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DEPARTMENT OF CIVIL ENGINEERING

EN8592 – WASTEWATER ENGINEERING

UNIT– 1
PLANNING AND DESIGN OF SEWERAGE SYSTEMS
PART-A

1) What do you mean by time of concentration? State its significance in sewage design. CO1, BTL-K1 (Apr/May-11, Apr/May-17)

- The period after which the entire area will start contributing to the runoff is called time of concentration.
- Tc = Ti+Tf
  Tc=Time of Concentration,
  Ti=InletTime,
  Tf=Channel Flow Time (or)
- It is defined as the longest time without unreasonable delay that will be required for a drop of water to flow from further point of drainage area.
- It indicates the time of flow, time of entry, exit and the run off times.

2) List the factors influencing the fixing of design period. CO1, BTL-K1 (Apr/May-11)

1. Weather flow condition.
2. Rate of water supply.
3. Type of area served.
4. Population growth.
5. Performance of the system
6. Availability of investment funds

3) Distinguish between dry weather flow and wet weather flow. CO1, BTL-K4 (May/Jun-12)

Dry weather flow	Wet weather flow
It refers to the wastewater flow in sewerage system during the period of any weather.	It refers to the wastewater flow in sewerage system during the period of wet weather.
It follows minimum filtration.	It follows maximum filtration.

4 Listthe necessity of wastewater characterization. CO1, BTL-K1 (May/Jun-12)

- It's indicates the amount of heavy metals and synthesized organic compounds generated by industrial activities.
- As technological changes takes place in manufacturing. Changes also occur in the compounds discharged and the resulting wastewater characteristics.
- Therefore wastewater characterization on becomes an essential part of an overall water quality management program.

5 Relate sewage and sewerage. CO1, BTL-K2 (May/Jun-13,May/Jun-14,Nov/Dec-15)

Sewage: It is a wastewater coming from sources or community it includes sullage, night soil, etc.

Sewerage: The process of collection and conveyance of sewage from source to treatment plant.

6 Define BOD & COD. CO1, BTL-K1 (May/Jun-13, Nov/Dec-17)

BOD (Bio chemical Oxygen Demand): The amount of oxygen required for survival of microorganism to oxidize the organic substances at standard temperature and standard time.

COD (Chemical Oxygen Demand): The amount of oxygen required to oxidize the chemicals present in the wastewater.

7 Define sullage. CO1, BTL-K1 (May/Jun-14)

The fresh wastewater coming out from bathroom, kitchen except water closets (latrine).

8 What are the two factors affecting sanitary sewage? CO1, BTL-K1 (May/Jun-14)

Type of area to be served, Rate of water supply, Population growth, Infiltration of ground water, Un accounted water supply

9 Write the Chezy's and Bazin's formula for velocity of flow. CO1, BTL-K1 (May/Jun-14)

Chezy's formula :

$$V = c\sqrt{rs}$$

Where, V – velocity of flow
r – Hydraulic mean depth
s – Hydraulic gradient

Bazin's formula:

$$C = \frac{157.6}{1.81 + \frac{K}{\sqrt{r}}}$$

10 What are the sewerage systems available? CO1, BTL-K1 (Nov/Dec-15,Nov/Dec-14)

Combined system: When the drainage is taken along with the sewage then it is called as combined system.

Separate system: When the drainage and sewage are taken independently of each through two different sets of sewage is called separate system.

11 What is drop manhole? CO1, BTL-K1 (May/Jun-13)

It is a setup which is provided bottom of manhole to transfer the sewage. When a branch sewers enters a manhole by more than 0.5 – 0.6 m above the main sewer, the sewage is generally not allowed to fall directly into the manhole, but is brought into it through a down pipe taken from the branch of sewer to the bottom of manhole. The setup is called 'drop manhole'.

12 How do you classify the sewage? CO1, BTL-K1 (April/May 2018)

The sewage systems are classified as follows

i. Combined stsystem
ii. Separate system
iii. Partially separate system

13 Relate sewage, sullage and garbage. CO1, BTL-K2 (Nov/Dec-17)

Sewage: Liquid waste from a community that includes sullage, discharge from urinals, latrines, industrial waste, ground and storm waters.

