TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2079 Jestha

Exam.	Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Sanitary Engineering *(CE 656)*

- Candidates are required to give their answers in their own words as far as practicable.
- *Attempt **All** questions.*
- *The figures in the margin indicate **Full Marks**.*
- *Assume suitable data if necessary.*

1. Briefly explain the methods management of wastewater and solid waste produced in the society. [4]
2. Define dry and wet weather flow. Discuss the factors affecting storm water. [1+1+2]
3. Propose the diameter and slope of a concrete sewer to carry runoff within its 0.7 depth at peak condition. The catchment area to be served is of 225 hectares with an overall coefficient of runoff of 0.35 and a time of concentration of 60 minutes. The velocity in the sewer is to be maintained as 1.3 m/s at peak flow. Assume Manning's coefficient as 0.013. [8]
4. Why is flushing necessary in sewers? With a neat sketch describe an automatic sewer flushing tank. [1+3]
5. How do you determine BOD of a sewage sample in laboratory from the dilution method? If 4 day BOD of a sewage sample at 20°C is 300 mg/l and K_{20} = 0.1/day, what will be its 7 day BOD at 25°C? [4+4]
6. Determine the degree of treatment required to reduce BOD containing in the sewage. The characteristics of raw sewage and a nearby river in which the sewage is discharge are as follows: [8]
   a) Sewage discharge = 1.7 m^3/s
   b) BOD_5 at 20°C of sewage = 230 mg/l
   c) Minimum river discharge = 7.5 m^3/s
   d) BOD_5 at 20° of river water = 1.2 mg/l
   e) Temperature of the river after mixing = 20°C
   f) De-oxygenation constant = 0.1/day at 20°C
   g) Re-oxygenation constant = 0.4/day at 20°C
   h) Initial DO deficit just at mixing = 2.0 mg/l
   i) Critical DO deficit = 4.7 mg/l
7. What is wastewater treatment? What are its objectives? Enlist the commonly used treatment processes with their specific impurity removal abilities. [1+3+4]
8. Calculate the depth and diameter of a secondary filter of a double stage trickling filter treating sewage of 2 MLD at a recirculation ratio of 2:1. The BOD_5 of the influent sewage to first filter is 170 mg/l and final effluent BOD_5 should be less than 30 mg/l. Take efficiency of first stage filter as 70%. Assume the organic loading in the filter as 8000 kg BOD_5/ha-m/day. [8]

9. Design the aeration tank for a conventional activated sludge treatment plant to treat domestic sewage with an average flow of 15 MLD considering the following data:
   BOD of settled sewage = 200 mg/l; F/M = 0.25/d; MLSS = 3000 mg/l; ML VSS/MLSS = 0.8 and SVI = 100 ml/g [8]

10. A PST sludge only containing fixed solids of 4000 kg/d having moisture content of 60% and specific gravity of 2.6 is mixed with SST sludge only containing volatile solids of 1500 kg/d having moisture content of 95% and specific gravity of 1.2. The mixture is then conveyed in an anaerobic digester for 35 days digestion. Determine the volume of digester. Assume linear digestion and neglect the monsoon requirements. [8]

11. Define onsite and offsite sanitation. With a neat sketch, describe pit latrine. What are its advantages and disadvantages? [2+4+2]

12. Why is separation of organic part from solid waste necessary for composting? Describe open windrow composting method of solid waste disposal. [1+3]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2079 Jestha

Exam.	Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Sanitary Engineering *(CE 656)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
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- ✓ *Assume suitable data if necessary.*

1. Briefly explain the methods management of wastewater and solid waste produced in the society. [4]
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4. Why is flushing necessary in sewers? With a neat sketch describe an automatic sewer flushing tank. [1+3]
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   d) BOD_5 at 20° of river water = 1.2 mg/l
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7. What is wastewater treatment? What are its objectives? Enlist the commonly used treatment processes with their specific impurity removal abilities. [1+3+4]
8. Calculate the depth and diameter of a secondary filter of a double stage trickling filter treating sewage of 2 MLD at a recirculation ratio of 2:1. The BOD_5 of the influent sewage to first filter is 170 mg/l and final effluent BOD_5 should be less than 30 mg/l. Take efficiency of first stage filter as 70%. Assume the organic loading in the filter as 8000 kg BOD_5/ha-m/day. [8]

9. Design the aeration tank for a conventional activated sludge treatment plant to treat domestic sewage with an average flow of 15 MLD considering the following data:
   BOD of settled sewage = 200 mg/l; F/M = 0.25/d; MLSS = 3000 mg/l; ML VSS/MLSS = 0.8 and SVI = 100 ml/g [8]

10. A PST sludge only containing fixed solids of 4000 kg/d having moisture content of 60% and specific gravity of 2.6 is mixed with SST sludge only containing volatile solids of 1500 kg/d having moisture content of 95% and specific gravity of 1.2. The mixture is then conveyed in an anaerobic digester for 35 days digestion. Determine the volume of digester. Assume linear digestion and neglect the monsoon requirements. [8]

11. Define onsite and offsite sanitation. With a neat sketch, describe pit latrine. What are its advantages and disadvantages? [2+4+2]

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2079 Ashwin

Exam.		Back	
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Sanitary Engineering *(CE 656)*

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- ✓ *Attempt **All** questions.*
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[8]

1. Define Sanitary Sewage. Justify to adopt the separate system of sewage. [4]
2. Define Dry Weather Flow (DWF) and discuss in brief about the key factors affecting DWF. [4]

[8]

3. Calculate the diameter of a sewer to serve an area of 1200 hectares with a population density of 300 persons per hectare. The average rate of sewage flow is 250 lpcd. The coefficient of runoff for 60% farthest area is 0.4 and rest of the area is 0.8. Time taken to reach storm water inlet from farthest point of catchment is 30 min. Assume storm duration = 25 min and Manning's 'n' as 0.012. [8]

[2+4+2]

[1+3]

4. Describe about a drop manhole with a neat sketch. [4]
5. Discuss about BOD and COD with respect to its significance. Calculate the ultimate BOD if 5 day BOD of sewage sample at 25° is given as 500 mg/l. [4+4]
6. In a town, the treated domestic sewage is to be discharged in a natural stream. Determine the percentage purification required in the treatment plant with following data. [8]

   Population = 40,000
   BOD contribution per capita = 0.075 kg/day
   BOD at upstream side = 2 mg/l
   DO to be maintained in downstream side = 5 mg/l
   Domestic sewage production rate = 80 lpcd
   Minimum discharge of stream = 0.3 m^3/sec
   Rate Constants (Base 10), K_1 = 0.1/day, K_2 = 0.5/day

7. a) Design grit chamber to treat peak design flow of 150 Mld (3 x average sewage flow of 50 Mld) of sewage to remove grit particles upto a size of 0.15 mm and of specific gravity 2.65. The minimum temperature is 15°C. The grit chamber is equipped with proportional flow weir as control device. Take $\upsilon = 1.141 \times 10^{-6}$ m^2/s at 15°C. [8]

   b) Calculate the effluent BOD_5 of a two stage trickling filter with the following flows, BOD_5 and dimensions, using NRC formula: Q = 5000 m^3/day, BOD5 = 300 mg/l, volume of primary filter = 1200 m^3, volume of secondary filter = 1000 m^3, filters depth = 2 m, recirculation ratio for primary filter = 1.5 and recirculation ratio for secondary filter = 1.25. [8]

8. Briefly illustrate about oxidation pond including role of algae. State the procedure to design it with an example. [4+4]
9. List and the methods of sludge treatment and describe briefly about any two of the method. [8]
10. a) Calculate size of septic tank and soak pit for a residential facility in an academic institution with 200 users. For septic tank, consider sludge digestion rate of 0.0425m^3/person and volume required for storage of digested sludge 0.0708m^3/person for 2 years cleaning period. [8]

    b) Describe the method sanitary landfilling for solid waste disposal. [4]

TRIBHUVAN UNIVERSITY
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Examination Control Division
2078 Chaitra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Sanitary Engineering *(CE 656)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
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- ✓ *Assume suitable data if necessary.*

1. Define sewerage system and recommend a suitable type of sewerage system for highly populated city with justifications. [4]
2. List out potential sources of sanitary sewage and discuss briefly about key factors affecting quantity of sanitary sewage. [4]
3. Calculate the diameter of a circular sewer laying at a slope of 1:150 when it is running just fall with a discharge of 1.6 m^3/sec. and Manning's coefficient, 0.013. Also, determine the discharge capacity if it is permitted to flow half full with the same gradients. [8]
4. Define sewer appurtenances. Justify the need of installation of sewer appurtenances with suitable examples. [4]
5. Discuss first-stage and second stage BOD with a suitable figure. Calculate ultimate BOD if 5 day BOD of sewage sample at 20°C is 400 mg/l. [8]
6. a) A wastewater treatment plant dispose of its effluents into a stream at a point A. The characteristics if effluents and stream water are given below.

Item	Effluent	Stream
Flow (m^3/s)	0.18	0.46
DO mg/lit	1.5	8.3
Temp (°C)	25	22
BOD at 20°C mg/lit	32	2

Assume that deoxygenating constant K' at 20°C (base e) = 0.2 /day and oxygenation constant R' (base e) = 0.4 /day for the mixture. Equilibrium of dissolved oxygen for fresh water is as follow:

Temp(°C)	18	20	22	23	24	25	26
DO mg/lit	9.54	9.17	8.99	8.83	8.53	8.38	8.22

The velocity of the stream D/S of the point A is 0.16 m/sec. Determine the critical oxygen deficit and its location. [8]

b) The effluent from PST is applied to a standard rate trickling filter at the rate of 3 million liters/day with BOD_5 300 mg/l. Calculate the depth and volume of filter considering the surface loading of 3000 liters/m^2day and organic loading of 300 gm/m^3day. [8]

7. Describe the fundamentals on removing dissolved carbonaceous substance in the Activated Sludge Process (ASP). Also, justify the need of sludge re-circulation in the ASP with suitable examples. [8]

8. Design a grit chamber for wastewater flow of 190 liter/sec with surface overflow rate = 2cm/s and detention time = 60 sec. Take specific gravity of organic and inorganic particles are 1.2 and 2.65 respectively. Assume size of both organic and inorganic materials as 0.21 m. Take k = 0.06 and f = 0.03.

