Scoring Indicators

COURSE NAME : PUBLIC HEALTH ENGINEERING

COURSE CODE : 6011A **QID : 2102240003**

Q No	Scoring Indicators	Split score	Sub Total	Total score
	PART A (answer all questions in one word or sentence)			**9**
I. 1	Springs are natural outflow of groundwater at the earth's surface.	1	1	
I. 2	Number of years for which provisions are made while designing a water supply scheme is called design period.	1	1	
I. 3	Colour, taste, odour, temperature and turbidity	Any two 2 x 0.5	1	
I. 4	Water softening	1	1	
I. 5	Sluice valve / Gate valve/ Shut-off valve / Stop valve	1	1	
I. 6	Sullage	1	1	
I. 7	Amount of oxygen demanded to decompose biodegradable & non biodegradable organic matter present in the sewage using a strong oxidising agent.	1	1	
I. 8	Skimming tanks.	1	1	
I. 9	Traps	1	1	
	PART B (Answer any eight questions)			**24**
II. 1	• An infiltration gallery is a horizontal or nearly horizontal tunnel which is constructed through water bearing strata. • It is also called as the horizontal well. • The gallery is usually constructed of brick walls with slab roof. • The gallery obtains its water the from water bearing strata by various porous drain pipes. • These pipes are covered with gravel, pebble, etc. so as to prevent the entry of very fine material into the pipe. • The infiltration galleries are useful as source of water supply	Any 3 points 3 x 1	3	

<table>
<tr><td></td><td>when ground water is available in sufficient quantity just below ground level.
• The galleries are usually constructed at depth of about 5 to 10 m from the ground level.</td><td></td><td></td><td></td></tr>
<tr><td>II. 2</td><td>1. Climatic conditions
2. Cost of water
3. Distribution pressure
4. Habits of population
5. Industries
6. Policy of metering
7. Quality of water
8. Sewerage
9. Size of city
10. System of supply.</td><td>Any 6 points 0.5 each</td><td>3</td><td></td></tr>
<tr><td>II. 3</td><td>
<table>
<tr><td>Year</td><td>Population</td><td>Increase in population</td></tr>
<tr><td>1951</td><td>258000</td><td></td></tr>
<tr><td>1961</td><td>495000</td><td>237000</td></tr>
<tr><td>1971</td><td>735000</td><td>240000</td></tr>
<tr><td colspan="2">Total</td><td>238500</td></tr>
<tr><td colspan="2">Average increase/ decade</td><td>$\bar{x} = \frac{238500}{2} = 119250$</td></tr>
</table>
$P_n = P_o + n\bar{x}$
Population in 1991 = 735000 + 2 x 119250 = 9,73,500</td><td>1.5
0.5
1</td><td>3</td><td></td></tr>
<tr><td>II. 4</td><td>• Collection of rain water from paved or GI corrugated roofs and paved courtyards of houses either in storage tanks or in the ground water reservoir is known as rain water harvesting.
• Roof top water harvesting for direct use involves taking down PVC or MS pipe of 90 - 120 mm dia from roof's outlets to the ground floor which can be connected to water tank.
• Rain water collection for ground water recharge can be</td><td>Any 3 Points 1 x 3</td><td>3</td><td></td></tr>
</table>

	practiced by directing rainwater to join ground water table through recharge pits or recharge wells. • The rain water before collection should pass through simple sand or charcoal filters for the removal of suspended matter.			
II. 5	Prechlorination - Process of applying chlorine to the raw water or before filtration. Breakpoint chlorination - It is the dose of chlorination beyond which any further addition of chlorine will appear as free residual chlorine. Super chlorination - Addition of excessive amount of chlorine for highly polluted waters or during epidemics of water borne diseases.	3 x 1	3	
II. 6	• To provide hygienic and aesthetic environment • To collect and treat the sewage in a scientific way • To dispose the treated sewage by proper methods to avoid pollution of surface and ground water sources • To prevent the occurrence and spread of water borne diseases and thus protecting the health of public • To prevent and control the nuisance due to the growth of houseflies and mosquitoes by avoiding the stagnation and indiscriminate disposal of human excreta and other liquid waste • To effectively drain away the storm water from the town and thus avoiding inundation.	Any 3 points 3 x 1	3	
II. 7	• Water carriage system uses water as medium to convey the waste from its point of production to the point of its treatment or final disposal. • Compact design and hence less land required • It is hygienic and hence no chances for the outbreak of epidemics and no possibility of groundwater contamination, • Minimum labour required, • High initial cost, high water requirement	Any 3 points 3 x 1	3	