Sullage: Waste water from Bathroom and Kitchen

Garbage: Dry refuse-paper, decayed vegetables, street sweepings, organic and untreated putrifying organic matter etc.

14 Define self-cleaning velocity. CO1, BTL-K1 (May/Jun-13, Nov/Dec-14,Nov/Dec-15, Apr/May-18)

The minimum velocity required to keep the solid particles in suspended forms in sewer is called self cleaning velocity or minimum velocity.

15 What do you understand by sewer appurtenances? Enumerate appurtenances commonly used. CO1, BTL-K1 (May/Jun-12)

In order to make the process easy and to have efficient working and maintenance, Sewer system requires various appurtenances for their proper functioning and maintenance.

1. Manholes 2. Catch basis3. Clean outs

16 What is the role of velocity in a sewage system? CO1, BTL-K1 (May/Jun-13)

In order to keep the solid particle in suspended form, avoid the solid particles settled down on sewer and to avoid scouring in sewer, minimum and maximum velocity should be maintained.

17 List out the sewer appurtenances. CO1, BTL-K1 (May/Jun-13, Nov/Dec-15)

Manholes, Catch basis, clean outs, Inlets, Ventilators, Oil and greases trap, Flushing tank, Inverted siphon

18 A sewer has to be designed by considering both minimum velocity and maximum velocity of flows – state true or false and justify the answer. CO1, BTL-K5 (May/Jun-12)

α. The sewers should be designed to follow minimum velocity also called as self cleaning velocity should be generated at least once a day because if certain deposition takes place and is not removed it will obstruct free flow.

β. It is necessary to maintain the velocity of sewer pipes to prevent scouring of pipe.

UNIT-2
PRIMARY TREATMENT OF SEWAGE
PART-A

1) Define humus tank? CO2, BTL-K1 (May/Jun-16)

The efficient of the filter is therefore, passed through a sedimentation tank called humus tank otherwise called secondary clarifier or secondary settling tank.

2) What are the patterns of mechanical aeration? CO2, BTL-K1 (Nov/Dec-14)

i) Haworth paddle or Sheffield aeration system
ii) Hartley paddle or birMingham Bio flocculation system
iii) Simplex aeration system
iv) Link belt aeration system
v) Kessner Brush aeration system

3) What are the advantages of intermittent filters? CO2, BTL-K1 (May/Jun-13)

(i) The efficient from intermittent sand filter is of better quality. It is more clean and more stable and hence does not need further treatment before disposal

(ii) The filter work under aerobic conditions, and hence there is no trouble of odour, flies and insects

(iii) The operation is very simple, requiring no mechanical equipment except for dosing

4) What are the disadvantages of intermittent sand filters? CO2, BTL-K1 (Nov/Dec-12)

i) The rate of filtration and hence that of load long is very small per unit surface area of the filter hence they cannot be employed for medium size or bigger plants

ii) They require large area and large quantity of sand due to which their construction is very costly.

5) What are the methods involved in the treatment of wastewater? CO2, BTL-K1 (May/Jun-14)

1. Conventional treatment methods 2. Advanced wastewater treatment

Conventional treatment methods

i Preliminary processes ii. Primary treatment iii. Secondary treatment

Advanced wastewater treatment

i. Tertiary treatment

6) **What are the functions involved in the chemical unit processes? CO2, BTL-K1 (May/Jun-14)**

Chemical precipitation, Gas transfer, Adsorption, Disinfection, Combustion loss exchange, Electro dialysis

7) **What do you understand by waste water treatment? CO2, BTL-K1 (Nov/Dec-13)**

The wastewater treatment or sewage treatment is a broad term that applies to any process/operation or combination of processes and operations that can reduce the objectionable properties of water carried waste and render it less dangerous with the following.

