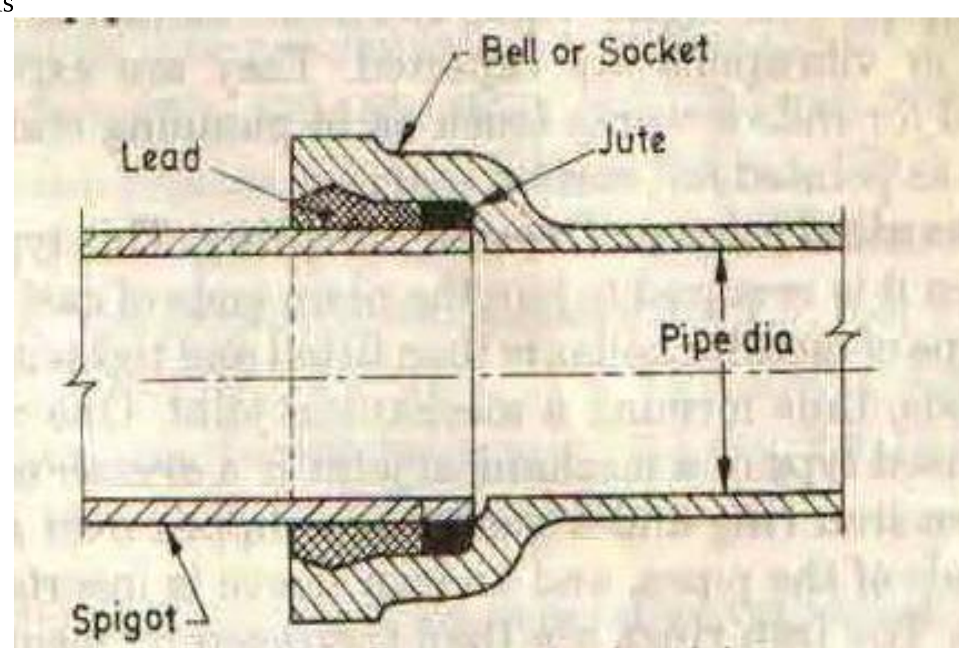
- The natural outflow of ground water at the earth's surface.
- It is a pervious layer sandwiched between two impervious layers
- Based on geological formations, they are classified as,

1. Gravity springs
2. Surface springs
3. Artesian springs

- **<u>Gravity Springs</u>**: When the surface of the earth drops sharply the water bearing stratum is exposed to atmosphere and gravity springs are formed
- **<u>Surface Spring</u>**: This is formed when an impervious stratum which is supporting the ground water reservoir becomes out crops
- **<u>Artesian Spring</u>**: When the ground water rises through a fissure in the upper impervious stratum, When the water-bearing stratum has too much hydraulic gradient and is closed between two imperious stratum, the formation of Artesian spring from deep seated spring

(b) **Explain the construction of socket and spigot joint with a neat sketch.** (8)

Also known as bell and spigot joint. • Enlarged end – bell or socket • Normal end – spigot • Quantity of lead needed per joint – 3.5 to 4 kg for 15cm dia pipe, to about 45 to 50 kg for 1.2m dia pipe. • Somewhat flexible joint • Allows the pipes to be laid on flat curves without any specials




**UNIT- II**

**V** (a) **List the points to be considered in the location and layout of treatment plant.** (7)

- It should be along the flow (level).
- Near to an industry
- At a distance from the community
- Accessible
- Large enough with the possibility of extension in future.
- Source of water such as river/bore wells/ catchment/ water shed should be closer to water quality treatment plant.

(b) **Design a rectangular sedimentation tank to treat 5 MId of average demand Velocity of flow = 20 cm/min**
**Detention period = 2 hours = 120 minutes**