II. 8	• As circular section gives least perimeter for a given area, construction material required is minimum and hence economical. • There are no corners and hence chances of deposition of organic matter is reduced. • Easy to construct and handle • They possess excellent hydraulic properties as they provide maximum hydraulic mean depth.	Any 3 points 3 x 1	3	
II.9	• BOD (Biochemical Oxygen Demand) test gives the amount of oxygen required by the microorganisms to carry out decomposition of biodegradable organic matter under aerobic conditions. • It is used as a measure for determining pollution strength of sewage. • It helps in finding out the amount of clear water required for successful disposal of sewage by dilution. • It is the one of the most important test in stream pollution control activities. • This test can be used to evaluate the purification capacity of receiving bodies of water. • It is also useful in design of wastewater treatment plant and also to measure the efficiency of some treatment processes.	Any 3 points 3 x 1	3	
II.10	• To avoid pollution of receiving water bodies and thus preventing the health hazards • To create sanitary and hygienic environment around the town • To protect the fish and other aquatic life • To avoid the sewage sickness of land on to which it is disposed • To derive the useful components after treatment of sewage in the form of sludge cake (used as manure), liquid effluent (useful for sewage farming) and biogas (as fuel) • To prevent offensive odour and unsightly conditions of the	Any 3 points 3x1	3	

	water bodies used for swimming, boating etc.			
	PART C(Answer all questions)			**42**
III.				

Year	Population	Increase in population	Growth rate (%)
1950	120000		
1960	150000	30000	25
1970	200000	50000	33.33
1980	250000	50000	25
1990	290000	40000	16

3

7

Geometric mean of growth rate, $r = \sqrt[4]{25 \times 33.33 \times 25 \times 16}$

1

$= 24.03\ \%$

$$P_n = P_o\left(1 + \frac{r}{100}\right)^n$$

$P_{2000} = 290000\left(1 + \frac{24.03}{100}\right)^1 = 3{,}59{,}687.$ 1

$P_{2010} = 290000\left(1 + \frac{24.03}{100}\right)^2 = 4{,}46{,}120.$ 1

$P_{2020} = 290000\left(1 + \frac{24.03}{100}\right)^3 = 5{,}53{,}322.$ 1

IV

Year	Population	Increase in population	Incremental increase
1880	30000		
1890	32500	2500	
1900	39100	6600	(+) 4100
1910	46500	7400	(+) 800
1920	52050	5550	(-)1850
1930	59500	7450	(+) 1900
Total		29500	4950
Average/decade		$\bar{x} = \frac{29500}{5} = 5900$	$\bar{y} = \frac{4950}{4} = 1238$

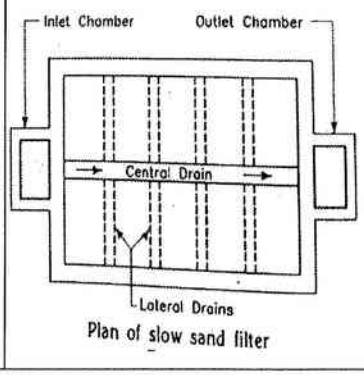
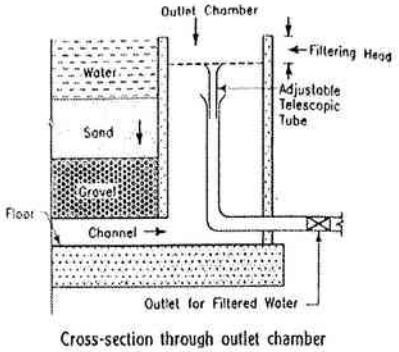
4

7

2 x 0.5

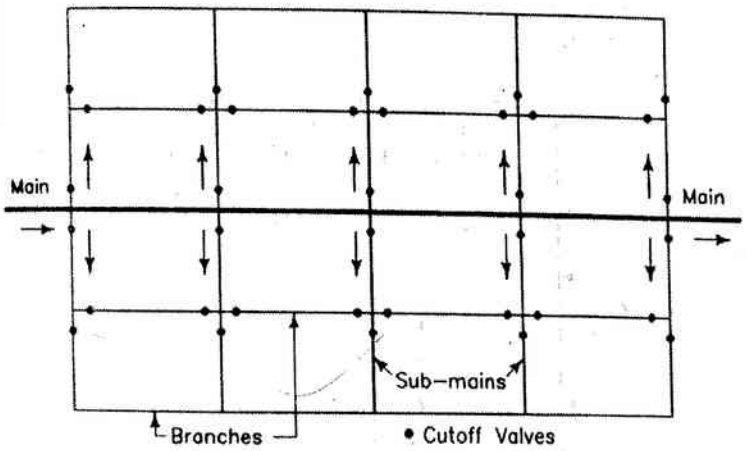
$$P_n = P_o + n\bar{x} + \frac{n(n+1)}{2}\bar{y}$$ 1

