(46) (D) April-24 Page No – 14

Revision (15) 6012 Course title: **Environmental Engineering**

Qst. No.	Scoring indicator	Split up score	Sub Total	Total
PART A				
I (1)	Springs, wells, infiltration wells, infiltration galleries	Any two 2 marks	2	10
I (2)	Super chlorination is defined as administration of a dose considerably in excess of that necessary for the adequate bacterial purification of water	2	2	
I (3)	dead end, grid, radial and ring system	Any two 2 marks	2	
I (4)	• It Indicate waste water from bathrooms, kitchens, washing places, wash basins etc. • It does not include waste water from W.C., urinals etc.	2	2	
I (5)	•Activated Sludge • Aerated Lagoon • Contact Bed • Intermittent sand filters • Sludge Digestion • Trickling filter	Any 2- 2 marks	2	
PART B				
II (1)	The following are the different types of water demands 1. Domestic water demands 2. Industrial and commercial water demands 3. Demand for public use 4. Fire demand 5. Water demand to compensate losses and thefts	6	6	
II (2)	• In this method water level in the well is depressed by pumping to any level below the normal level. • Then the pumping is stopped and time taken by the percolating water to fill the well to any particular level is noted. • Total quantity of water percolated into the well is calculated by knowing cross-sectional area and rise in the water level after stoppage of pumping. • The rate of percolation or the yield of well can be arrived at by dividing the quantity of water by the time. • Recuperation test is very simple to perform but it does not give the maximum safe yield. • The reason is as the water level in the well rises the safe maximum	6	6	

	working head is not maintained throughout the period of observation.			
II (3)	• To eliminate odour and flavour • To raise the amount of dissolved oxygen in the water • To lower the carbon dioxide concentration of water, lowering corrosiveness and raising the pH value • To oxidise iron and manganese so that these can be precipitated and removed • To destroy bacteria to some extent, by agitation of water during aeration • To remove carbon dioxide	1 x6	6	
II (4)	1. Pipe corrosion may lead to the tuberculation (formation of small projections on the inside surface of pipe) which decreases carrying capacity of water 2. The pipe corrosion leads to the disintegration of pipeline and it demands heavy repairs 3. The pipe corrosion imparts colour, taste and odour to the flowing water 4. The pipe connections are seriously affected by pipe corrosion 5. The pipe corrosion may make the water dangerous for drinking and other purposes. 6. Pipe corrosion can cause leakage in distribution system	1x6	6	Any 5-30 marks
II (5)	Strength of sewage is its potentiality to produce nuisance to man and his environment. The oxidizable organic matter and other pollutants in sewage, is unstable in nature – they undergo putrefaction and produces very bad odor and causes unhealthy environment. If concentration of organic matter more – strong sewage. If concentration of organic matter is less – weak sewage. Strength of sewage – generally expressed in terms of B.O.D	6	6	
II (6)	In this process, effluent from primary sedimentation tank is mixed with activated sludge in aeration tank. • Activated sludge is a sludge of sewage which is previously agitated under aerobic conditions containing full of aerobic bacteria. • The mix is then aerated so as to oxidize the organic matter and convert it into settleable flocs. • The flocs can be removed in secondary sedimentation tank Primary effluent is mixed with a portion of activated sludge and then allowed in the tank. • The mixed liquor is then aerated or mechanically agitated in the presence of air. • The aerobic bacteria present in suspension oxidize the sludge. • Oxidized sludge is withdrawn and sent to secondary clarifier for sedimentation	6	6	
II (7)	• Effects on human health • Effects on physical properties of atmosphere • Effects on plants • Effects on materials and properties • Effects on climate change • Air pollution can directly harm wildlife and their habitats.	1 x 6	6	

PART C

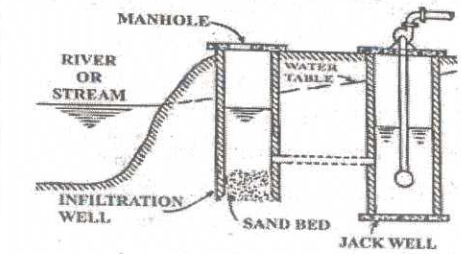
III (a)