**Total depth of tank =4m with a free board of 0.5 m.** (8)

**Solution :**

Quantity of water to be treated = 5 x $10^6$ litres

Quantity of water to be treated during 2 hours detention period

$$= \frac{5 \times 10^6 \times 2}{24 \times 10 \times 10 \times 10}$$

$$= 416.6 \text{ cu.m}$$

Velocity of flow = 20 cm/minute = 0.2 m/minute

Length of tank required = velocity of flow x detention period

= 0.2 x 120 = 24 m

Cross sectional area of tank = capacity of tank / length of tank

= 416.6/24 = 17.35 sq.m = 17.4 sq.m

Given tank depth = 4m

Width of tank = 17.4/4

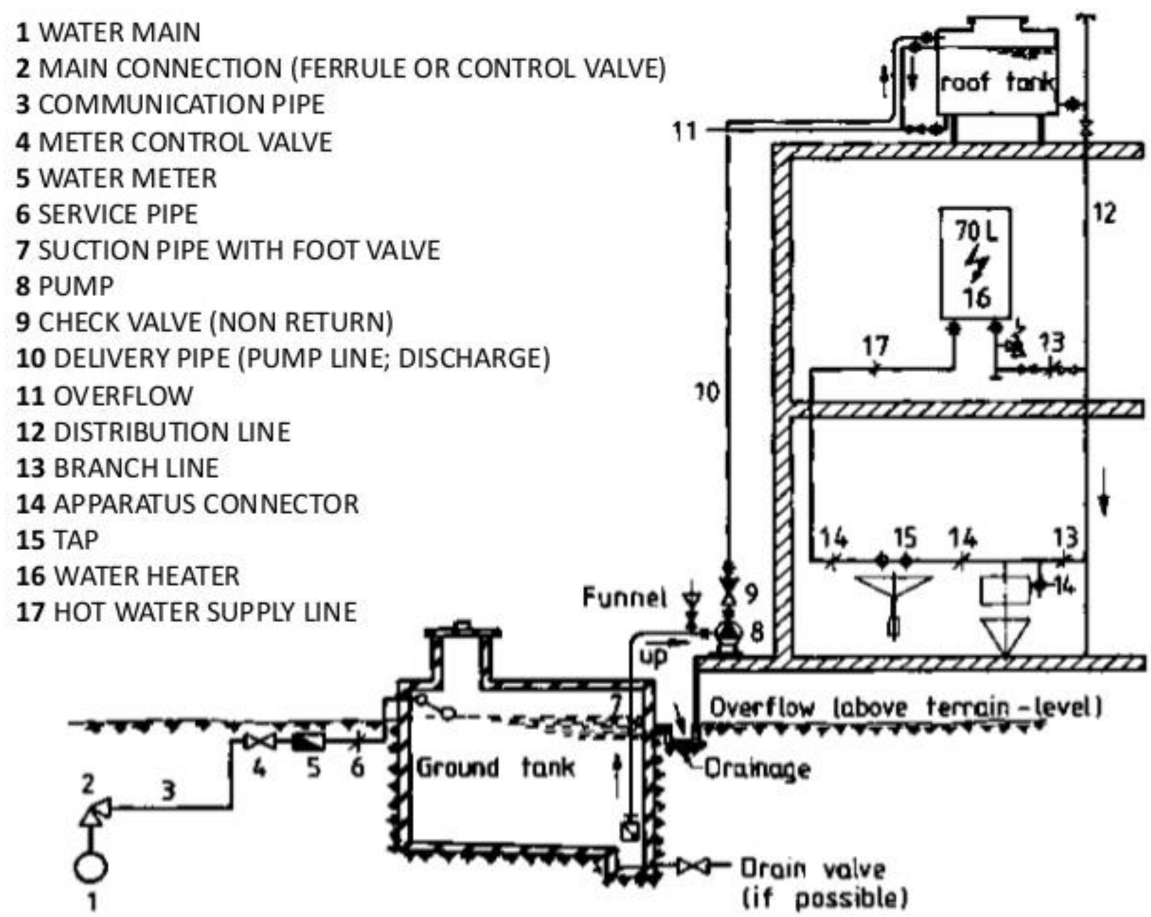
= 4.3 m = 4.5 m

Using a free board of 0.5m, overall depth = 0.5 + 4 = 4.5 m

Hence a rectangular sedimentation tank with size 24 m X 4.5 m X 4.5 m can be used.

**OR**

**VI (a) Explain the details of water connection taken from water main to the building with a neat sketch**.




- Branch - Any part of the piping system other than a main pipe is known as branch
- Direct tap - A tap or faucet, which is connected to a supply pipe and subject to pressure from the water main

- Service pipe - The pipe that runs between the distribution main in the street and the riser in case of a multi-storeyed building, or the water in case of an individual house, and is subjected to water pressure from such a main
- Supply pipe - The pipes which lead from the distribution main of water supply to the plumbing system of the house
- Water line - A line marked inside a cistern to indicate the highest water level at which the supply valve should be adjusted to shut off
- Water main (street main)- It is a pipe laid by the water undertakers for the purpose of giving a general supply of water as distinct from a supply to individual consumers. It includes any apparatus used in connection with such a pipe.
- Water outlet- As used in connection with the water distributing system, it is the discharge opening for the water (1) to a fitting; (2) to atmospheric pressure (except into an open tank which is part of the water supply); and (3) to any water-operated device or equipment requiring water to operate. (7)

(b) **Explain radial system. List advantages and disadvantages.** (8)