9. Determine the sludge volume before and after digestion and percentage reduction for 600 kg (dry basis) of primary sludge having following characteristics:

	Primary Sludge	Digested Sludge
Solids (%)	6	12
Volatile Matter (%)	65	Digested removes 65% of volatile matter.

Take specific gravity of volatile and fixed solids 1.0 and 2.5 respectively for both primary and digested sludge. [2+

10. a) Describe in brief about the purpose and design criteria of pit privy. Also, with a neat sketch, discuss the suitable disposal of septic tank effluent for the rocks area with high ground water table.

b) Discuss in brief about open dumping and sanitary landfill.

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TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2078 Poush

Exam.	Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Sanitary Engineering *(CE 656)*

- Candidates are required to give their answers in their own words as far as practicable.
- *Attempt **All** questions.*
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1. What are positive and negative aspects of wastewater management practice in context of Nepal. What could be possible way outs for improvement? [2+2]
2. As a designer for a highly populate urban area how would you determine quantity of storm water? Discuss in detail. [4]
3. What are non-silting and non-scouring velocities? Calculate the velocity and discharge of flow if a circular concrete storm drain with 0.8 m diameter having 80% flow depth at maximum condition and laid at 1:200 slope. Consider manning coefficient of drain is 0.012. [8]
4. Why are manholes important in sewer lines? What are components of manholes? Draw neat sketches of manholes showing components in detail. [8]
5. Explain BOD with its significance. How do you perform BOD test in laboratory from dilution method? [4+4]
6. The characteristics of putrefied sewage and river are given as: [8]
   a) sewage discharge of town = 1.72 m^3/s
   b) river discharge = 7.24 m^3/s
   c) temperature of sewage and river = 30.5°C and 17.5°C respectively
   d) Deoxygenation and reoxygenation constants = 0.1/day and 0.5/day respectively at 20°C
   e) BOD_5 at 20°C of sewage and river = 225 mg/l and 1.2mg/l respectively
   f) DO of river water is 90% of saturation value
   g) Saturation of DO of water at 20°C is 9.17 mg/l and at 17.5°C is 9.64
   h) Average velocity of river water is 2 km/hr.

   Calculate critical oxygen deficit, its location (downstream in km) and DO that place. Estimate the BOD of river at the same location.
7. Calculate the size of grit chamber to treat wastewater with 20 MLD at 20°C to remove 0.2 mm size having specific gravity of 2.65. [8]
8. Determine the dimensions of high-rate trickling filter with sewage flow of 4 MLD, recirculation ratio 1.5, BOD of raw sewage 300 mg/l, BOD removal in primary settling tank 30% and final effluent BOD required is 25 mg/l. [8]
9. Design an oxidation pond to treat 300 m^3/d of sewage from a community with permissible organic loading of 450 kg/ha/d. The influent BOD is 250 mg/l and the efficiency of the pond is maintained to be 90%. [4]
10. Describe aerobic and anaerobic digestion of sludge. Design a sludge digestion tank for treating sludge with following data: [3+5]
    a) Water content of fresh sludge = 95%
    b) Water content of digested sludge = 87%
    c) Digestion period = 30 days
    d) No monsoon requirements
    e) Fresh sludge form PST ans SST going to digestion tank is 90 m^3/d
    f) Assume necessary data.
11. Explain about VIP latrine with its neat sketch. Describe about the soak pit with its design criterias and figure for a family having 20 persons in a hill area. [4+4]
12. Describe the methods of composting for solid waste disposal. [4]

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TRIBHUVAN UNIVERSITY
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Examination Control Division
2078 Baishakh

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Sanitary Engineering *(CE 656)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt All questions.*
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1. What is sewer and sewage? Why is the sewage disposal needed in today's civilizations? [2+2]
2. Describe briefly the conservancy and water carriage system of sanitation. When is it necessary and useful to employ separate system of sewerage? [2+2]
3. Determine the design discharge for a combined sewer to convey sewage from an overall area of 300 hectares with a water supply rate of 100 lpcd and a peak factor of 2.5. The projected population of the area is 50000 numbers and only 85% of water supply contributes for the sewage. The 40% of the area has a runoff coefficient of 0.9, next 30% has 0.8 and remaining has 0.7. The time of concentration is assumed to be 90 minutes. [4]
4. What is sampling? What does BOD in sewage mean? In a test, 10ml of raw sewage sample is pipetted out into a 300ml BOD bottle and is filled with distilled water. The DO test reveals 9mg/l that day and after 5 days incubation at 20°C, it was found to be 2mg/l. Calculate the BOD_5 of raw sample. Also determine Ultimate BOD of that raw sample at 20°C if K (base e) is 0.23/day. [1+1+6]
5. Design a sewer for a town having population of 75000 persons with an average sewage flow rate of 200 lpcd and a peak factor of 3 running 0.6 times full at maximum discharge. The sewage is laid on a slope of 1 in 450 and has Manning's coefficient of 0.012. Also check velocity only at the peak conditions. [8]
6. Explain street inlets with neat sketch? Where are these located? Differentiate between a curb inlet and a gutter inlet. [1+1+1+1]
7. A large city is discharging 120 m^3/s sewage in to a perennial river which is 90% saturated with O_2 and flows at a minimum rate of 1500 m^3/s with a velocity of 0.12m/s. If the 5 day BOD of sewage is 280 mg/l, find out where the critical dissolved oxygen will occur in the river. Assume

   (i) Coefficient of purification of the river is 0.4.
   (ii) Coefficient of DO as 0.1d
   (iii)Ultimate BOD as 120% of 5 day BOD mixture of sewage and water
   (iv)Dissolved oxygen in saturation at 20°C is 9.17mg/l.
   (v) No dissolved oxygen is left in the effluent

   Assume any other data f necessary. [8]
8. Design a horizontal flow rectangular grit chamber for removing grit size of 0.2mm having a specific gravity of 2.65 from average wastewater flow rate of 0.3m^3/s, a peak factor of 3 and temperature of 28°C. The specific gravity of organic particles can be taken as 1.2. [8]

9. Design a 2 stage high rate trickling filter with its organic loading rate of 0.8 kg$BOD_5/m^3/d$ for a sewage of BOD_5 260mg/l for an average flow of 60 Mld and desired effluent BOD_5 is 30mg/l. Assume necessary data. [8]

10. Design an oxidation pond for a domestic wastewater with a BOD of 250 mg/l generated from a community situated in the semi-urban area of Bhaktapur for a population of 25000 numbers to obtain permissible BOD of 25mg/l. The maximum and minimum operation temperature of the pond in the coldest month is 24 and 8°C respectively. [8]

11. Discuss about volume moisture content relationship in sludge. Calculate the specific gravity of sludge considering 25% of solid matter in a sludge containing 95% water is composed of fixed mineral solids with specific gravity 2.65 and 75% is composed of volatile solids with specific gravity 1.0. [8]

12. Design a septic tank and soak pit to dispose wastewater with an average flowrate of 95 lpcd generating from a rural household with 12 persons. The sludge from septic tank is cleaned once in 3 years, the percolation rate of surrounding soil as 30 minutes/cm and GWT is 4m below the ground surface. [5+3]

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2077 Chaitra

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Year / Part	III / II	Time	3 hrs.

Subject: - Sanitary Engineering *(CE 656)*

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1. What is the major difference between conservancy and water carriage systems of sanitation? Why water carriage system is preferred in the disposal of sewage? Justify your answer. [1+3]

2. State the factors influencing the discharge of sanitary sewage. What are the sources of sanitary sewage? [2+2]

3. A small town of population 500 with water supply of 160lpcd. Town covers about 1.5 hectares and has a maximum rainfall intensity of 50mm/hr. Roughly 40% is occupied by roofs and pavements of C=0.8 and 60% of lawn and gardens of C=0.2. Calculate the discharge of sewage out of the town in wet weather conditions if combined sewer is adopted. (C is coefficient of runoff) [4]

4. If 1 day BOD of sewage sample at 20°C is 300 mg/l, what will be its 5-day BOD at 30°C. Consider rate constant of 0.1/day (base 10) at 20°C. [4]

5. A city is discharging sewage of 50 l/s in the river having discharge of 500 l/s and a velocity of 48 km/day. The 5-day BOD of sewage and river water are 400 mg/l and 4mg/l respectively. The DO of sewage is zero. The DO in the river is 80% of saturation value. Saturation DO at 20°C is 9.17 mg/l. Consider deoxygenation constant (K) as 0.1/day (base 10) and reaeration constant (R) as 0.5/day. Calculate the time of critical DO deficit. [8]

6. What are street inlets? With neat sketches describe different types of street inlets. [1+3]

7. Design a rectangular grit chamber for maximum wastewater flow for 10Mld to remove particles up to 0.2mm diameter having sp.gr. 2.65. Settling velocities of grits is found to be 0.02m/s in average and maintain a flow velocity of 0.3m/s constant through a flow weir. [8]

8. A sewage having BOD of 200mg/l is fed to a two stage trickling filter with a flow of 4 million liters per day. The BOD required in the final effluent is ≤ 30mg/l. The efficiency of the first stage trickling filter is 2 times the efficiency of the second stages trickling filter. If depth and recirculation ration of both the first stage and second stage trickling filters are 1.2m and 2 respectively, determine the diameters of the first stage and second stage trickling filters. [8]

9. What is activated sludge processes and how does it works, explain with flow diagram? What are its advantages and disadvantages? [4+4]

10. Briefly illustrate about oxidation pond. With suitable example, state its procedure to calculate its area. [4+4]

11. If you are asked to design septic tank and soak pit for a hostel with 400 users, calculate sizes. For septic tank, consider sludge digestion rate of 0.0425 m^3/person and volume required for storage of digested sludge 0.085 m^3/person for 3 years cleaning period. [8]