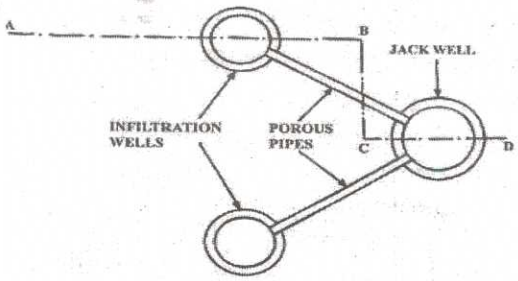
- The infiltration wells are sunk in series in the banks of river, to obtain large quantity of water.
- The wells are closed at top and open at bottom.
- They are constructed by brick masonry with open joints as shown in fig.
- For the purpose of inspection of well, the manholes are provided in the top cover.
- The water filtrates through the bottom of such wells and as it has to pass through sand bed, it gets purified to some extent.
- The infiltration well in turn is connected by porous pipes to collecting sump called jack well and there water is pumped to purification plant for treatment
- Can provide potable water from a surface source during the entire year if it is excavated below the stream bed level.
- Water quality is good. As the water passes through the ground, suspended particles and bacteria are removed and the stream water is considerably purified

5

7

Fig-2





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III (b)

Year	Population	Increment
1961	858545	-
1971	1015672	157127
1981	1201553	185881
1991	1691538	489985
2001	2077820	386282
2011	2585862	508042

2

Population in the year 2021 is, P_{2021} = 2585862 + (345463 x 1)
= 2931325

2

8

Population in the year 2031 is, P_{2031} = 2585862 + (345463 x 2)
= 3276788

2

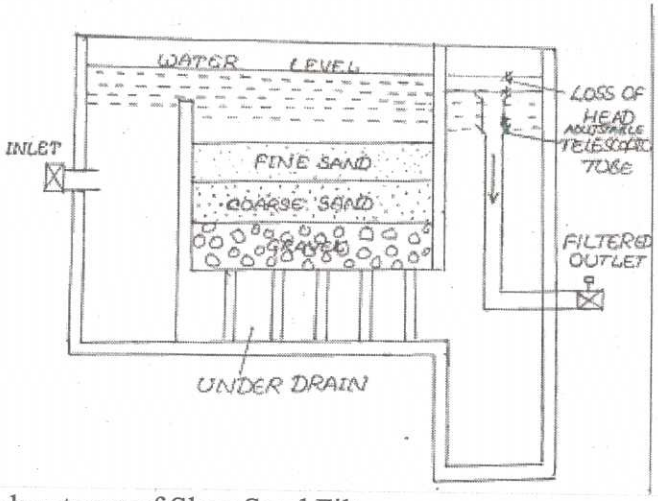
Population in the year 2041 is, P_{2041} = 2585862 + (345463 x 3)
= 3622251

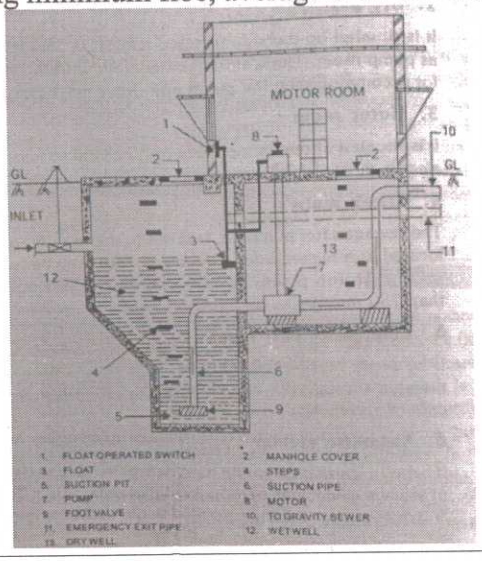
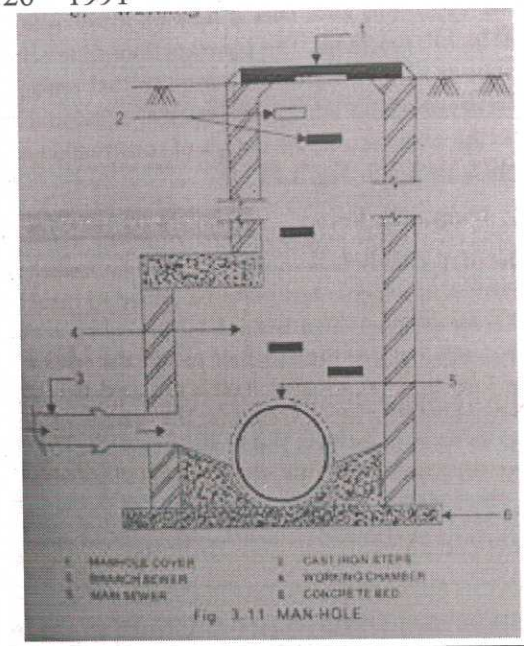
2