**RADIAL SYSTEM**

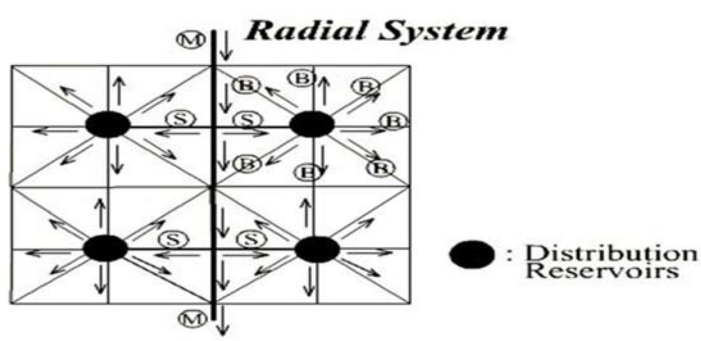
- ❖ The area is divided into different zones.
- ❖ The water is pumped into the distribution reservoir kept in the middle of each zone.
- ❖ The supply pipes are laid radially ending towards the periphery

**Advantages:**

- It gives quick service.
- Calculation of pipe sizes is easy.
- Ensures high pressures and efficient water distribution

**Disadvantages:**

- Overall cost is more
- Number of elevated reservoir are more
- Suitable for towns with radial layout of roads




**UNIT- III**

**VII** (a**) Explain the factors affecting dry weather flow**. (7)

## 1) Rate of water supply

- ∗ The quantity of sanitary sewage varies with the rate of water supply.
- ∗ The rate of water supply is not constant, but it fluctuates.
- ∗ These fluctuations may be seasonal, daily and hourly. The rate of sewage is assumed as equal to the rate of water supply.

## 2) Population

* The quantity of sanitary sewage directly depends on the population. As the population increases the quantity of sanitary sewage also increases and vice versa.

**3) Type of area served**

* The quantity of sanitary sewage also depends on the type of area such as residential, industrial or commercial.

**4) Infiltration and ex-filtration**

* The percolation of subsoil water in the sewer through the defective joints or cracks of sewer is called infiltration. The leakage of sewage from the sewer into the ground surrounding the sewer is called ex-filtration.
* Infiltration increases the quantity of sewage. On the other hand ex-filtration decreases the quantity of sewage.

(b) **Explain water carriage system. List advantages and disadvantages.** **(8)**

**Water carriage system**

In this system water is used as a medium to carry wastes to the point of final disposal.

The quantity of water is so high (99.9%) that wastes becomes liquid which is carried by the sewers.

The garbage is collected separately as in conservancy system.

The storm water may be disposed of separately or combined with sanitary sewage.

**ADVANTAGES**

- This system permits compact design of buildings.
- This system is hygienic.
- Less area is required for treatment and disposal.
- Only few labor are required.
- The risk of outbreak of epidemic is greatly reduced.
- There are no chances of nuisance on the streets.
- It requires large quantity of water.
- **DISADVANTAGES**
- The initial cost is very high.
- Highly skilled labor and technical persons are required for the maintenance of this system.
- This system is considered suitable for urban area.
- Wastage of water

**OR**

**VIII** (a) **List the factors influencing selection of shape of sewers and explain rectangular sewer.** (7)

* **a. Resistance to corrosion-**The formation of acids can lead to the corrosion of sewer pipe.
* **b. Resistance to abrasion-**This abrasion can reduce thickness of pipe by making the interior surface rough.
* **c. Strength and durability-**the material selected should be durable and should have resistance against natural weathering action and should withstand all the forces.
* **d. Weight of the material**

* The material should have less weight, which helps in easy handling and transportation.
* **e. Imperviousness**
* To eliminate chances of sewage seepage, from sewer to surrounding, the material selected for pipe should be impervious.
* **f. Economy and cost**

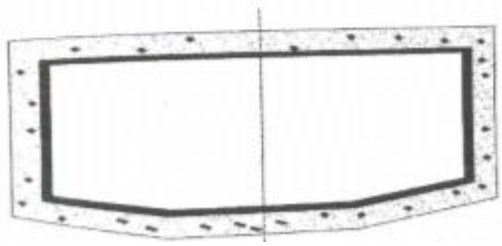
* RECTANGULAR SHAPED SEWER
* Generally it is used for covered storm water drains.
* It is stable and easy to construct.
* Sometimes it is used to work as a storage tank.