12. a) Calculate detention time and dimension of an oxidation pond for a town in Terai Region of Nepal with the following data: Draw neat sketch with necessary components showing buffer zone and detail dimensions as designed. [8]

    Population = 12,000
    Sewage flow = 100 lpcd
    BOD of incoming sewage = 250 mg/l
    Assume operational depth at 1.1m

    b) Explain about the solid waste disposal by incineration along with its merits and demerits. [4]

07 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Sanitary Engineering *(CE656)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
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1. Which type of sewerage system do you recommend in your locality? Discuss briefly with your justifications. [4]
2. Describe that time of concentration is an important while determining storm water discharge. Elaborate on time of concentration and time area graph. [4]
3. A sewage carries runoff water to its 0.6 depth at maximum flow which is entering from the catchment area of 200 hectare having overall coefficient of runoff as 0.45 and time of concentration of 55 minutes. The velocity in the sewer is to be maintained as 1.5 m/s at peak flow. Determine the diameter and slope of the cement concrete sewer with Manning's coefficient as 0.013? [8]
4. Why grease and oil should be excluded from wastewater? Explain the principle of working of a sand, grease and oil rap with neat sketch. [1+3]
5. Show the effect of temperature on decomposition rate of organic matters in waste water. If one day BOD of a sewage sample at 20°C is 100 mg/l, what will be its five day BOD at 20°C? Consider $K_{20} = 0.1$/day. [8]
6. An industry is going to be established in a rural municipality near to the river side. The river water and industrial effluent characteristics are as follows: [8]

Description	Industrial Effluent	River Water
Flow (m3/sec)	2.0	20.0
Dissolved Oxygen (mg/l)	0.8	7.14
BOD5 at 20°C (mg/l)	350	3.0
De-oxygenation rate constant at 20°C (per day, base 10)	0.1	
Re-oxygenation rate constant at 20°C (per day, base 10)	0.3	
Saturation DO at 20°C (mg/l)	9.17	

At what location in the river, the critical DO deficit would occur if the flow velocity in the river is 2 km/hr?

7. a) Design a grit chamber to remove grit size of diameter more than 0.2 mm present in 58 MLD of sewage at a temperature of 25°C. Assume specific gravity of grit and organic matters as 2.65 and 1.2 respectively. Adopt k = 0.06 and f = 0.03 to calculate critical velocity. [8]

   b) Design a conventional activated sludge treatment plant to treat the domestic sewage with diffused air aeration with the following data. (Design up to dimensions of aeration tank only) [8]

      Population = 50,000

      Per capita sewage flow = 80 liters/day

      Settled sewage BOD_5 = 200 mg/L

      Food/micro-organisms = 0.3

      Concentration of microorganisms (MLSS) = 2000 mg/L

   c) Calculate the effluent BOD of a two stage trickling filter with the following data: [8]

      i) Sewage flow = 5 MLD

      ii) Influent BOD in first tricking filter = 350 mg/l

      iii) Volume of first filter = 650 m^3

      iv) Volume of second filter = 450 m^3

      v) Recirculation ratio for both filters = 2.0

8. What is sludge digestion? Explain the periods during sludge digestion and the factors affecting the digestion process. [2+6]

9. A household having 22 persons produces 135 liter/person/day of sewage. Design a septic tank and drain field to dispose the sewage in a soil having infiltration rate of 35 liters/m^2/day. Assume that the septic tank is cleaned once in three years. [8]

10. Describe the methods of composting for solid waste management and its merits and demerits. [4]

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06 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2075 Baisakh

Exam.	Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Sanitary Engineering *(CE656)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
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- ✓ *Assume suitable data if necessary.*

1. Describe the methods used in the management of wastewater and solid waste producing from a locality. [5]
2. Describe the method of estimating quantity of sewage for a city in Nepal in detail. [6]
3. Determine the size of combined circular sewer for a discharge of 1.5 m^3/s running half full. Assume a gradient of 1 in 2000 and Manning's rugosity coefficient N = 0.013 (Constant for all Flows). In the dry season if the flow drops to 0.50 m^3/sec, does the flow maintain desired self cleaning velocity of 0.60m/sec. [8]
4. Define manhole. Explain the construction of manhole with the help of neat sketch. [1+4]
5. 5 ml of a sewage sample taken under the Thapathali bridge of Bagmati river was pipetted into a 300 ml capacity BOD bottle which was then completely filled with dilution water. The DO concentration of this mixture is tested and found to be 9.2 mg/l. Now it is kept in the incubator maintained at 25°C for a period of 7 days. The DO concentration after incubation is found to be 5.3 mg/l. Adopting base 10 value of K as 0.1/d, determine the 4 day BOD of sewage at 30°C in Bagmati river at that particular location. [8]
6. A city discharges sewage at the rate of 1200 l/s, into a stream whose minimum flow is 5000 liters/sec, the temperature of both being 20°C. The 5 day BOD at 20°C for sewage is 160mg/l and that of river water is 2mg/l. The DO Content of sewage is zero while that of stream is 90% of the saturation DO. Find out the degree of treatment required if the minimum DO to be maintained in the stream is 4 mg/lit. Assume deoxygenation coefficient as 0.10 (base 10) and re-oxygenation coefficient as 0.30 (base 10). Given saturation DO at 20°C as 9.17 mg/lit. [8]
7. What is a grit chamber? Why do a sewage treatment plant need grit chamber? Enlist the considerations adopted in the design of grit chamber. [1+2+5]
8. Determine the size a high rate trickling filter for the following data: [10]

   Sewage flow = 5 Mld
   BOD of raw sewage = 250 mg/l
   BOD removal in primary clarifier = 30%
   Final effluent BOD desired = 30 mg/l
9. Design a sludge digestion tank to treat siudge of primary sedimentation tank from the following data: [8]
   a) Average flow of the sewage = 6.5 MLD
   b) Total suspended solids in raw sewage = 250 mg/l
   c) Water content of fresh sludge = 95%
   d) Water content of digested sludge = 85%
   e) Specific gravity of sludge = 1.02
   f) Digestion period = 2 months
   g) Primary settling tank removes 55% of suspended solids
10. Design VIP latrine and septic tank for a family of 10 users. The detention time for septic tank is 24 hr. Sludge is cleaned in every three years. [8]
11. Explain sanitary land fill[illegible]

06 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2074 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Sanitary Engineering *(CE656)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. What do you mean by sanitation? How it is related with our human life? Why water-carriage system of sanitation is popular than conservancy system nowadays. [4]
2. As a sanitation engineer how would you determine the quantity of storm water for a highly populated urban area? What type of limitations exists in storm water quantity determination for such area? Discuss in detail. [4]
3. What would be your preferable combined sewer section for an 85-hectare residential area having average runoff coefficient of 0.45 for serving altogether 1500 population? average rainfall duration is 26-min. Self-cleansing velocity is 0.98 m/sec. residential area have average elevation difference of 22m in horizontal 5 km longitudinal distance. Assume any other appropriate data if required. [8]
4. Briefly describe drop-manhole with neat sketch mentioning its importance and discuss its alternative structural option with applicability. [4]
5. $BOD_{1,22°C}$ of a sewage sample is 310 mg/l. What will be its $BOD_{5,30°C}$? Assume reaction rate $K_{20} = 0.12$ per day. [8]
6. You are assigned by an industry as a Sanitary Engineer to recommend the degree of treatment required for their industrial waste water. The effluent from the treatment plant is to be discharged into a river with a minimum flow of 5000 lps, a dissolved oxygen content of 7.4mg/l and BOD of zero. In order to thrive aquatic life, it is necessary to maintain a minimum DO content of 4mg/l in the river. A sanitary reveals the characteristics of industrial waste water as follows: [8]

   Discharge = $2*10^6$ l/day
   BOD = 5000 mg/l
   DO = 0

   Recommend the degree of treatment required for the plant. Assume saturation DO of 9.2 mg/l in the river after mixing with wastewater. It is equal to DO content of river before mixing. Assume any other appropriate data if required.
7. a) With neat sketches, describe the purpose and construction of a skimming tank. [4]
   b) If the effluent BOD is to be equal to or less than 35 mg/l, what will be the recirculation ratio required of a single high rate trickling filter having volume of 510 m^3 which receives a flow of 2.8 MLD. The raw sewage has BOD of 210 mg/l. The primary treatment removes 20% BOD. [8]

c) What will be the suitable dimensions of a circular sewage sedimentation tank for an industrial area having population of 5500? The average water demand is 180 lpcd. Assume that 75% water reaches the treatment plant and maximum demand is 2.4 times average demand. Dimension of the suspended silica particles available in influent water are larger than 0.14 mm. [8]

d) What are the advantages in using the dorrco aerator in activated sludge process method; briefly describe its operation with neat sketch. [4]

8. The biological process occurs in trickling filter. PST removes 60% suspended solids and 30% of BOD. Determine the volume of sludge produced by PST as well as SST with the following data. [8]

Sp. gr. of inorganic solids	= 2.65,	Sp. gr. of organic solid	= 1.02
Flow of sewage	= $20*10^6$ l/d	BOD_5 of sewage	= 220 mg/l
Suspended solids in the sewage	= 280mg/l	Water content of the sludge	= 95%

9. What would be the internal dimension of a septic tank and numbers of soak pits for an isolated hotel situated at mid-southern zone of Nepal having average 80 numbers of average users? Rate of sewage discharge is 210 lpcd. Cleaning period of septic tank is 3 years. Assume other necessary data if required. [8]

10. Discuss about the solid waste composting and its methods? [4]

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06 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Magh