IV (a)	• Laboratory testing of water is crucial for protecting public health, maintaining environmental quality, and ensuring the sustainable use of water resources. • Ensuring Safety: Water quality testing helps ensure that drinking water is safe for human consumption. It helps detect harmful contaminants such as bacteria, viruses, heavy metals, and chemicals that can pose health risks if present in high concentrations. • It helps identify sources of pollution and assess the health of aquatic ecosystems. • Detecting Emerging Contaminants: Water quality testing can help identify emerging contaminants that may not be regulated but could pose risks to human health or the environment. Examples include pharmaceuticals, personal care products, and microplastics. • Ensuring Water Quality in Various Uses: Water quality testing is important for various uses of water, including agriculture, industry, and recreation. It helps ensure that water is suitable for these uses and prevents contamination. • Regulatory agencies set standards for water quality to protect public health and the environment. Water utilities and other organizations must comply with these standards and regularly test their water to ensure compliance	7	7	
IV (b)	1. Arithmetical Increase Method 2. Geometrical Increase Method 3. Incremental Increase Method 1. Arithmetical Increase Method : In this method it is assumed that the population is increasing at constant rate. Rate of change of population with respect to time is constant. Forecasted population (Pn) after n decades from the present is given by, $\boxed{P_n = P_0 + n.\bar{x}}$ • P0 = Population at present (i.e. last known census) • n = Number of decades between present and future • $\bar{x}$= Average increase in population of the known decades • Suitable for large and old city with considerable development 2.Geometrical Increase Method In this method the percentage increase in population from decade to decade is assumed to remain constant. ◦ Also known as "uniform increase method" ◦ Forecasted population (Pn) after n decades from the present is given by, $\boxed{P_n = P_0\left(1+\frac{r}{100}\right)^n}$ P0 = Population at present (i.e. last known census) n = Number of decades between present and future r = Assumed growth rate ◦ This method gives the highest value and is best suited for new cities 3. Incremental Increase Method In this method the rate of growth is not assumed as constant. ◦ Also known as 'Method of Varying Increment'. ◦ Forecasted population (Pn) after n decades from the present is given by $\boxed{P_n = P_0 + n.\bar{x} + \frac{n(n+1)}{2}.\bar{y}}$	1 2 2 3	8	15