1. Removal of suspended and floatable material 2. Treatment of biodegradable organics
3. Elimination of pathogenic organisms

8) **What is the detention periods range for sedimentation? CO2, BTL-K1 (Nov/Dec-13)**

The detention periods range 45 to 120 min

9) **Plan a general layout for sewage treatment process? CO2, BTL-K4 (May/Jun-12)**

1. Screening 2. Sedimentation 3. Oxidation 4. Disinfection

10) **Give example for single & Double storied sedimentation tank? CO2, BTL-K1 (May/Jun-12)**

Single stored tanks - septic tank

Double stored tank - Imhoff tank

11) **What are the Demerits of chemical precipitation? CO2, BTL-K1 (May/Jun-16)**

High cost of chemicals, large quantity of sludge which offers difficulty in removal, skilled labour, Putrescible efficient

12) **What do you mean by chemical precipitation? (May/Jun-16)**

When certain chemicals are added to, sewage they produce a precipitate known as flow which is insoluble or slightly soluble in water. The flow attracts small particles to form large size and thus size goes on increasing during the process of settlement.

13) **What is do you mean by transitional setting zone? CO2, BTL-K1 (Nov/Dec-15)**

Grit particles however, generally lie between 0.1mm and 1 mm, and hence undergo settling which lies in between streamline settling and turbulent settling. This settling zone is called the transitional settling zone

14) **What are the classifications of biological process? CO2, BTL-K1 (May/Jun-15)**

a) Aerobic processes b) Anaerobic processes c) Aerobic – anaerobic processes

15) **List out the aerobic processes? CO2, BTL-K1 (May/Jun-15)**

1. Activated sludge processes 2. Trickling filters 3. Aerobic stabilization pond 4. Aerated lagoon

16) **List out the anaerobic process? CO2, BTL-K1 (Nov/Dec-14)**

1. Anaerobic sludge digestion 2. Anaerobic contact processes 3. Anaerobic filters 4. Anaerobic lagoons or ponds

21) **What is the function of septic tank? CO2, BTL-K1 (Apr/May17)**

The three major functions of a septic tank are:

i) Sedimentation: removal of suspended solids by gravity

ii) Digestion of settled sludge

iii) Storage of digested sludge.

25) **Why a constant velocity have to be maintained in a grit channel? CO2, BTL-K1 (Apr/May-17)**

The constant velocity has to be maintained in the grit chamber is to provide uniform settling of the grit particles. If all the organic matter is removed it can be scoured and removed.

26) **What is sludge? CO2, BTL-K1 (Nov/Dec-17)**

The sludge is the solids that settle to the bottom of the sewage treatment units. The sludge contains 90 to 95% moisture content and only 5 to 10% solids.

27) Name the significance of Grey water harvesting. CO2, BTL-K1 (Apr/May-18)

- Lower freshwater use
- Less load on treatment plant
- Highly effective purification
- On sites unsuitable for a septic tank
- Groundwater recharge
- Plant growth

28) Why Grit chamber is provided in sewage treatment process? CO2, BTL-K1 (Apr/May-18)

Grit chamber is the second unit operation used in the primary treatment of wastewater and it is intended to remove suspended inorganic particles. they are provided to protect the moving mechanical equipments from abrasion, avoid deposition in pipelines and to reduce frequency of digestor cleaning.

UNIT 3
SECONDARY TREATMENT OF SEWAGE
PART-A

1) Give any 4 advantages of activated sludge process? CO3, BTL-K1 (May/Jun-16)

i) Lesser land area is required
ii) The head loss on the plant is quite low

2) What are the disadvantages of the activated sludge plant? CO3, BTL-K1 (May/Jun-16)

i) High cost of operation and greater power consumption
ii) A lot of machinery to be handled
iii) The sudden change in the quantity and character of sewage may produce adverse effects on the working of the process thus producing inferior efficient

3) Differentiate between oxidation ditch and oxidation pond. CO2, BTL-K2 (Nov/Dec-17)

Oxidation ditch	Oxidation Pond
• It is an extended aeration process for similar to ASP with high microbial concentration • The Aeration period extends from 12 to 15hrs • Efficiency: 95 to98% removal of suspended solids and BOD • No need of primary settling tank and sludge digesters	Open large earthen basin to store sewage for several days Suitable for rural areas Low initial and operational cost Odour nuisance and poor effluent quality

4 Distinguish between SRT and HRT. CO3, BTL-K4 (Apr/May-17)

SRT	HRT
• Solids retention time • It is the average time for which the mass of suspended solids is detained in the aeration tank • It depends on the recirculation of activated sludge and sludge wasting • It is the ratio of mass of suspended	Hydraulic retention time It decides the sewage loading in the aeration tank It is the average time for which sewage is detained in the aeration tank It is the ratio of volume of aeration tank to the

solids in the aeration tank to the mass of suspended solids leaving the system	discharge