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Sanitary Engineering *(CE656)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Which type of sewerage system do you recommended for urban area of Nepal? Discuss briefly with your justification. [4]
2. How do you determine the quality of storm water for a locality? [4]
3. Calculate the diameter of a sewar to surve an area of 12 sq.km with a population density of 250 persons per hectare. The average rate of sewage flow is 235 lpcd. The coefficient of runoff for 50% farthest area is 0.3 and rest of the area is 0.75. Time taken to reach storm water inlet from the farthest point of the catchment is 25 min. Assume storm duration = 20 min and n = 0.013 [8]
4. Explain sand, grease and oil trap with the help of neat sketch. [4]
5. Why BOD value is important for waste water? Describe the procedure for determining BOD of waste water sample in laboratory by dilution method. [8]
6. The treated domestic sewage of a town is to be discharges in a natural stream. Calculate the percentage purification required in the treatment plant with the following data: [8]

   Population = 50000
   BOD contributed per capita = 0.07 kg/day
   BOD of stream on U/S side = 3 mg/lit
   DO to be maintained in D/S = 5 mg/lit
   Domestic sewage = 140 lpcd
   Lean period discharge of stream = 0.13 m^3/sec

   Assume, rate constants K_1 = 0.1 per day, K_2 = 0.5 per day and stream with a saturation DO as 9.17 mg/lit

7. a) In a continuous flow sedimentation tank, 4 m deep, 60 m long, if flow velocity of sewage is observed as 1.20 cm/sec, what size of particles with specific gravity 2.65 may be effectively removed? Assume 25°C temperature and kinematic viscosity of water is 0.01 cm^2/sec. If the particle size is half, determine the change in % of particles removed. [8]

   b) What will be the recirculation ratio required of a single stage filter having volume of 350 m^3. A effluent having maximum BOD concentration of 35 mg/lit, for a flow sewage of 5 MLD having BOD of 180 mg/lit and 33% BOD is removed in PST. [8]

   c) With the neat sketch, describe the purpose and location of skimming tank. Explain the factors govern the degree of treatment required of municipal wastewater. [8]
8. Discuss about volume moisture content relationship in sludge. Calculate the specific gravity of sludge considering 20% of solid matter in a sludge containing 95% water is composed of fixed mineral solids with specific gravity of 2.65 and 80% is composed of volatile solids with specific gravity 1.0. [8]
9. a) What is the purpose of pit privy? Describe the construction of pit privy with a neat sketch. [4]
   b) Design a septic tank for a household having average users of 15. Assume suitable data suitably. [4]

06 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2073 Bhadra

Exam.	Regular		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Sanitary Engineering *(CE656)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Why scientific management is necessary for wastewater and solid waste produced in community? Enlist the objectives of the sewage disposal. [1+3]
2. What are various factors affecting the discharge of sanitary sewage? How do you calculate sanitary sewage discharge? [4]
3. What will be the diameter of a circular concrete sewer carrying 2/3rd depth at the peak discharge of 0.70 m^3/s laid in a gradient of 1 in 1000? Also check whether it is safe for non-scouring velocity or not. Assume Manning's 'n' as 0.012. [8]
4. Explain the necessity of providing manhole in sewer line with a neat sketch. [4]
5. How do you determine the Total Solid, Total Volatile Solid, Total Fixed Solid, Settable Solid and Non-settable Solids contained in a sewage sample? [8]
6. A city is discharging sewage of 100 *l*/s in the river having discharge of 1000 *l*/s and a velocity of 60 km/day. The BOD_5 of sewage and river water are 450 mg/l and 4mg/L respectively. The DO of sewage is zero. The DO in river is 70% of saturation DO value. And, the saturation DO at 20°C is 9.17mg/l. Take deoxygenation constance (K_1) = 0.1/day (base 10) and reaeration constant (k_2) = 0.5/day (base 10). Calculate the value of critical DO deficit. [8]
7. a) Propose the dimensions of grit chamber for a sewage treatment plant with 50 MLD of sewage flow at 25°C to remove 0.2 mm size of grit having specific gravity of 2.65. The Specific gravity of organic matter is 1.02. Assume k = 0.06 and f = 0.03. [8]

   b) Design a conventional activated sludge treatment plant to treat the domestic sewage with diffused air aeration with the following data. (Design up to dimensions of aeration tank only) [8]

   Population = 1,00,000
   Per capita sewage flow = 96 liters/day
   Settled sewage BOD_5 = 200 mg/L
   Food/micro-organisms = 0.3
   Concentration of microorganism (MLSS) = 2000 mg/L

   c) What is an oxidation Pond? Explain the theory of oxidation pond with a neat sketch. Explain its commissioning methods. [1+3+4]
8. A raw sewage having suspended solids content of 220 mg/lit is passed through primary sedimentation tank at a flow of 4 MLD. The PST removes 55% suspended solids. Determine the volume of sludge produced per day if moisture content and specific gravity of sludge are 95% and 1.02 respectively. What will be the volume if its moisture content reduces to 80% after digestion? Also design a digester for sludge digestion period of 80 days. [8]
9. a) With a neat sketch, describe the suitable septik tank effluent disposal method for the area of high ground water table and for the rocky area. [4]

   b) Design a VIP latrine for a household with 10 numbers of people. Assume necessary data suitably. [4]

06 TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

Examination Control Division

2072 Magh

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Sanitary Engineering *(CE656)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. What are the favorable conditions for the adoption of separate and combined sewerage system? [4]

2. A population of 30000 is residing in a rural area of 60 hectares. If the average coefficient of runoff for this area is 0.60, time required to the entry port is 25 minutes and the time of travel from the entry port to the section of sewer under consideration for design is 5 minutes. What will be the design discharge for a combined sewer at the section to be considered if the average flow of sewage in rural is 45 lpcd and pack factor is 2.7? [4]

3. Design a sewer for separate system to carry peak flow 0.5 m^3/sec at a slope 10 in 10000. Sewer should run 0.7 times depth at peak flow. The value of n in Manning's formula is 0.012. Will the self cleansing velocity be maintained in the sewer during dry weather flow? Take peak factor = 3. [8]

4. Explain the necessity of providing drop manhole in sewer line with a neat sketch. [4]

5. a) Describe the procedure of BOD in laboratory. [4]
   b) If the 5 day BOD at 37°C is 200 mg/lit and if the rate of deoxygenation is 0.17/ day, calculate the ultimate BOD and BOD remaining after 5 days. [4]

6. What are various methods of sewage disposal? Describe with their advantages and disadvantages. [8]

7. a) What is tricking filter? Why it is used? Explain the construction of tricking filter with a neat sketch. [8]
   b) Design a sedimentation tank and oxidation pond for a town with the following data: [8]
      Population = 10,000
      Sewage flow = 100 lpcd
      BOD of incoming sewage = 250 mg/l
      BOD in the effluent of oxidation pond should be less than 30 mg/l
   c) Design a grit chamber for the following data: [8]
      Discharge = 5 MLD
      Size of the grit particles = 0.2 mm
      Sp. gravity of grit particles = 2.65 at temperature 20°C

8. Design a sludge digestion tank to treat sludge of primary sedimentation tank from the following data: [8]
   Capacity of sedimentation tank = 812.5 m^3
   Detained time in Sedimentation = 3 hrs.
   Suspended Solids in raw sewage = 250 mg/lit
   Water content in fresh sludge = 95%
   Water content in digested sludge = 80%
   Specific gravity of sludge = 1.02
   Digestion period in digester = 2 months
   Primary sedimentation tank removes 55% of suspended solids

9. Design the septic tank and dispersion trenches in Nepalese perspectives for 20 users. [8]

10. Write short notes on sanitary landfill of solid waste. What are its advantages and disadvantages? [4]

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06 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Bhadra

Exam.	Regular / Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Sanitary Engineering *(CE656)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Describe the components of solid waste management methods. [4]

2. Differentiate dry weather flow and we weather flow. Briefly describe various sources of sanitary sewage. [4]

3. Design a circular section of combined sewer from the following data: [2+6]

Area to be served = 60 ha
Population = 65,000
Maximum permissible velocity = 3.2 m/sec
Time of entry = 5 minutes
Time of flow = 18 minutes
Rate of water supply = 235 lpcd
Overall runoff coefficient = 0.55

Assume suitably any other data required.

4. Describe street inlets and catch basins with neat sketches. [4]

5. Describe briefly the physical characteristics of wastewater. How the decomposition of wastewater takes place? Explain the processes. [8]

OR

Define BOD and COD and explain their significance in wastewater examination. Derive BOD equation showing relation between ultimate BOD and BOD remaining at any time, t. [8]

6. A wastewater treatment plant disposes off its effluents into a stream at a point A. Characteristics of the stream at a location upstream of point A and of the effluent are as follows: [8]

Item	Effluent	Stream
Flow Rate, m^3/sec	0.35	0.60
Dissolved Oxygen, mg/l	2	7
Temperature, °C	29	22
BOD_5 at 20°C, mg/l	155	2

Assume that the deoxygenation constant at 20°C (base e) = 0.2 per day and the reaeration constant at 20°C (base e) = 0.35 per day. For the mixture, equilibrium concentration of dissolved oxygen for the freshwater is as follows:

Temperature, °C	21	22	23	24	26	28
DO, mg/l	8.99	8.83	8.68	8.53	8.22	7.92

The velocity of stream downstream of the point A is 0.25 m/sec. Determine the critical oxygen deficit and its location.