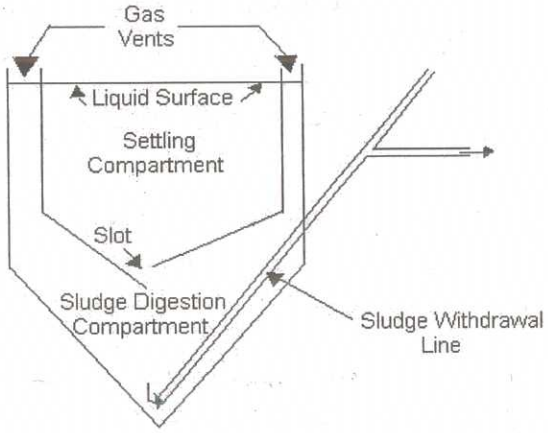
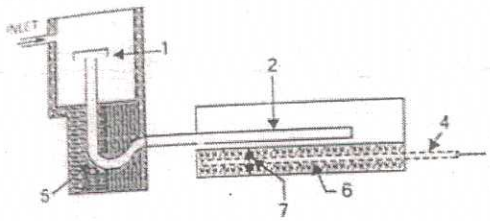
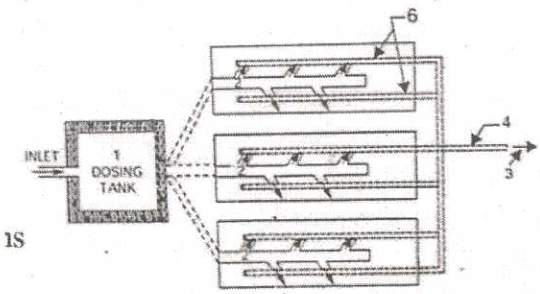
	P0 = Population at present (i.e. last known census) n = Number of decades between present and future = Average increase in population of the known decade $\bar{y}$ = average of incremental increases of the known decades. ◦ Suitable for an average size town under normal condition where the growth rate is found to be in increasing order	2		
V (a)	In a dead-end water distribution system layout, water flows from a single source (like a water treatment plant or a well) through a network of pipes to various endpoints, such as homes, businesses, or other buildings. In a dead-end system, the pipes terminate without connecting back to the main supply line. Advantages of Dead-End Water Distribution Systems: 1. Simplicity: Dead-end systems are often simpler and less costly to design and construct compared to looped systems, especially in smaller or less densely populated areas. 2. Ease of Maintenance: Dead-end systems can be easier to maintain, as there are fewer pipes and connections to manage. This can lead to lower maintenance costs and less complexity in operation. 3. Lower Initial Cost: Building a dead-end system may be more cost-effective initially, as it requires fewer pipes and materials compared to looped systems. 4. Efficient for Smaller Systems: Dead-end systems can be more efficient for smaller water distribution systems with lower water demand, as the water flow is more straightforward. Disadvantages of Dead-End Water Distribution Systems: 1. Water Quality Issues: One of the primary drawbacks of dead-end systems is the potential for water quality issues. Stagnant water in the pipes can lead to bacterial growth, sediment buildup, and other contaminants, affecting the overall water quality. 2. Pressure Fluctuations: Dead-end systems can experience pressure fluctuations, especially at the endpoints, which can lead to issues such as low water pressure or water hammer. 3. Limited Water Circulation: Without a looped system to promote water circulation, dead-end systems can be less efficient in terms of water flow and distribution. 4. Difficulty in Expansion: Dead-end systems can be more challenging to expand or modify, as they may require significant redesign and construction to add new connections or loops. 5. Potential for Water Ageing: Stagnant water in dead-end systems can lead to water ageing, where the water quality deteriorates over time due to a lack of circulation.	2 3 3	8	
V (b)	The two types of sedimentation are: 1. Plain Sedimentation Sedimentation is done to remove the impurities which have specific gravity more than that of water and are settle able. When water is moving these impurities remain in suspension due to the turbulence and as the velocity is reduced they settle down. It is not necessary to stop the motion of water completely as it will require more volume of the sedimentation tanks. 2. Sedimentation Aided with Coagulation The fine suspended particles like mud particles and the colloidal matter	3	7	15