5) What do you mean by secondary treatment? CO3, BTL-K1 (Nov/Dec-15)

The efficient from the primary sedimentation tank contains about 60 to 80% of the unstable organic matter originally present in sewage. Thus colloidal organic matter, which passes the primary clarifies, without setting there, has to be removed by further treatment. This is called secondary or biological treatment

6) What are the filters used in sewage treatment? CO3, BTL-K1 (May/Jun-15)

1) Contact beds (very small plant)
2) Intermittent fillers (small plant)
3) Trickling filters (commonly used in modern days)

7) What are the types of trickling filters? CO3, BTL-K1 (May/Jun-15)

1) Conventional trickling filter or ordinary or standard rate or low rate trickling filter
2) High rate filters or high rate trickling filter

8) What are the advantages of trickling filters? CO3, BTL-K1 (Nov/Dec-14)

i) Rate of filter loading is high as such requiring lesser land areas and smaller quantities of filter media for their installations. ii) They are self- clearing

9) What are the disadvantages of trickling filters? CO3, BTL-K1 (Nov/Dec 14)

i) The head loss through these filters is high, making automatic during of the filters necessary
ii) Cost of construction is high
iii) There filters cannot treat raw sewage. primary sedimentation is a must.

10) What are the types of high rate Filters? CO3, BTL-K1 (May/Jun-13)

Bio filters, Accelo filters, Aero filters

11) What are the special types of filters? CO3, BTL-K1 (May/Jun-13)

Durban filter, Magnetic filters, Rapid sand filters

12) What are functions of aeration in ASP? CO3, BTL-K1 (May/Jun-15)

1) Oxygenation of the mixed water
2) Flocculation of the colloid in sewage influent
3) Suspension of activated sludge

13) What are the methods employed for the purpose of certain in ASP? CO3, BTL-K1 (May/Jun-15)

Diffused aeration, Mechanical aeration, Combined diff used air and Mechanical aeration. In this type of filter, a layer of crashed magnetic ore of Iron is provided in about 80mm, thickness, and is supported on a non-magnetic metal wire screen sewage is filtered through the magnetic layer which removes the impurities purely by mechanical starching action.

14) List out the important aeration processes in the ASP? CO3, BTL-K1 (Nov/Dec-14)

Conventional process, Tapered aeration process, Step aeration process, Contact stabilization process, completely mixed process, Modified aeration, Extended aeration

15) What are the advantage of stabilization ponds or cagoins? CO3, BTL-K1 (May/Jun-14)

1. Lower initial lost than required for a mechanical plant.
2. Tower operation costs
3. Regulation of efficient discharge possible their pro evolving control of pollution during critical times of the year.

16) What are the disadvantages of lagoons? CO3, BTL-K1 (May/Jun-14)

1. It requires extensive land area. Hence the method can be used only on rural area.
2. If used in urban areas, expansion of town and new developments may encroach on the lagoon site.

17) What do you understand by facultative ponds? CO3, BTL-K1 (Nov/Dec-13)

1. A facultative panel combine the features of the aerobic and anaerobic ponds.
2. Constructed for intermediate depths (1, to 1.5m)
3. A facilitative pond consists of three

18) What are the remedial measures for rising sludge problem? CO3, BTL-K1 (Nov/Dec13)

1. Increasing the return sludge age
2. Increasing the speed of the sludge scraper mechanism, where possible
3. Decreasing the cell residence time by increasing the sludge rate

19) What is meant by sludge bulking? CO3, BTL-K1 (May/Jun-13)

Sludge with poor setting characteristics is termed as bulking sludge. It results on poor influent due to the presence of excessive suspended solids and also in rapid loss of MLSS from aeration

20) What do you understand by contact beds? CO3, BTL-K1 (Nov/Dec-12)

Contact beds, also called contact filters, are similar to intermittent sand filters in construction, except that the filtering media is very coarse, consisting of broken stones called ballast of 20 to 50mm gauge. A contact bed is a water tight take of masonry walls and of rectangular shape. The depth of filtering media is kept between 1 to 1.8m