7. a) Design a grit chamber for a wastewater flow of 180 l/s with SOR = 1.5 cm/second and detention period of 50 seconds. Specific gravity of organic and inorganic particles are 1.2 and 2.65 respectively. Assume the size of both organic and inorganic particles as 0.25 mm. Take k = 0.06 and f = 0.03. [8]

b) A municipal wastewater having a BOD_5 of 190 mg/l is to be treated by a two stage trickling filter. The desired BOD_5, 20°C of the final effluent is to be 25 mg/l. If both the filter's depth is to be 1.85 m and recirculation ratio for both filters is 0.5, determine the required filter diameters. Assume the wastewater flow rate of 7665 m^3/day, and 35% BOD is removed in primary sedimentation tank. [8]

c) What is meant by activated sludge? Describe with sketches the treatment process of wastewater by activated sludge process. [8]

OR

Describe the theory of oxidation pond. Design an oxidation pond for treating domestic sewage of 2500 persons supplied with 225 lpcd of water. The BOD_5 of the wastewater is 250 mg/l. Permissible organic loading for the pond is 550 kg/ha/day and the detention time is 12 days. Assume the width to length ratio of the pond as 1:2 and the operational depth as 1.25 m. [3+5]

8. Why treatment of sludge is necessary? Explain the method of dewatering of sludge by sand drying bed. [8]

9. Describe the purpose, construction and design criteria of VIP latrine with neat sketch. Differentiate it with pit latrine. [8]

10. Write a short note on incineration of solid waste. [4]

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01 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2071 Magh

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Sanitary Engineering *(CE656)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Compare between water carriage and conservancy methods of sewage disposal with merits and demerits of each method. [4]
2. The catchment area of a city is 45 hectares. Assuming that the surface on which rain falls is classified as follows: [4]

Type of Surface	% Area	Runoff Coefficient
1. Forest and Wooden Area	10	0.15
2. Open ground + Unpaved street	10	0.20
3. Parks + Lawns + Gardens	15	0.15
4. Gravel Road	20	0.25
5. Asphalt Pavements	20	0.85
6. Water tight Roof Surfaces	25	0.90

   Calculate the quantity of storm water if time of entry is 20 minutes and time of flow is 10 minutes.
3. With the help of neat sketches, describe in detail the various steps of sewer construction. [8]
4. With the help of neat sketch, describe the purpose and construction of a drop manhole. [4]
5. a) Describe in detail about BOD and COD with their significances. [4]
   b) 2.5 ml of raw sewage is diluted to 250 ml. D.O. concentration of the diluted sample at the beginning was 8.0 mg/l and 54.0 mg/l after 5 days of incubation at 20°C. Find 5-day B.O.D. of raw sewage and kg. B.O.D. contained in 5 million liters of sewage. [4]
6. The population of a town is 30,000 and domestic sewage is 175 lpcd. The per capita BOD is 50 gm/day. The dairy waste of the town is 2.2×10^6 liters/day with BOD of 5000 mg/l and the waste from other industries is 1.80×10^6 liters/day with BOD of 2200 mg/l. DO of both domestic and industrial wastes are zero. The effluent from the sewage treatment plant is to be discharged in the natural river having minimum discharge of 8000 liters/sec, a dissolved oxygen content of 8.0 mg/l and BOD of zero. The minimum DO content in the river to be maintained is 4.5 mg/l. Determine the degree treatment required to the sewage. Assume saturation DO in the river after mixing with waste is equal to DO content of river before mixing. Assume any other data not given. [8]
7. a) Design a grit chamber for a sewage flow of 200 liter/sec with SOR = 2 cm/sec and detention time = 1 min. Specific gravity of organic and inorganic particles are 1.2 and 2.7 respectively. Assume size of both organic and inorganic materials as 0.21 mm. Take k = 0.06 and f = 0.03. [8]

b) With the help of neat sketch, explain the activated sludge process. What are its advantages and disadvantages? [8]

c) A sewage having BOD of 180 mg/l is fed to a two stage trickling filter with a flow of 5 million liters per day. The BOD required in the final effluent is ≤30 mg/l. The efficiency of the first stage trickling filter is 2 times the efficiency of the second stage trickling filter. If depth and recirculation ratio of both first stage and second stages are 1.2 m and 2 respectively, determine the diameters of the first stage and second stage trickling filters. [8]

8. a) Describe the purpose and methods of sludge thickening. [4]

b) A sedimentation tank treats 6 mld of sewage containing 300 mg/l of suspended solids. The tank removes 65% of the suspended solids. Compute the volume of the sludge produced yearly if the moisture content of the sludge is 95%. [4]

9. a) Describe the purpose and construction of an evapo-transpiration mound. [4]

b) Design a double pit VIP latrine for a family of 15 users. Assume the necessary data suitably. [4]

10. Describes briefly the various methods of solid waste disposal. [4]

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06 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2070 Magh

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Sanitary Engineering *(CE656)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Why waste water management is important for civil society. State the objectives of waste water disposal. [4]
2. Calculate the diameter of combined circular sewer with following data: water supply rate = 100 lpcd, population density = 100 persons/hec, peak factor = 2.7, area = 35 hectares, rainfall intensity = 15mm/hr, slope = 1/750, Manning's coefficient of rugosity = 0.011. The coefficient of run-off = 0.4. The sewer should run 0.6 depth full during peak flow. [8]
3. State the steps envolved in construction of sewers in urban area. Briefly describe the testing of sewer line. [4]
4. With the help of neat sketch, explain the necessity and construction of drop manhole. [4]
5. If one day BOD of a sewage sample at 23°C is 105 mg/l. What will be its five day BOD at 30°C? Assume $K_{20} = 0.1$ per day. [8]
6. An industry is going to be established in an urban area near to the river side. The river water and industrial effluent characteristics are as follows: [8]

	Industrial effluent	River water
Flow (m^3/s)	1.8	22
DO (mg/*l*)	0	8.7
BOD_5, 20°	350	6.0

k_d, 20°=0.25 d^{-1}
k_r, 20°=0.11 d^{-1}
DO saturation = 9.1 mg/l

At what location in the river critical DO deficit would occur if the flow velocity in the river is 0.20 m/s. Also find out DO at the end of 1 and 3 days.

7. a) With neat sketch, describe briefly about the skimming tank. Also enlist differences between grit chamber and sedimentation tank. [5+3]

   b) What do you mean by suspended and attached growth process? Explain the principals of biological treatment. [8]

OR

The effluent from PST is applied to a standard rate Trickling Filter at the rate of 1.2 million liters/day having BOD_5 of 200 mg/l. Determine the depth and volume of filter considering surface loading of 1200 liters/m^2 day and organic loading of 250 gm/m^3. day. Also, calculate the efficiency of fiter using NRC equation. [5+3]

   c) A town discharges sewage at the 55×10^6 l/d. The specific gravity of gift particles in that sewage is found from an experiment as 2.65 and the temperature as 27°C. Design grit chamber for removal of grit particles of 0.21 mm. Use: K = 0.06 and f = 0.03. [8]

8. Briefly describe about the methods of sludge treatment with its functions. [8]
9. With a neat sketch describe the working and design procedure of ventilated improved pit latrine. [8]
10. Describe sanitary landfill with its advantages and disadvantages. [4]

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05 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division.
2069 Bhadra

Exam.	Regular (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Sanitary Engineering *(CE656)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. Compare the separate and combined systems of sewerage in a tabular form. [4]
2. Define sanitary sewage. Describe various factors affecting quantity of sanitary sewage. [4]
3. Design a circular sewer running 0.70 full at maximum discharge for a town provided with the separate system serving a population of 100000 persons. Water is supplied from the water works at a rate of 200 liters per capita per day. Take a constant value of n = 0.013 at all depths of flow. The permissible slope is 1 in 600. Take a peak factor of 2.25. [8]
4. What are sewer appurtenances? Explain brief the necessity of sewer appurtenances. [4]
5. How sewage sampling is done? Explain the method of BOD determination in the laboratory by dilution method. [8]

OR

Why examination of wastewater is necessary? Describe in detail the procedure of determining fixed, volatile and total solids in the laboratory.

6. A stream saturated with DO has a flow of $2m^3/s$, BOD of 3mg/l and rate constant (K_1 to base 10) of 0.1 per day. It receives an effluent discharge of $0.5m^3/s$ having BOD of 200 mg/l and DO of 2mg/l. The average velocity of stream is 0.2m/s. The average depth of stream is 1.2m. Calculate DO deficit 60km downstream of outfall. Assume temperature of 20°C throughout and saturation DO at 20°C is 9.17mg/l. [8]
7. a) With neat sketches, describe the theory, construction, design criteria, commissioning and maintenance of an oxidation pond with its advantages and disadvantages. [8]

OR

What do you understand by suspended growth and attached growth processes in wastewater treatment? Explain in detail the principles of biological wastewater treatment.

b) Determine the size of a high-rate single stage trickling filter for the following data: [8]

i) Sewage flow = 5MLD (ii) Recirculation ratio = 1.5 (iii) BOD of raw sewage = 250mg/lit (iv) BOD removal in primary clarifier = 30% (v) Final effluent BOD desired = 30mg/lit

c) What is a grit chamber? Describe with the help of neat sketches the construction and design criteria of a grit chamber. [8]

OR

OR

Why recirculation is necessary in trickling filters? Compare the low rate and high rate trickling filters.

8. Sewage with a suspended solid content of 200mg/l flows continuously in a sedimentation tank of $500m^3$ capacity. Sewage is detained in the sedimentation tank for 4 hours. Sixty percentages of solids are removed in the sedimentation tank during its detention. The sludge produced in the sedimentation tank has moisture content of 98% and specific gravity of 1.02. The sludge from sedimentation tank is fed to digestier for its digestion. The volume of sludge is reduced to 40% of its original volume during digestion. Calculate the diameter of digester if its effective depth is 6m. Assume detention period in the digester is 30 days. [8]

9. Design a septic tank and soak pit to dispose the sewage generated from a household of 8 persons. The sewage is generated at the rate of 100 liters/person/day. Assume that septic tank is cleaned once in 3 years and infiltration rate of soil is 50 liters/m^2/day. [8]

10. Describe the methods of composting for solid waste disposal. [4]

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06 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2069 Poush

Exam.	New Back (2066 & Later Batch)		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Sanitary Engineering *(CE656)*

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt **All** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Wastewater and solid waste management are the major issues in metropolitan cities. Discuss it briefly with respect to their importance and types of sanitation systems. [6]

   b) A wastewater sample was incubated at 25°C and following observations were made: 5 day BOD of sample = 200mg/l, 11 day BOD of sample = 268mg/l. Calculate rate reaction constant and 6 day BOD at 30°C. [10]

2. a) If you were appointed as a sanitary engineer, how would you determine quantity of storm water for a highly populated sub-urban area. What type of limitations exist in storm water quantity determination for such area? Discuss in detail. [6]

   b) Calculate the diameter and velocity of a circular combined sewer at a slope of 1 in 150 when it is running just full at a discharge of 1.05m^3/sec. The value of n in Manning's formula is 0.011. What will be the discharge and velocity when flowing at 0.75 depth of pipe for the same slope? [10]