$P_{2000} = 59500 + 7 \times 5900 + 28 \times 1238 = 1{,}35{,}464.$ 1

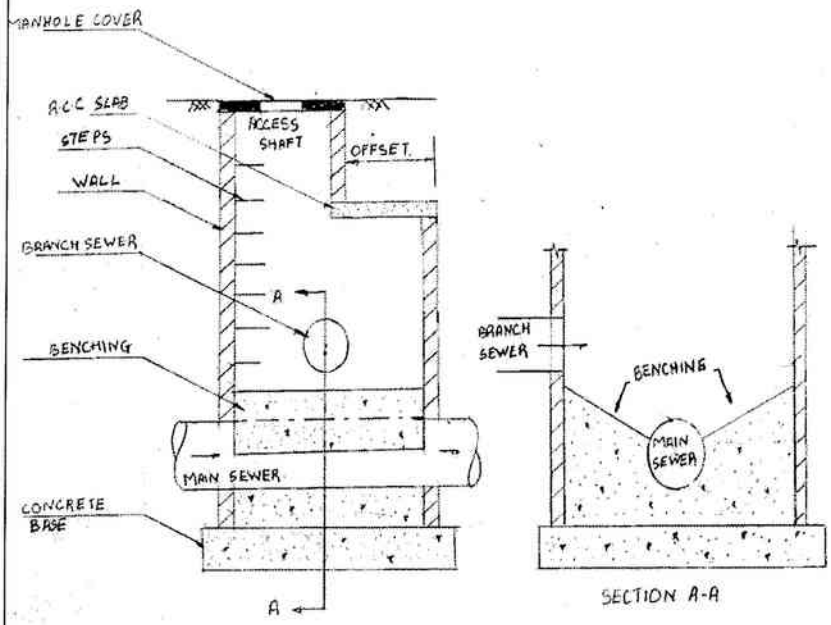
V	1. **Air diffusion**: In this method, the perforated pipes are installed at the bottom of tanks. The compressed air is blown through these pipes. The air bubbles while coming up from the bottom of tank come into close contact of water Contained in the tank and aeration of water is thus achieved. 2. **Cascades**: A cascade is a waterfall and a simple cascade consists of a series of three or four steps. The steps may be of concrete or metal. The water is allowed to fall through a height of about 1 to 3 m and during this fall, it comes into close contact with air. 3. **Spray nozzles**: In this method, the water is sprinkled in fine jets through nozzles to a height of about 2 m to 2.5 m. This method of aeration removes carbon dioxide to the extent of about 90 per cent or so. But it requires considerable head of water for its working. 4. **Trickling beds**: The beds of coke or slag are prepared which are supported over perforated trays. Usually three beds are placed one above the other. The water is discharged through perforated pipes placed at the level of top bed and it is then allowed to trickle down from top bed to bottom bed. During the trickling process, the aeration of water occurs.	Types–2 ~~Expl–5~~ Any 1	7	
VI	**Construction**  Plan of slow sand filter  Cross-section through outlet chamber			