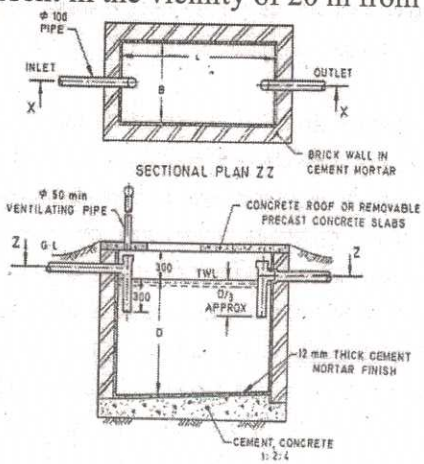
	present inwater cannot settle down by plain sedimentation with ordinary (lesser) detentionperiods. Some of the colloidal impurities will not settle even if the water is detainedfor long periods in the sedimentation tanks as the same charge on the clay particlesrepel each other and do not allow them to settle down. So the sedimentation is aidedwith coagulation. Coagulation is a process in which some chemical like alum orferrous sulphate is mixed in water resulting in particle destabilization.	4		
VI (a)	Necessity of disinfection are • Remove Pathogens • Prevent Disease Spread • Compliance with Regulations. • Maintain Water Quality • Control Algal Toxins METHODS OF DISINFECTION Disinfection of water by different physical and chemical methods ➢ PHYSICAL METHODS ➢ CHEMICAL METHODS PHYSICAL METHODS 1.BOILING:Boil the water for 15 to 20 minutes and it kills the disease-causing bacteria. This process is applicable for individual homes 2. ULTRA-VIOLET RAYS: Water is allowed to pass about 10cm thickness byultraviolet rays. This process is very costly and not used at water works. Suitableforinstitutions. 3. ULTRASONIC RAYS: Suitable for institutions. <u>CHEMICAL METHODS</u> 1. CHLORINATION:Using chlorine gas or chlorine compounds. 2. BROMINE AND IODINE:It is expensive and leaves taste and odour. 3. POTASSIUM PERMANGANATE: This method is used for disinfection of dugwell water, pond water or private source of water. 4. OZONE:Very expensive process, leaves no taste, odour or residual. 5. EXCESS LIME TREATMENT: Needs long detention time andlarge limesludge to be treated.	2 2 3	7	15
VI (b)	Slow sand filters are best suited for the filtration of water for small towns. CONSTRUCTION Slow sand filter is made up of a top layer of fine sand of effective size 0.2. to 0.3mm and uniformity coefficient 2 to 3 . The thickness of the layer may be 75 to 90 cm. Below the fine sand layer, a layer of coarse sand of such size whose voids do not permit the fine sand to pass through it. The thickness of this layer may be 30cm. The lowermost layer is a graded gravel of size 2 to 45mm and thickness is about 20 to 30cm. The gravel is laid in layers such that the smallest sizes are at the top. The gravel layer retains the coarse sand layer and is laid over the network of open jointed clay pipe or concrete pipes called under drainage. Water collected by the under drainage is passed into the out chamber	2	8	

		2		
	Advantages of Slow Sand Filters: Effective Removal of Pathogens Natural Filtration Process Long Filter Life Low Operating Costs Removal of Suspended Solid	2		
	Disadvantages of Slow Sand Filters: Slow Filtration Rate Large Footprint Clogging Risk of Biofilm Formation Limited Removal of Chemical Contaminant	2		
VII (a)	Component parts of a pumping station are: • Sump well / wet well – sewage from lower level is collected in this well. • Dry well / pump room – situated by the side of sump well. Should have enough working space to accommodate pumps and other machinery. • Motor room – situated above pump room & accommodates electric motor which runs the pump. • Rising main – sewage after pumping is taken to the gravity sewer located at a higher level. Made of cast iron pipes. • Emergency exit pipe – if by some reason the sump overflows, the excess is diverted through the emergency exit pipe. • Automatic starter – helps in starting the pump automatically when the sewage in wet well rises beyond a particular point. This is achieved by a float operated switch arrangement. • Valves – sluice valves to control flow of sewage. Reflex valves are fitted next to pump allowing sewage only in one direction. Air valves provided ay summits to prevent air locks. • Flow recorders – installed to measure the rate of pumping of sewage. • Pumping unit – consists of a suitable motor and pump. Total power required for pumping is divided into smaller units, so that each can be	Parts-7 marks Fig- 2 marks	9	15

	separated during minimum floe, average flow and maximum flow.  			
VII (b)	Three important components: 1. Man hole cover 2. Access shaft 3. Working chamber • Working chamber – with sufficient space for a man to stand inside and carry out work. • working chamber – either circular (minimum 1.2 m dia) or rectangular (0.9 X 1.2 m) in plan. • Access shaft provides access to working chamber. A series of steps are provided for descending into the working chamber • Top of access shaft is covered with RCC slab with an opening. Opening is covered with a manhole cover made of cast iron. Dimensions and weights of C.I covers and frames should be as per IS 1726 – 1991  Fig. 3.11 MAN-HOLE	4 2	6	
VIII a.	In this system, the excremental matters are mixed up in the large quantity of water and are taken out from the city through properly			