3. a) What do you understand about the Dorrco aeration method; briefly describe its operation with neat sketch. [6]

   b) The raw sewage has ultimate BOD of 215 mg/l. The primary treatment removes 30% BOD. The required effluent BOD should be equal to or less than 32 mg/l. Does a single high rate trickling filter having volume of 550m^3 which receives a flow of 4.1 MLD is enough to attain required effluent BOD level? What will be the recirculation ratio required for a single/two stage high rate trickling filter? [10]

4. a) In what cases natural methods of sewage disposal systems are applied and what are the necessary condition for implementation of those methods? Discuss. [4]

   OR

   Describe the purpose and working of sludge drying bed with a neat sketch.

   b) A small town with a population of 12000 is to be designed with a sewage treatment plant to handle both its industrial and domestic wastewater. A sanitary survey reveals the following: dairy waste of 2.7*10^6 *l*/d with BOD of 4400 mg/*l*, sugar mill waste of 2.2*10^6 *l*/d with BOD of 2200mg/*l*, and domestic sewage is 200 *l*pcd having BOD 88 gm/day. DO of both industrial and domestic waste are zero. The effluent from the treatment plant is to be discharged into a stream with a minimum flow of 7000 lit/sec. and dissolved oxygen content of 8.0 mg/l. It is necessary to maintain a DO content of 4.0mg/l. Find the degree of treatment required for the plant? Assume K_1 = 0.4 day^{-1}, K_2 = 0.6 day^{-1} (both to the base 10) and saturation DO in the river after mixing with

waste is equal to the DO content of river before mixing. $DO_{saturation}$ = 9.1mg/l and BOD = 0mg/l of river. [12]

5. a) What will be the internal dimension and numbers of soak pit for a resort at Dhangadhi having 110 number of average users. Rate of sewage discharge is 65 /pcd. Cleaning period of septic tank is 4 years interval. Assume other necessary data if required. [6]

b) What will be the suitable dimensions of a circular sewage sedimentation tank for an industrial area having population of 5500. The average water demand is 210 /pcd. Assume that 70% water reaches the treatment plant and maximum demand is 2.7 times average demand. Diameter of the suspended silica particles available in influent water is more than 0.14mm. [10]

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5a) $t = 25$ $Q = 7150$ l/p

$I = 26$ l/m²/day

$A = 275\ m^2 \Leftarrow \frac{7150}{26}$

$\phi = 3.5$ $\phi = 0.9$

$n \simeq 13$ $n \simeq 49$

depth = 2 + 0.3 FB

= 2.3 m

5b) $Q = 2182.95\ m^3/d \Rightarrow 0.025264\ m^3/s$

$T = 1hr$ [1 – 3hr]

$C = 90.956\ m^2$

$h = 2m$ [2 to 3.5m]

$A_s = 45.478\ m$

Check SOR = $48\ m^3/d/m^2$

[40.50 $m^3/d/m^2$]

circular tank okay

$\phi = 7.609$ [12/30m]

Not okay

$H = 2 + 0.5 + 0.5$

= 3m

$0.78737 = \frac{1}{1 + 0.44\sqrt{\frac{617.05}{550 \times F_1}}}$

$F_1 = 2.978$

$\frac{1+r}{(1+0.18)^2} = 2.978$

= 913.957 ppm < 2435.068 ppm

BOD sewage allowable

Treatment necessary

% treatment = 62.466 %

ppm

reatable = 10.9 ppm

05 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2068 Bhadra

Exam.	Regular / Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Sanitary Engineering

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt any **Five** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Describe in detail the objectives of sewage disposal. [6]

   b) Calculate the diameter and velocity of a circular sewer at a slope of 1 in 400 when it is running just fall at a discharge of $1m^3$/sec. The value of n in Manning's formula is 0.012. Will the self cleansing velocity be maintained in the sewer when flow drops to $0.6m^3/s$? [10]

2. a) As a designer for a highly populated urban core area how would you determined quantity of storm water? Discuss. [6]

   b) The BOD_5 of a sewage incubated for one day at 30°C has been found to be 170mg/l. What will be the 5 day BOD at 20°C? Assume K = 0.12 per day (base10) at 20°C. [10]

3. a) Explain the necessity of providing a manhole in a sewer line. Describe, with the help of a neat sketch the components of a manhole. [6]

   b) The sewage of a town is a mixture of domestic sewage and industrial sewage. The sewage is to be treated at the sewage treatment plant before discharging into river. Determine the degree of treatment required for the following data: [10]

   Population = 40000
   Domestic sewage = 175lpcd
   BOD of domestic sewage = 50gm/capita/day
   Flow of industrial waste = 4×10^6 liters/day
   BOD of industrial waste = 4000mg/l
   DO of both domestic and industrial sewage = 0
   River discharge = 8500 liters/sec
   BOD of river water = 0
   Do of river water = 8mg/l
   $k_1 = 0.1$/day and $k_2 = 0.1$/day.

   Assume other data as required.

4. a) With neat sketches, describe the purpose and construction of a grit chamber. [6]

   b) The effluent from a primary sedimentation tank is applied to a standard rate filter at the rate of 3 million liters per day, having a BOD_5 of 175mg/l. Determine the depth and volume of filter, adopting a surface loading of $150gm/m^3$/day. Also determine the efficiency of such filter unit, using NRC formula. Assume recirculation ratio = 1:2. [10]

5. a) Explain the necessity of sludge treatment. Draw a sketch of sludge digester and explain its working. [2+6]

   b) Design a double pit VIP latrine for a family of 15 users. [8]

6. Write short notes on: (any four) [4×4]

   a) Types of sewerage system
   b) Catch basin
   c) Time of concentration
   d) Bacteria-algal-symbiosis process
   e) Incineration of solid waste

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05 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2067 Mangsir

Exam.	Regular / Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Sanitary Engineering

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt any **Five** questions.*
- ✓ ***All** questions carry equal marks.*
- ✓ *Assume suitable data if necessary.*

1. a) Compare separate and combined systems of sewerage in a tabular from.
   b) As a designer for rural with scattered populated area how would you determined the quantity of storm water? Discuss in detail.
2. a) The BOD_5 of sewage sample at 20°C is 300mg/l. If K=0.23(base e), what is the ultimate BOD? Calculate BOD_3 at 15°C.
   b) Design a septic tank and soak pit for the following data.

   No. of persons = 100
   Sewage/Capita/day = 120 liters
   Sludge cleaning period = 1 Year
   Soil infiltration = 40 $l/m^2/d$
3. a) Calculate the diameter and velocity of a circular sewer at a slope of 1 in 400 when it is running just full at a discharge of $0.85m^3/sec$. The value of n in Manning's formula is 0.011. What will be the discharge and velocity when flowing 0.6 depth of pipe for the same slope.
   b) With a neat sketch, describe the purpose and construction of a drop manhole.
4. a) In what cases natural methods of disposal systems are applied and how, discuss.
   b) Design an oxidation pond for a town with the following data:

   People = 10,000
   Sewage flow = 135 lpcd
   BOD of incoming sewage = 250mg/l
   Organic loading = 100Kg BOD/ hectare/day
   Detention time = 30 days
5. a) With neat sketches, describe the activated sludge process.
   b) The volume of fresh sludge obtained from PST and trickling filter humus tank is $85.1m^3$ at 98% moisture content. After sludge digestion, the moisture content reduced to 83%. What will be its volume and design a sludge digestion tank for it? Assume specific gravity remains same before and after dilution.
6. Write short notes on (any four):
   a) Inverted siphon
   b) Sewage sampling
   c) Bacteria-algal-symbiosis process
   d) Composting of solid waste
   e) Overland flow and rapid infiltration

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05 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2066 Magh

Exam.	Regular/Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Sanitary Engineering

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt any **Five** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Discuss the relative merits and demerits of the separate and combined system of sewerage. Also give the conditions favourable for the adoption of each one of them. Describe how time of concentration is found out graphically. [4+2+2]

   b) In a thickly built up residential area, the average surface coverage are 40% roofs and pavements having run off coefficient of 0.8 and 60% lawns and gardens having run off coefficient of 0.2. If the population density per hectare is 2000 and rate of water supply is 125 ℓpcd and time of concentration (t_c) is 30 min, calculate the required size of the combined sewer. [8]

2. a) Draw a neat sketch of manhole, showing its components. Where and why drop manhole is to be provided? [6]

   b) A town discharges 120 cumec of sewage into a river having a rate of flow 1600 cumec, during lean period with a velocity of 0.1 m/sec. The 5 day BOD of sewage at the given temperature is 250 mg/lit. Find the amount of critical DO deficit and when and where it will occur in the downstream portion of the river. Assume deoxygenation constant K as 0.1 day^{-1} and coefficient of self purification f as 3.5. Saturation DO at given temperature is 9.2 mg/lit. [10]

3. a) Draw 1st stage and 2nd stage BOD curve and indicate its salient features. Define grab sample and composite sample. Describe the factors affecting self purification of river. [3+1+4]

   b) A rectangular primary sedimentation tank is to treat 1 MLD sewage per day. If detention period is 1.5 hrs, the velocity of flow is 10 cm/min, depth of sewage and sediments is 3.5m, calculate [8]

   i) Dimension of tank ii) Overflow rate of the tank

4. a) What are the principles of biological treatment? Draw the figures of any one type of grit chamber and skimming tank. What are the working principle of those units? [7]

   b) Determine the dimensions of a high rate trickling filter for the following data: [9]

   i) Sewage flow = 3.0 MLD ii) Recirculation ratio = 1.5
   iii) BOD of raw sewage = 250 mg/lit iv) BOD removal in the primary settling tank = 25%
   v) Final effluent BOD desired = 30 mg/lit
   vi) By what percent the diameter of the filter will have to be modified if it is to be designed as a standard rate trickling filter for the above requirements.