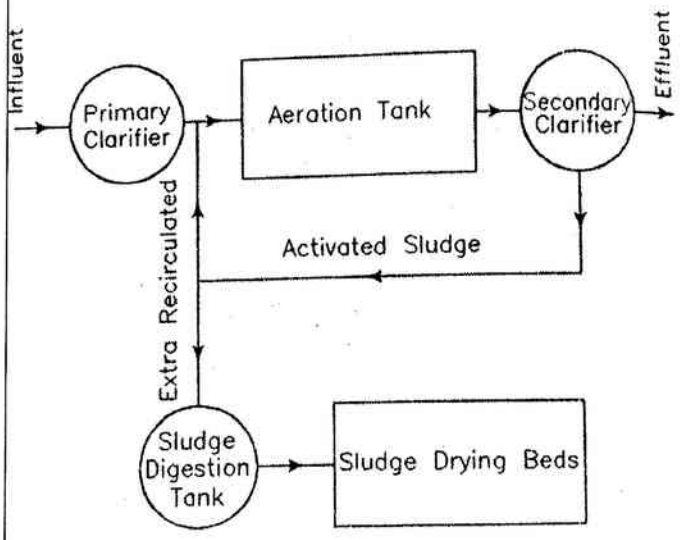
	• Enclosure tank - This consists of a watertight tank 2.5-3.5m. in depth and area 30 - 2000 sqm, constructed in stone or brick masonry and bed sloping towards a central longitudinal drain. • Under drainage system - Consist of central drain and lateral drains of of baked clay or concrete pipe. Latrals are spaced at a distance of 2.5 to 3.5 m. • Base material: The base material is gravel, 0.3 to 0.45 m thick laid in 5 to 6 layers, placed on the top of underdrainage system. • Filter media of Sand : A layer of sand, 0.6 to 0.9 m thick, is placed above gravel. • Appurtenances : The various appurtenances like vertical air pipe passing through layer of sand, devices for measuring loss of head, for controlling depth of water above sand layer and for maintaining rate of flow through filter are to be suitably installed. **Operation** : The water is allowed to enter the filter through the inlet chamber. It descends through the filter media and during this process, it gets purified. It is then collected in the outlet chamber and taken to the clear water storage tanks. For cleaning filter when specified head is reached, the top layer of sand is scraped or removed through a depth of about 15 mm to 25 mm. The water is then admitted to the filter. But the purified water is not taken into use for a period of about one or two days.	4 3	7	

VII	• Removal of temporary hardness a) **Boiling** - When hard water containing bicarbonates of Calcium is boiled, CO_2 gas will get out leading to the precipitation of $CaCO_3$ which can be removed in settling tanks. But this method cannot remove magnesium hardness and boiling of water on a large scale is uneconomical. b) **Addition of lime** - Hydrated lime, $Ca(OH)_2$ when added to hard water will react with bicarbonates of Ca and Mg resulting the precipitation of $CaCO_3$ and $Mg(OH)_2$ which can be removed in the sedimentation tanks. • Removal or permanent hardness a) **Lime and Soda Ash Process** - lime ($Ca(OH)_2$) and sodium carbonate or soda ash (Na_2CO_3) are added to hardwater which react with calcium and magnesium salts to form insoluble precipitates of $CaCO_3$ and $Mg(OH)_2$. These precipitates can be removed in a sedimentation tank. b) **Base-Exchange Process** (Zeolite Process)- Zeolites are natural salts which are hydrated silicates of sodium and aluminium. They have excellent property of exchanging their cations and hence during softening operation, the sodium ions of zeolite get replaced by calcium and magnesium ions present in hard water. a) **Demineriłzation process** (De-ionisation) - It is the process of removing minerals present in water by first passing through a bed of cation exchange resins and then a bed of anion exchange resins.	Types - 2 marks Expl - 5 marks any 1. 7	7	
VIII	• This is also known as the interlaced system or reticulation system. • The mains, sub-mains and branches are all interconnected with each other to eliminate dead ends. • More suitable for towns with well planned roads and streets. • Free circulation of water avoid pollution due to stagnation	Expl - 4 Fig - 3	7	

	• In case of repairs, a very small portion of distribution area will be affected • Minimum loss of head • When a fire occurs, plenty of water will be available for fire fighting by closing and manipulating cut off valves. • Require more length of pipe and cut off valves • Construction cost is more • Calculations for determining sizes of pipe and pressures at key points are more complicated.  Grid-iron method of layout			
IX	• In this system two separate sets of sewer are installed, one for collection and conveyance of sanitary sewage and other for storm water. • Since the sanitary sewage and storm water flows in a separate pipes, the quantity of sewage to be treated is less. • Size of sewer required is less. • As the sewer are smaller in section, they can be easily ventilated. • During disposal if the sewage is to be pumped, the separate system is cheaper. • Rain water can be discharge in to steams without any treatment. • Since the sewer are smaller size, it is difficult to clean them	Expl - 4 Suitability - 3 (any 3 points)	7	

	and are likely to get chocked. • Initial cost is high, when two separate set are used. • Maintenance cost of sewer is also high. • Generally self cleaning velocity is not available due to small quantity of sewage therefore, flushing is required at various point. • Suitability ▪ Where rainfall is uneven ▪ Sanitary sewage is to be pumped ▪ Sanitary sewage is to have one outlet and other outlets for storm or surface water are available. ▪ Separate sewers must be placed deeper and storm water drains nearer the surface to economize excavation. ▪ The drainage area is steep allowing water to run off quickly ▪ Sewers are to be constructed in rocky strata ▪ Finance available are small			
X	**Function** - Manholes are masonry or R.C.C. chamber constructed at suitable intervals along the sewer lines or drains for providing access to men so that they can attend inspection, cleaning and maintenance of sewer. **Construction** A manhole is made up of following parts **Access Shaft** - The upper portion of a deep manhole is called access shaft. **Working chamber** - The lower portion of the manhole is known as the working chamber, as it provides a working space for inspecting and cleaning-operations. **Side walls** - The side walls of the manhole are made of brick or stone masonry or R.C.C. **Steps or Ladders** - cast iron steps for descending into the manhole.	Function - 2 Construction - 5	7	