**(b) Rectangular Sewers:**

**Merits:** 1. Easy to construct 2. Can be used for storage also 3. Economical

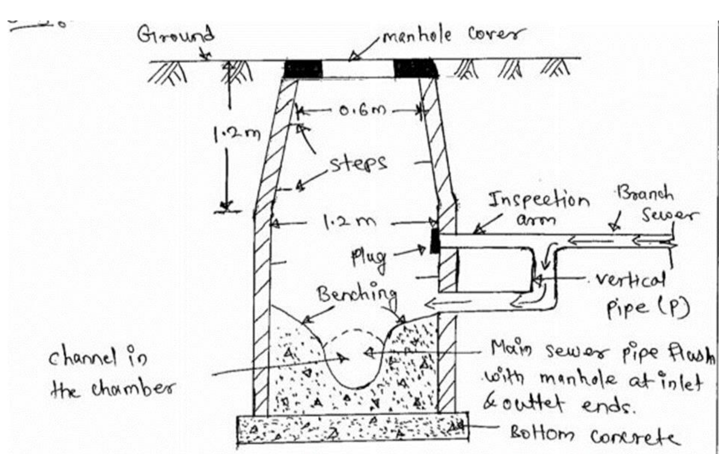
**Demerits:** 1. Hydraulic mean depth is low for small discharges

2. Cannot effectively take the load of over burden when width is large.

* 

(b) **Explain drop manhole with a neat sketch.** (8)

* Man hole on sewer line which is constructed to provide a connection between high level branch sewer and low level main sewer.
* The branch sewer will be 500 to 600mm above main sewer.
* When the drop pipe is inside the shaft, it should be of cast iron
* The diameter of the drop pipe should be at least equal to incoming pipe



## UNIT – IV

**IX** (a) **Design a septic tank for a group of houses with a population of 250 persons. The rate of water supply is 100 lpcd.** (7)

**SOLUTION**

Population = 250 persons

Sewage/capita/day = 100 litres

Quantity of sewage produced= population X per capita
= 250 X 100

= 25000 lit/day

Assuming 80% of water becomes sewage.

Therefore, Quantity of sewage= 25000 X 80/100

= 20000 lit/day

Assuming detention period = 24 hours.
Therefore, quantity of sewage = 20000 X 24/24

During detention period

= 20000 litres

Assuming rate of sludge deposited = 30lit/capita/day & sludge periods =1year.
Therefore, volume of sludge

= rate of sludge deposited X population X sludge period

= 30 X 250 X 1

= 7500 litres.

Therefore, required capacity of tank = 20000 + 7500 = 275000 litres.

Or = 27.5m^3

Assuming depth of tank = 1.5m (Range= 1.5 to 2.5m)

Therefore, surface area available = 27.5/1.5

= 18.3 m^2

Assuming length & width ratio i.e. (L: B = 3:1)

Therefore, surface area of tank = L X B

18.3 = 3B X B

B = 2.46m

Therefore, L = 3B

L = 3 x 2.46

L = 7.40m

Assuming free board surface 0.3m.

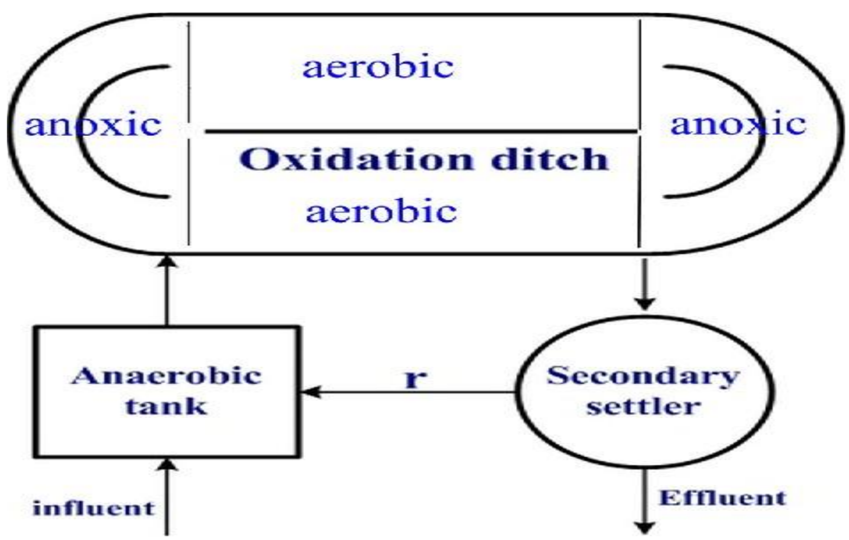
Therefore, depth (d) = 1.8m

Therefore, a septic tank of size 7.40mX2.46mX1.8m

(b) **Explain oxidation ditch with neat sketch. (8)**

# OXIDATION DITCH

- Oval shaped, long, narrow channel circuit provided with a rotor.
- Principle : **Extended aeration** activated sludge process that uses long solids retention times (SRTs) to remove biodegradable organics.
- Oval shape structure – surface is lined with impermeable lining , earth, brick or concrete walls
- Rotor provided for circulating sewage under aerobic conditions.
- Aerated sludge is then settled in settling tanks and clear liquid is taken out.
- Stabilized sludge is the dried on sand beds and disposed suitably.
- **Detention time** : 24 hr of average flow / 16 hrs if influent BOD5 is less than 200 mg/l.
- 150 to 1000m long, 2 to 5m wide and 1 to 1.5m deep.