5. a) What is septic tank and soak pit? Describe about design procedure of septic tank and soak pit. [7]

   b) What is primary and secondary sludge? List out the necessity of sludge treatment. Assuming 30% solid matters in a sludge (containing 90% water) is composed of fixed mineral solids with sp.gr. of 2.5 and 70% composed of volatile solids with sp.gr. of 1. Find specific gravity of sludge. [2+2+5]

6. Write short notes on: (any four) [4×4]

   a) Evapotranspiration mound b) Sewage sickness c) Street inlets
   d) Solid waste and its types e) Testing of sewer

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0825

05 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2066 Magh

Exam.	Regular/Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Sanitary Engineering

- Candidates are required to give their answers in their own words as far as practicable.
- *Attempt any **Five** questions.*
- *The figures in the margin indicate **Full Marks**.*
- *Assume suitable data if necessary.*

1. a) Discuss the relative merits and demerits of the separate and combined system of sewerage. Also give the conditions favourable for the adoption of each one of them. Describe how time of concentration is found out graphically. [4+2+2]

   b) In a thickly built up residential area, the average surface coverage are 40% roofs and pavements having run off coefficient of 0.8 and 60% lawns and gardens having run off coefficient of 0.2. If the population density per hectare is 2000 and rate of water supply is 125 ℓpcd and time of concentration (t_c) is 30 min, calculate the required size of the combined sewer. [8]

2. a) Draw a neat sketch of manhole, showing its components. Where and why drop manhole is to be provided? [6]

   b) A town discharges 120 cumec of sewage into a river having a rate of flow 1600 cumec, during lean period with a velocity of 0.1 m/sec. The 5 day BOD of sewage at the given temperature is 250 mg/lit. Find the amount of critical DO deficit and when and where it will occur in the downstream portion of the river. Assume deoxygenation constant K as 0.1 day^{-1} and coefficient of self purification f as 3.5. Saturation DO at given temperature is 9.2 mg/lit. [10]

3. a) Draw 1st stage and 2nd stage BOD curve and indicate its salient features. Define grab sample and composite sample. Describe the factors affecting self purification of river. [3+1+4]

   b) A rectangular primary sedimentation tank is to treat 1 MLD sewage per day. If detention period is 1.5 hrs, the velocity of flow is 10 cm/min, depth of sewage and sediments is 3.5m, calculate [8]

   i) Dimension of tank ii) Overflow rate of the tank

4. a) What are the principles of biological treatment? Draw the figures of any one type of grit chamber and skimming tank. What are the working principle of those units? [7]

   b) Determine the dimensions of a high rate trickling filter for the following data: [9]

   i) Sewage flow = 3.0 MLD ii) Recirculation ratio = 1.5
   iii) BOD of raw sewage = 250 mg/lit iv) BOD removal in the primary settling tank = 25%
   v) Final effluent BOD desired = 30 mg/lit
   vi) By what percent the diameter of the filter will have to be modified if it is to be designed as a standard rate trickling filter for the above requirements.

5. a) What is septic tank and soak pit? Describe about design procedure of septic tank and soak pit. [7]

   b) What is primary and secondary sludge? List out the necessity of sludge treatment. Assuming 30% solid matters in a sludge (containing 90% water) is composed of fixed mineral solids with sp.gr. of 2.5 and 70% composed of volatile solids with sp.gr. of 1. Find specific gravity of sludge. [1+2+5]

6. Write short notes on: (any four) [4×4]

   a) Evapotranspiration mound b) Sewage sickness c) Street inlets
   d) Solid waste and its types e) Testing of sewer

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05 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2065 Chaitra

Exam.	Regular/Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Sanitary Engineering

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt any **Five** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Describe the systems of sanitation with their advantages and disadvantages. Why water-carrying system of sanitation is popular than conservancy system? [6]

   b) If the seven-day BOD at 20°C is 280 mg/l and one day BOD at 20°C is 35 mg/l. Calculate the rate reaction constant k' 20°C and five-day BOD at 25°C. [10]

2. a) Design a combined sewer section for a 45-hector residential area having runoff coefficient 0.40, 0.70, 0.25, 0.80, 0.10 for area of 15, 20, 25, 10 and 30% respectively with altogether 1500 population? Average rainfall duration is 21-min. Self-cleansing velocity is 0.88 m/sec. Assume water supply rate = 100 lpcd and time of concentration = 20 min. [10]

   b) With a neat sketch, describe the construction of a manhole. [6]

3. a) Suggest suitable dimensions of a circular sewage sedimentation tank for an industrial area having population of 4800. The average water demand is 150 lpcd. Assume that 70% water reaches at treatment plant. [10]

   b) What do you understand by self purification of stream? Describe the various factors affecting self purification. [6]

   c) What will be the recirculation ratio required of a single stage trickling filter having volume of 550m^3 at flow of 3.7 MLD. The raw sewage has BOD of 180 mg/l. The primary treatment removes 33% BOD. The effluent BOD is to be equal or less than 35 mg/l. [10]

   b) Describe activated sludge treatment process with schematic diagram. Also describe the principle of BOD reduction in the treatment process. [6]

5. a) A raw sewage having suspended solids content of 250 mg/l is passed through primary sedimentation tank at a flow of 5 MLD. The sedimentation tank removed 55% suspended solids. Determine the volume of sludge produced per day if moisture content and specific gravity of sludge are 98% and 1.02 respectively. What will be the volume if its moisture content reduces to 81.5% after digestion? [10]

   b) Describe the various methods of solid waste composting. [6]

6. Write short notes on (any four): [4×4]

   a) Time of Concentration
   b) Incineration of Solid Waste
   c) Intermittent Sand Filter
   d) Inverted Siphon
   e) Bacteria-Algal-Symbiosis Process

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05 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2065 Kartik

Exam.	Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Sanitary Engineering

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt any **Five** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Explain water carriage system. What are its merits and demerits? Why is it not suitable to adapt water carriage system in rural areas? [8]

   b) A sewage sample incubated for one day at 30°C has BOD of 150 mg/l. What will be its 5 day BOD at 20°C if the value of the de-oxygenation constant is 0.13 per day (base 10) for 20°C? [8]

2. a) Discuss briefly the methods of land treatment. How sewage sickness occurs? [6]

   b) Determine the volume of sludge produced in a sewage sedimentation tank for the following data: [10]

   Flow rate = 10 million liters/day
   Suspended solids content in raw sewage = 250 mg/l
   Sedimentation tank removes 60% of suspended solids
   Specific gravity of sludge = 1.02
   Moisture content of sludge = 95%

3. a) Draw a neat sketch of manhole and describe it with necessary labeling. [6]

   b) Design a sewer for a population of 100,000 persons with water supply per capita of 120 l/d. It is expected that 80% of the water is converted into sewage. The DWF estimated will be 1/3rd of the maximum discharge in this separate sewer. The permissible slope is 1:1000 and rugosity coefficient is taken as 0.012. For the self purpose at least 0.75 m/s velocity need to be developed in the drain. [10]

4. a) Discuss the working of trickling filter with neat sketch. [6]

   b) Design a conventional activated sludge plant to treat settled domestic sewage with diffused air aeration system for the following data: [10]

   i) Population served = 90,000
   ii) Per capita sewage contribution = 100 l/d
   iii) BOD_5 of settled sewage = 220 mg/l
   iv) Effluent BOD_5 allowed = 30 mg/l
   v) F/M ratio = 0.2
   vi) MLSS = 3000 mg/l

5. a) Discuss the principles of oxidation pond. Why is it believed that they are better alternatives to small towns of Nepal? [8]

   b) Design a circular sewage sedimentation tank for a population of 50,000. The per capita sewage contribution is 80 lpcd. Assume necessary data suitably. [8]

6. Write short notes on any four of the followings: [4×4]

   a) Construction of septic tanks
   b) Inverted siphon
   c) Gravity thickener
   d) Double pit pour flush latrine
   e) Soak pits

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05 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2064 Poush

Exam.	Regular/Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Sanitary Engineering

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt any **Five** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) As a designer for a highly populated urban area how would you determine quantity of storm water? Discuss in detail. [6]

   b) If the five-day BOD at 20°C is 280 mg/l and one day BOD at 20°C is 111.80 mg/l. Calculate the rate reaction constant k at 20°C and 7-day BOD at 25°C. [10]

2. a) Determine the diameter and velocity of a circular sewer at a slop of 1 in 500 when it is running just full at a discharge of $1 m^3$/sec. The value of n in Manning's formula is 0.012. What will be the discharge and velocity when flowing half full for the same slope? [10]

   b) Describe the purpose and working of sludge drying bed with a neat sketch. [6]

3. a) Design a grit chamber from the maximum flow of sewage = $40*10^6$ l/d, Sp. gr. of grit = 2.7, Size of grit particle to be removed = 0.25mm, Assume temp T = 20°C. Assume other necessary data suitably. [10]

   b) Describe the purpose, construction and working of a manhole. [6]

4. a) Calculate effluent BOD of two stage trickling filter for the following data: [10]

   Sewage flow = 2 m^3/min,
   BOD of sewage after primary treatment = 300 mg/l,
   Volume of both filters = 900 m^3 and
   Recirculation ratio for both filters = 1:5.