21) What are the operations involved in the contact beds? CO3, BTL-K1 (May/Jun-12)

Filling, Contact, Emptying, Oxidation

22) What are the advantages of contact of beds? CO3, BTL-K1 (May/Jun-12)

i) Contact beds can work under small heads.ii) Contact beds can be operated without exposing the sewageefficient to view.iii) There is no nuisance of filter flows

23) What are the disadvantages of contact beds in T.F? CO3, BTL-K1 (Nov/Dec-11)

i) Rate of loading is much less in comparison to trickling filters.
ii) Large areas of land is required for their installation
iii) Intermittent operation requires continuous attendance

24)What do you mean by tricking filters? CO3, BTL-K1 (Nov/Dec-11)

Tricking filters, also known as percolating filters or sprinkling filters are similar to contact beds

in construction, but their operation is confinceous and they allow constant aeration. In this system sewage is allowed to sprinkle or trickle over a bed of course, rough hard filter media and it is then collected through the under drainage system

25) What are the purposes of under drainage system? CO3, BTL-K1 (May/Jun-11)

The purpose of under drainage system is two fold
(i) To carry away the liquid efficient and sloughed biological solids.
(ii) To distribute air through the bed

26) What are the merits of conventional trickling filter? CO3, BTL-K1 (May/Jun-11)

1) The efficient obtained from trickling filters is highly nitrified and stabilized. The efficient can therefore be disposed of in smaller quantity of deputation water
2) It has good dependability to produce good efficient under very widely varying whether and other conditions

27) What are the demerits of conventional trickling filters? CO3, BTL-K1 (Nov/Dec-10)

1) The loss of head through the filter system is high they are making the automatic dosing through siphonic doing tank necessary
2) The cost of construction of the filter is high

31) Define the term Activated sludge? CO3, BTL-K1 (Apr/May-18)

In ASP wastewater containing organic matter is aerated in an aeration basin in which microorganisms metabolize the suspended and soluble organic matter. Part of organic matter is synthesized into new cells and part is oxidized to CO_2 and water to derive energy.ynthesized into new cells and part is oxidized to CO_2 and water to derive energy.

32) Write a short note on USAB. CO3, BTL-K1 (Apr/May-18)

Upflow anaerobic sludge blanket maintains a high concentration of biomass through the formation of highly settlable microbial sludge aggregates.

The waste water flow upwards through a layer of active sludge to cause anaerobic digestion of organics of wastewater

UNIT-4 DISPOSAL OF SEWAGE
PART-A

1) **Define the term "Dilution Factor". CO4, BTL-K1 (May/Jun-16)**

The ratio of the quantity of the diluting water to that of the sewage is known as the Dilution Factor..

2) **What are the methods adopted for sewage disposal? CO4, BTL-K1 (May/Jun-16, Apr/May-18)**

1. Dilution is disposal in water.
2. Effluent Irrigation or Broad Irrigation or Sewage forming is disposal on land.

3) **What are the conditions adopted for disposal by dilution? CO4, BTL-K1 (Nov/Dec-15)**

1. When sewage is comparatively fresh (4 to hr old) and free from floating and settleable solids.
2. When the dilution water has high dissolved oxygen (D.O.) content.

4) **What are the natural forces of purification? CO4, BTL-K1 (Nov/Dec-15)**

1. Dilution and dispersion, Sedimentation ,Oxidation – reduction in sun-light, Oxidation, Reduction

5) **What are the factors affecting self purification of polluted streams? CO4, BTL-K1 (May/Jun-15)**

a) Temperature
b) Turbulence
c) Hydrography such as the velocity and surface expanse of the river stream.

6) **What are the types of self purification? CO4, BTL-K1 (May/Jun-15)**

1. Zone of degradation.
2. Zone of active decomposition.
3. Zone of recovery
4. Zone of Cleaner water

7) **What is meant by "Self purification phenomenon"? CO4, BTL-K1 (Nov/Dec-14)**

When sewage is discharged into a natural body of water, the receiving water gets polluted due to waste products, present in sewage effluent. The natural forces of purification such as dilution, sedimentation, and oxidation – reduction in sun light go on acting upon the polluted elements and bring back the water into its original condition. This automatic purification of polluted water, in due course is called the self purification phenomenon.