**X** (a) **Explain the requirements of good drainage system in buildings.** (7)

**Basic Principles of Drainage system:**

*House Drainage should be **preferable laid by side of the building** to facilitate easy repair and better maintenance.

*The sewage or sullage **should flow under the force of gravity.**

*The house sewer should **always be straight.**

The entire system should be **well ventilated** from start to the end.

*The house sewer should be connected to the manhole such that the invert level is sufficiently higher to avoid back flow of sewage in house sewer.

*Where ever there is change in direction of sewer line in the premises, provide **inspection chamber at the junction**.

*House sewer joints should be leek proof because leakage if any shall create an odour problem and leaked wastewater shall infiltrate in the ground and shall reduce bearing capacity of soil below foundation, which is not desirable.

***Rain water** from roofs or open courtyards **should not be allowed** to flow through the **house sewers**.

*Siphonage action can never be permitted and therefore adequate ventilation systems should be installed.

(b) **Explain the construction and working of Janata model biogas plant**. (8)

Biogas is made in a biogas digester.

- The main part of a biogas system is a large tank, or digester.
- Inside this tank, **bacteria convert organic waste into methane gas** through the process of **anaerobic digestion**.
- Each day, household by-products such as market waste, kitchen waste, and manure from livestock are feeded to digestor.
- The methane gas produced inside biogas system may be used for cooking, lighting, and other energy needs.
- Waste that has been fully digested exits the biogas system in the form of organic fertilizer.

**ADVANTAGES**

- Ground water pollution is prevented
- Pathogenic organisms are destroyed
- House fly and mosquito breeding is eliminated.

## Advantages of biogas plants

- Reduces burden on forests and fossil fuels
- Produces a clean fuel - helps in controlling air pollution
- Provides nutrient rich (N & P) manure for plants
- Controls water pollution by decomposing sewage, animal dung and human excreta.

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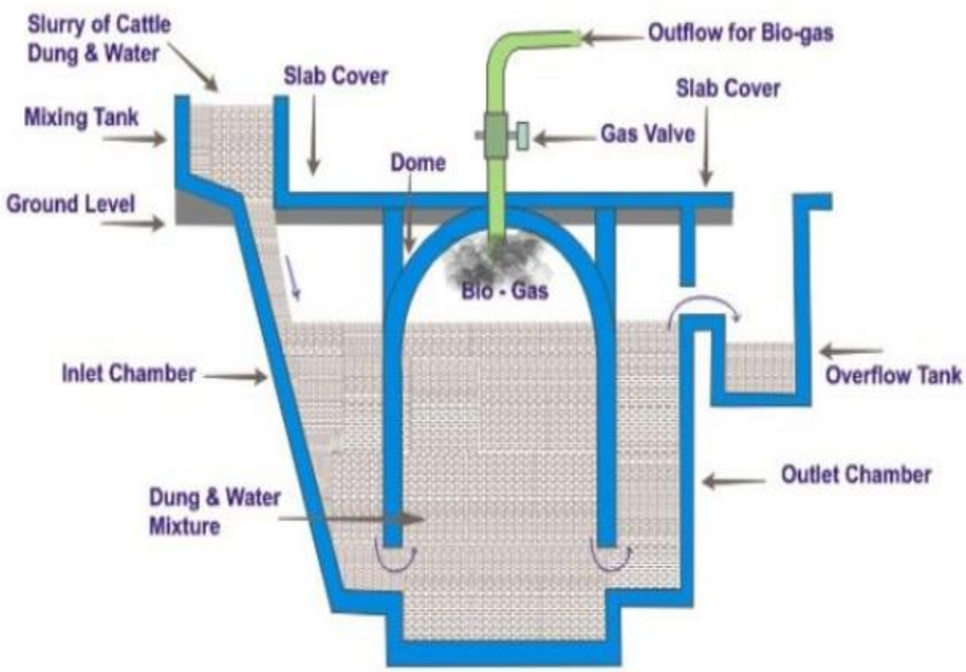


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