	Cover and Frame - The manhole is provided with a cast iron cover and a cast iron frame at its top. **Benching** - It is the Bottom or invert portion of manhole constructed in cement concrete. It allows the entry of sewage into the main sewer.  			
XI	• **Function** - Grit chambers are sedimentation basins placed in front of wastewater treatment plant to remove inorganic particles such as sand, gravel, grit, egg shells etc. • **Working** Grit chambers may be horizontal flow type or vertical flow type. In the horizontal flow type, the sewage enters and leaves the chamber in horizontal direction. In vertical flow type, sewage is brought in the chamber through vertical pipe. The velocity of flow is decreased to such an extent (0.15 - 0.3 m/s) that the heavier inorganic materials settle down at the bottom and lighter organic materials are carried forward for further treatment. A minimum depth of 300 mm should be provided below the invert level of sewer.	Function - 2 Working - 5 marks	7	

	The grit chambers are designed for a detention time of 1 minute. The grit accumulated at the bottom has to be periodically cleaned manually or mechanically and disposed.			
XII	Activated sludge process is used to treat either raw sewage or settled sewage. The term activated sludge is used to indicate the sludge which is obtained by settling sewage in presence of abundant oxygen. It contain great number of aerobic bacteria and other microorganisms which can oxidize organic matter. Operation: 1. **Mixing of activated sludge** - The sewage effluent from primary sedimentation tank is mixed with activated sludge 2. **Aeration** - The mixture enters an aeration tank where it is mixed with a large quantity of air for about 4 to 8 hours. Organic solids are rapidly oxidized and suspended and colloidal matters coagulate to form readily settle-able precipitate. 3. **Settling in secondary clarifier** - The mixed liquor after agitation is taken to secondary clarifier where it is allowed to settle in this tank. The settled sludge is the activated sludge and a portion of it is sent for re circulation.The extra activated sludge is taken to sludge digestion tanks and disposed.  Flow diagram of activated sludge process	7	7	

XIII	**Disposal by dilution -** • It is the process whereby treated sewage or effluent from treatment plant is discharged into water bodies. • Conditions favoring dilution i. Where sewage is comparatively fresh ii. Where sewage has been mostly removed of floating and settle able Solids iii. Where it is possible to thoroughly mix or diffuse sewage through diluting water. iv. Where diluting water has high DO content v. Where currents are favourable causing no deposition or destruction to aquatic life. **Disposal on land** • In this method, raw or partly treated sewage is applied on land. • A part of sewage evaporate and remaining portion percolates through the ground and is caught by underground drains for disposal into natural waters. • Sewage adds fertilizing value of land and hence it is also known as sewage farming. • Conditions favoring disposal on land i. Where dilution water is not easily available ii. Climate is dry iii. Land is cheap and plentiful iv. Subsurface strata are porous favoring large infiltration v. Rainfall is low and demand for irrigation is heavy vi. Depth of water table is low.	Any 4 points 3.5 marks Any 4 points 3.5 marks	7	

XIV	a) Flushing Cistern • The arrangement made to flush out the water closets or urinals • Made of cast iron or porcelain • Capacity varies from 5 to 15 litres • May be hand operated or automatic b) Inspection chambers • Constructed on house drain to provide access for cleaning, inspection and repair • Chamber is provided with C I Cover • Size may be 60 x 75 cm and 90 cm deep • They should be constructed at all junctios, bends and at about 10 m interval. c) Anti-siphonage pipe. • Pipe installed to preserve the water seal of traps through ventilation. • If several blocks are situated on different storeys discharging into same soil pipe, antisiphonage pipe has to be provided. Because the flushing of upper floors creates partial vacuum in the pipe at lower region, including syphonic action and thus water seals are sucked in the lower floors. • Back syphonage causes breaking of water seal, therefore anti-siphonage pipe is required.	2 points 2 3 ponts 2.5 3 points 2.5	7	