	designed sewerage systems where they are disposed off after necessary treatment in a satisfactory manner. The sewage so formed in water carriage system consists of 99.9 percentage of water and 0.1 percentage of solid matters. All the solid matters remain in suspension in the sewage and do not change the specific gravity of water. So, all the hydraulic formulae can be directly used in the design of sewerage system and treatment plants. Advantages • It is a hygienic and decent system • The sewage is properly treated and then disposed. • No chances for ground water pollution • No involvement of human agency in the collection, conveyance and disposal Disadvantages • Initial cost is high. • It may require pumping of sewage at certain stages • It requires skilled supervision and maintenances	3 3 2	8	
VIII b.	• To provide hygienic and aesthetic environment • To collect and treat the sewage in a scientific way so as to avoid the nuisance to public and also pollution of environment. • To dispose the treated sewage by proper methods to avoid pollution of surface and ground water sources • To prevent occurrence and spread of water borne diseases. • To take out all kinds of wastewater from the locality immediately after its use, so that mosquitos, files, bacteria etc. may not breed in it and cause nuisance. • To effectively drain away storm water from the town and thus avoiding inundation. • As far as possible the fertilizing elements of sewage may be used in growing crops through farming and getting some income in addition to the disposal of sewage • In unsewered areas, the treatment of sewage from individual houses, should be done by septic tank or other suitable means and the effluent should be disposed of. • If the sewage is disposed of on land, it should have such degree of treatment that it may not affect the sub-soil in anyway	Any 7 points	7	15
IX a	The Imhoff tank was developed to correct the two main defects of the septic tank. It prevents the solids once removed from the sewage from again being mixed with it, but still provides for the decomposition of these solids in the same unit. It provides an effluent amenable to further treatment. Contact between the waste stream and the anaerobic digesting sludge is practically eliminated and the holding period in primary settling compartment at the tank is reduced. The Imhoff tank may be either circular or rectangular and is divided into three compartments: the upper section or sedimentation compartment,the lower section known as the digestion compartment and the gas vent and scum section	6	7	

		1		
IX b	• It is constructed in excavation in earth. • Normally constructed with rectangular plan with a depth of 0.5 m to 0.75m. • It is filled with filtering material consist of sand with uniformity co-efficient 2 to 5. • Bed of filter is provided with a gentle slope towards drain system. • The effluent from primary sedimentation tank is applied on to the filter intermittently by means of dosing tank. • Solids are trapped in sand and aerobic bacterial film developed on the surface of grains and get oxidized. • Continuous operation leads to clogging of filter and it should be periodically cleaned	6	8	15
	 L-SECTION  PLAN 1. SYPHONIC DOSING TANK 2. DISTRIBUTORY PIPES 3. OUTLET FOR EFFLUENT 4. EFFLUENT PIPE 5. SYPHON PIPE 6. UNDER DRAINE 7. SANDBED	2		
X a	• Prevents Water Damage: A properly functioning drainage system effectively removes excess water from the building, preventing water damage to the structure, foundations, walls, and interior spaces. It helps avoid issues like leaks, dampness, mold growth, and deterioration of building materials. • Minimises Health Risks: Efficient drainage systems ensure the prompt removal of wastewater, reducing the risk of stagnant water			