   Assume necessary data suitably.

   b) What do you understand by self purification of streams? Describe the factors affecting self purification of streams. [6]

5. a) The volume of fresh sludge obtained from PST and trickling filter humus tank is $84.1 m^3$ at 97% moisture content. After sludge digestion, the moisture content reduced to 83%. What will be its volume after digestion? Also design a sludge digestion tank for it. Assume sludge digestion period as 30 days. [10]

   b) How does an oxidation pond work? Describe its construction with a neat sketch. [6]

6. Write short notes on (any four): [4×4]
   a) Evapo-transpiration mound
   b) Skimming tank
   c) Catch basin
   d) Composting of solid waste
   e) VIP latrine

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INSTITUTE OF ENGINEERING

Examination Control Division

2064 Shrawan

Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

6

Subject: - Sanitary Engineering

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt any **Five** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Discuss the various methods of sewage disposal by land treatment with their merits and demerits. [8]

   b) Calculate 5-day biochemical oxygen demand of a sewage at 20°C. Its sample analysis shows 180mg/l of BOD after 3 days at 30°C. [8]

2. a) What is dry weather flow? Discuss various factors affecting quantity of dry weather flow. Justify why we need to consider peaking factor. [6]

   b) A sewage sample has suspended solid contents of 240 mg/l. The sedimentation tank removes 65% of the suspended solids. If the water content of the sludge is 95% determine volume of sludge produced in a sedimentation tank after treating 8.5×10^6 l of sewage. Assume specific gravity of the sludge as 1.02. [10]

3. a) With a neat sketch of describe the process of sludge thickening. [6]

   b) A newly added ward of a municipality with 40,000 populations covers an area of 50 ha. The projected surface of the area is given as follows: [10]

% of total surface	Type of surface	Runoff coefficient
25	Hard pavement	0.85
35	Roof surface	0.80
15	Unpaved street	0.30
25	Gardens and lawns	0.15

   The time of concentration is 30 minutes. Use US Ministry of Health formula for the intensity of the rainfall. The average daily water consumption of the area is 180 liters per capita out of which 80% turns into waste water. The peak flow is three times the dry weather flow. Determine the discharge of the waste water from the area.

4. a) Explain principles of activated sludge process with neat sketch. Elaborate why food/micro-organism ratio is important in this process. [6]

   b) Sewage from Primary Settling Tank is discharged to Standard-rate Trickling Filter at the rate of 4 MLD having 150 mg/l of 5-day BOD. Determine the depth and velocity of the filter adopting surface loading of 2400 l/m^2-day and organic loading of 160 g/m^3-day. Also determine the efficiency of the Trickling Filter. Assume necessary data if necessary. [10]

5. a) What is oxidation pond? Elaborate various physical and biochemical processes that take place in oxidation pond. [6]

   b) Design a septic tank for a house in Kathmandu with 12 inhabitants. The rate of sewage dispósal is 100 l/c-day. De-sludging is expected every 2 years. Make assumptions for necessary data. Draw a plan and cross section of the septic tank with designed dimensions. [10]

6. Write short notes on any four of the followings [4×4]

   a) VIP latrine
   b) Testing of sewer lines
   c) Composting of solid wastes
   d) Grit chamber
   e) Manhole
   f) Self purification of streams

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05 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2063 Kartik

Exam.	Regular/Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Sanitary Engineering

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt any **Five** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Define sewage, sullage, sewer and garbage. Compare between separate and combined systems of sewerage. [6]

   b) Calculate the diameter and velocity in a circular sewer at a slope of 1 in 400 when it is running just full at a discharge of $2m^3$/sec. The Manning's coefficient n = 0.013. What will be the discharge and velocity when flowing one third full? [10]

2. a) What is dry weather flow? Discuss the various factors affecting the dry weather flow. [6]

   b) A stream saturated with DO has a flow of $1.5m^3$/s, BOD 4 *mg/l* and rate constant (K_1) of 0.3 per day. It receives an effluent discharge of 0.5 m^3/s having BOD 20 *mg/l* and DO 5 *mg/l*. The average velocity of flow of stream is 0.20 m/s. The average depth of stream is 1.2m. Calculate DO deficit at 30 km and 50 km downstream. Assume temperature throughout 20°C and BOD is measured in 5 days. Take saturation DO at 20°C as 9.17 *mg/l*. [10]

3. a) With neat sketches, describe the working of an activated sludge process. [8]

   b) If BOD_3 at 15°C is 220 *mg/l*, find BOD_7 at 25°C. [8]

4. a) State and explain the following terms [8]

      i) aerobic decomposition
      ii) BOD
      iii) COD
      iv) anaerobic decomposition

   b) A sedimentation tank treats 8 *Mld* containing 200 *mg/l* of suspended solids. The tank removes 60% of the suspended solids. Compute the weight and volume of sludge produced daily if the moisture content of the sludge is (i) 95% (ii) 90%. [8]

5. a) What is oxygen sag curve? Describe the self purification of streams. [8]

   b) Calculate the BOD removal efficiency for the single stage high rate trickling filter. BOD loading is 750 g/m^3/day and recirculation ratio is 0.6. [8]

6. Write notes on any four: [4×4]

   a) Soak Pit
   b) Pour Flush Latrine
   c) Manhole
   d) Composting of Solid Waste
   e) Flushing Device

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05 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2062 Bhadra

Exam.	Regular / Back		
Level	BE	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Sanitary Engineering

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt any **Five** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) Discuss principles of VIP latrine and its construction with neat sketch. [8]
   b) If 3 day BOD of a sewage sample is 200 *mg/l* at 25°C, calculate its 5 day BOD at 20°C. [8]
2. a) Describe that the time of concentration is an important factor while determining storm water discharge. Elaborate on time of concentration and time area graph. [8]
   b) A grit chamber is provided to remove grit particles up to 0.2mm from a sewage of a town of population 800,000 producing 100 litre waste water per capita per day. Working at 20°C temperature, the specific gravity of the grits may be taken as 2.6. Determine the size of grit chamber. Assume necessary data. [8]
3. a) Describe the various methods of land treatment. [6]
   b) Determine the size of combined circular sewer for a discharge of 1.5 m^3/s running half full. Assume a gradient of 1 in 2000 and Manning's rugosity coefficient N = 0.013 (constant for all flows). In the dry season if the flow drops to 0.5 m^3/s, does the flow maintain desired self-cleaning velocity of 0.6 m/s? [10]
4. a) Discuss the principles of oxidation pond. Do you agree that this method is suitable for waste water treatment in Terai towns of Nepal? Give your opinion with reasons. [6]
   b) A single stage trickling filter receives sewage flow of 4 million litres per day containing raw sewage BOD of 300 *mg/l*. A primary settling tank is provided whose efficiency is 35%. Determine the recirculation ratio required to meet the maximum effluent BOD connection of 60 *mg/l*? The effective volume of filter is 300 m^3. [10]
5. a) What are the differences between high rate trickling filters and low rate trickling filters? [6]
   b) Determine storm water discharge for a town of 200 ha. The catchment surface and corresponding runoff coefficients are provided below. The maximum intensity of rainfall is 40 mm/hour. [10]

Type of surface	% area	Runoff coeff.
Vacant plots	40	0.15
Unpaved roads	10	0.40
Gardens and open spaces	20	0.15
Built up surface	30	0.90

It is expected that after 20 years the built up area will be 60% of the total by converting additional 30% area of vacant plots. What will be the storm water discharge at present and after 20 years?

6. Write short notes on any four of the followings: [4×4]
   a) Street inlets
   b) Testing of sewer lines
   c) Sludge digestion processes
   d) Composting of solid waste
   e) Septic tanks

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05/2-25 TRIBHUVAN UNIVERSITY
INSTITUTE OF ENGINEERING
Examination Control Division
2062 Baishakh

Exam.	Back		
Level	B.E.	Full Marks	80
Programme	BCE	Pass Marks	32
Year / Part	III / II	Time	3 hrs.

Subject: - Sanitary Engineering

- ✓ Candidates are required to give their answers in their own words as far as practicable.
- ✓ *Attempt any **Five** questions.*
- ✓ *The figures in the margin indicate **Full Marks**.*
- ✓ *Assume suitable data if necessary.*

1. a) What are the differences between separate and combined systems of sewerage? Discuss the factors considered to select combined and separate systems. [6]

   b) A wastewater sample is taken from a sewer. The 5-day BOD was found to be 180 *mg/l* at 20°C which is 70% of the ultimate BOD. What will be 4-day BOD of the wastewater at 30°C? [10]

2. a) Discuss with sketch the Oxygen Sag Curve in natural streams. [6]

   b) A perennial river is receiving waste water from a town with a discharge of 200 m^3/s. The river water fully saturated with oxygen is flowing at the rate of 1500 m^3/s at a velocity of 0.15 m/s. If the 5-day BOD of the sewage is 250 *mg/l*, find out where the critical dissolved oxygen will occur in the river. The BOD of the river water is zero. The DO of the river water and wastewater are 8.0 and 0.1 *mg/l* respectively. The deoxygenation co-efficient is 0.1 per day and self purification constant is 5. The dissolved oxygen in the river at saturated condition may be taken as 9.17 mg/litre. Assume necessary data. [10]

3. a) List the steps followed in sludge treatment. Discuss the anareobic digestion principle in a conventional sludge digester. [6]

   b) Design a circular sewage sedimentation tank for a population of 80,000. The rate of water supply is 150 *lpcd*. Assume necessary data suitably. [10]

4. a) What is land treatment of waste water? Discuss briefly the methods of land treatment. How does sewage sickness occurs? [6]

   b) Population of 100,000 is living in a town. A separate sewer system for the town is to be constructed. The water consumption rate is 125 *lpcd*. 80% of the water consumed is discharged as waste water. The topography do not allow the slope of the sewer line more than 1:1000. The self cleaning velocity can be achieved at 0.60 m/s. The dry weather flow may be taken as $1/3^{rd}$ of the maximum discharge. Design an outfall sewer with RCC hume pipe having Manning's coefficient of 0.013. [10]

5. a) What is sloughing? Discuss the biological process that takes place in trickling filters. [6]

   b) Design a two-stage high rate trickling filter for the following data. [10]

Organic loading of filter	= 10,000 kg BOD_5/hectares/day
Flow	= 4.5×10^6 litres/day
BOD of sewage	= 280 mg/litre
BOD removal in primary settling tank	= 30%
Recirculation ratio	= 1.4 for both filters
Max. BOD allowed in final effluent	= 35 mg/litre

   Assume an intermediate sedimentation tank. Assume appropriate data where required.

6. Write short notes to any four of the following. [4×4]

   a) Chemical Oxygen Demand
   b) Manhole with neat sketch
   c) Design considerations of septic tank
   d) Skimming tank
   e) Working of oxidation pond with neat sketch

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