8) **What is meant by photosynthesis? CO4, BTL-K1 (Nov/Dec-14)**

The sun light has a bleaching and stabilizing effect of bacteria. It also helps certain micro organisms to derive energy from it and convert themselves into food for other forms of life, thus absorbing CO_2 and releasing O_2 by a process known as Photosynthesis.

9) **What do you mean by Oxidation? CO4, BTL-K1 (May/Jun-14)**

The oxidation of the organic matter present in sewage effluents will start as soon as the sewage out falls into the river water containing dissolved oxygen. The deficiency of oxygen so created will be filled up by the atmospheric oxygen. The process of oxidation will continue till the organic matter has been completely oxidized. This is the most important action responsible for effecting self purification of rivers.

10) **What do you understand by Reduction? CO4, BTL-K1 (May/Jun-14)**

Reduction occurs due to hydrolysis of organic matter settled at the bottom either chemically or biologically. Anaerobic bacteria will help in splitting the complex organic constituents of sewage into liquids and gases and thus paving the way for their ultimate stabilization by oxidation.

11) **Define the term Re-oxygenation curve. CO4, BTL-K1 (Nov/Dec-13)**

In order to counter – balance the consumption of D.O, due to de-oxygenation, atmosphere supplies oxygen to the water and the process is called re-oxygenation.

12) **What is mean by "Oxygen sag curve"? CO4, BTL-K1 (Nov/Dec-13)**

The amount of resultant oxygen deficit can be obtained by algebraically adding the de-oxygenation and re-oxygenation curves. The resultant curve so obtained is called the oxygen sag curve or the oxygen deficit curve.

13) Define the term "limnology". CO4, BTL-K1

The study of the biological, chemical, and physical features of lakes and other bodies of fresh water is called limnology.

14) What is meant by epilimnion zone? CO4, BTL-K1 (May/Jun-13)

The water of a lake gets stratified during summers and winters. Since such turbulence extends only to a limited depth from below the water surface, the top layers of water in the lake become well mixed and aerobic. This warmer, well mixed and aerobic depth of water is called epilomnion zone.

15) What is meant by hypolimnion zone? CO4, BTL-K1 (May/Jun-13

The lower depth of water in the lake which remains cooler, poorly mixed and an aerobic, is called hypolimnion zone.

16) What do you understand by monocline? Give example. CO4, BTL-K1 (Nov/Dec-12)

The water of a lake gets stratified during summers and winters. The change from epilimnion to hypolimnion can be experienced while swimming in a lake. When you swim in top layers horizontally you will feel the water warmer and if you dive deeper, you will find the water cooler. The change line will represent monocline.

17) What are the classification of biological zones in lakes? CO4, BTL-K1 (Nov/Dec-12)

Euphotic zone, Littoral zone, benthic zone

18) What do you understand by "Euphotic Zone"? CO4, BTL-K1 (May/Jun-12)

The upper layer of lake water through which sunlight can penetrate is called the euphotic zone. All plant growth occurs in this zone. In deep water, algae grow as the most important plants, whole rooted plants grow in shallow water near the shore.

UNIT-5 SLUDGE TREATMENT AND DISPOSAL

PART-A

1) What are the distinct stages in the sludge digestion processes? CO5, BTL-K1 (May/Jun-16)

1) Acid fermentation 2) Acid repression 3) Alkaline fermentation

2) Define the term ripened sludge? CO5, BTL-K1 (Nov/Dec-15)

This digested sludge (from Alkaline fermentation stage)is collected at the bottom of the digestion tank and is also called repented sludge.