	accumulation and the associated health hazards. Preventing waterborne diseases and the growth of bacteria and fungi helps maintain a healthy and safe indoor environment. • Reduces the Risk of Flooding: Adequate drainage systems efficiently manage stormwater runoff, preventing flooding around and within the building. This protects the property, occupants, and belongings from water-related damages caused by heavy rainfall or other external factors. • Maintains Structural Integrity: By controlling the water table and preventing water accumulation in the soil surrounding the building's foundation, a well-designed subsoil drainage system helps maintain the structural integrity of the building. It minimises the risk of soil erosion, foundation settlement, and potential damage to the building's stability. • Improves Aesthetics and Landscaping: Proper drainage systems in outdoor areas, such as gardens, courtyards, and parking lots, prevent standing water, soil erosion, and muddy conditions. This contributes to a more visually appealing environment, enhances landscaping possibilities, and ensures safer and more accessible spaces for building occupants. • Enhances Longevity and Value: An effective drainage system helps protect the building's infrastructure, materials, and systems from water-related deterioration. Minimising damage and maintaining the building's condition can contribute to its longevity and retain or enhance its value over time.	7	7	15
X b	• The wastewater forms three layers inside the tank. Solids lighter than water (such as greases and oils) float to the top forming a layer of scum. Solids heavier than water settle at the bottom of the tank forming a layer of sludge. This leaves a middle layer of partially clarified wastewater. • Heavy solids settle at the bottom of the tank, where the organic fraction will decompose following anaerobic pathway in about 30 to 50 days. • The digested sludge is stored at the bottom of the tank upto the end of cleaning period and then removed through man hole. The cleaning operation is very important for the efficient functioning of septic tank. • Every septic tank should be provided with the ventilation pipe with the top of the pipe covered with suitable mosquito proof wire mesh. • The top of the pipe should extend to at least 2 m above the highest building height present in the vicinity of 20 m from the septic tank. 	6 2	8	

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BLUE PRINT

Sl No	Module	Type of Questions							
		Part A		Part B		Part C		Total	
		No of Questions	Score	No of Questions	Score	No of Questions	Score	No of Questions	Score
1	Module 1	1	2	2	12	4	30	7	44
2	Module 2	2	4	2	12	4	30	8	46
3	Module 3	1	2	1	6	4	30	6	38
4	Module 4	1	2	2	12	4	30	7	44
TOTAL		5	10	7	42	16	120	28	172

Signature: 

Name: Renju. A.J

Designation: Lr. in Civil Engg.

Institution: MVGM GPC Vennikulam

QUESTION WISE ANALYSIS

COURSE: Environmental Engineering
VERSION: Revision(15) 6012

Qn No	Specific Outcome (as per syllabus)	Module	Content Details	Score
			Part-A	
1	1.2.0	1	Understand the method of determining yield from surface and underground sources for a water supply scheme.	2
2	2.1.6	2	Identify the different forms and points of chlorination	2
3	2.3.2	2	Explain with sketches the different layouts of distribution system	2
4	3.1.1	3	Define terms: Sewage, Sewerage, Sewer, refuse, sullage, and garbage	2
5	4.1.0	4	Understand the primary and secondary treatment of sewage	2
			Part-B	
1	1.3.2	1	List the requirements of water for various purposes:	6
2	1.2.6	1	Explain procedure for determining yield of well by pumping tests	6
3	2.1.2	2	List the objects of aeration	6
4	2.2.5	2	State the causes and prevention of pipe corrosion.	6
5	3.2.1	3	Define strength of sewage	6
6	4.1.4	4	Describe with sketch the following treatment works: Activated sludge process	6
7	4.4.0	4	Understand the working of pollution control boards	6
			Part-C	
III a	1.2.7	1	Explain with sketches: Infiltration galleries, Infiltration Wells	7
III b	1.3.5	1	Solve simple problems on forecasting population by different methods	8
IV a	1.4.1	1	State the need for laboratory tests for testing water	7
IV b	1.3.4	1	Describe methods to forecast population.	8
V a	2.3.2	2	Explain with sketches the different layouts of distribution system	8
V b	2.1.3	2	Explain the process of aeration, plain sedimentation by coagulation, filtration	7
VI a	2.1.5	2	Explain the necessity and methods of disinfection of water	7
VI b	2.1.4	2	Describe the construction and operation of slow sand,	8
VII a	3.3.2	3	Explain the component parts of a pumping station and factors influencing its loc	9
VII b	3.3.3	3	Identify the location, function and construction of various sewer appurtenances	6
VIII a	3.1.3	3	Compare conservancy system with water carriage system	8
VIII b	3.1.5	3	Compare the systems of sewerage with each other	7
IX a	4.1.5	4	Explain with sketches the disposal of sewage by Imhoff and septic tanks	7
IX b	4.1.4	4	Describe with sketch the following treatment works: Sedimentation tank, Contact beds, Intermittent sand filters,	8
X a	4.2.1	4	State the aims of buildings drainage and its requirements	7
X b	4.1.5	4	Explain with sketches the disposal of sewage by Imhoff and septic tanks	8

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