3) What are the factors affecting sludge digestion? CO5, BTL-K1 (Nov/Dec-15)

1.Temperature Thermopolis
2. Pit value
3. Seeding digested sludge
4. Mixing and stirring of sludge.

the raw sludge with digested

4) List the methods of sludge thickening or concentration? CO5, BTL-K1

1. Gravity Thickening 2. Air floatation 3. Centrifuging

5) Compare the methods of sludge digestion CO5, BTL-K4

Anaerobic Digestion	Aerobic Digestion
• Biological decomposition of organic matter in sludge by anaerobic microorganism in the absence of oxygen	Biological decomposition of organic matter in sludge by aerobic microorganism in the presence of oxygen
• Operation cost is low	Operation cost is more
• Sludge production is less	Low capital cost
• Construction cost is more	Construction cost is more
• Odour nuisance	No Odour nuisance
• It takes time to start the operation	It takes time to start the operation

• By product biogas is recovered which can be used for power generation	and no by product is recovered

6) What is the objective of sludge treatment? CO5, BTL-K1

Reduce sludge volume, moisture reduction, increasing solids concentration, reduce transportation cost of sludge, minimize land requirement for sludge disposal, save fuel cost for incineration of sludge.

7) Define the term Eutrophication? CO5, BTL-K1 (Nov/Dec-15)

The excess growth of algae and other aquatic plants in a river stream is called eutrophication

8) What is meant by sludge conditioning? What are the methods of conditioning? CO5, BTL-K1 (Apr/May-17, Nov/Dec-17)

Sludge conditioning is a process whereby sludge solids are treated with chemicals or various other means to prepare the sludge for dewatering processes, in other words, to improve dewatering characteristics of the sludge. The methods of sludge conditioning are Chemical conditioning, thermal conditioning and Freeze-Thaw conditioning.

9) What is meant by dewatering? CO5, BTL-K1 (Apr/May-17)

Dewatering of residuals is the physical process of removing the water content of the sludgemaking it easier to handle and less expensive to transport, to compost to incinerate or to dispose of in a landfill. Dewatering can be done with the help of presses or centrifuges, filtration or physical processes in drying beds

10) List out the advantages of sludge thickening? CO5, BTL-K1 (Apr/May-18)

- Reduction of load on digesters, improved digestion and higher gas yield due to longer solids retention times
- The costs of the labor management and energy consumptions.

UNIT– 1
PLANNING AND DESIGN OF SEWERAGE SYSTEMS

PART –B

1) i) Explain in detail about the characteristics of sewage. (**CO1) (BTL-K2) (May/Jun-16)**
ii) Discuss the significance of total solids and BOD in determining the characteristics of sewage. **(CO1) (BTL-K6) (May/Jun-14, Nov/Dec-12)**

2) Find the combined flow discharge of sewage for the given data. Area to be served is 150 hectare. Population density is 50000. Time of entry is 5 minutes. Time of flow is 20 minutes. Rate of water supply is 135 Lpcd. Impermeability factor = 0.45. Assume 80% of water supplied turns into sewer and peak factor as 1.5. (**CO1) (BTL-K1) (May/Jun-15, Apr/May-18)**

3) Estimate the total runoff if the population density is 250/hectare. The rainfall distribution of an area is as follows. The total area of distribution is 36 hectares and the maximum rainfall is 5 mm/hour. **(CO1) (BTL-K5) (May/Jun-14)**

Type of area	% of area	Run off coefficient
Roof	20	0.9
Pavement	20	0.85
Housing	5	0.80
Roads	15	0.4
Lawns	35	0.1
Wooden area	5	0.05

4) i) Explain the terms BOD and COD. Differentiate between first and second stage BOD. (**CO1) (BTL-K2) (May/Jun-12,Apr/May-17)**
ii) The BOD of a sewage incubated for one day at 30^0 C has been found to be 120 mg/l. What will be the 5-day BOD at 20^0 C. Assume BOD rate constant K = 0.21 (base e) per day at 20^0 C and temperature correction coefficient Θ = 1.056. (**CO1) (BTL-K1)** (**May/Jun-12, Nov/Dec-12,Apr/May-17)**

5) i) BOD of a sewage incubated for one day at 30^0 C has been found to be 120 mg/l. What will be its 5 day 20^0 C BOD, if K at 30^0 C is 0.16 per day (base 10). (**CO1) (BTL-K1) (May/Jun-12)**
ii) Discuss the choice available and the factors to be considered while selecting pumps and pipes for sewerage system and explain. (**CO1) (BTL-K6) (May/Jun-15, Nov/Dec-11)**

6) Explain in detail the various adverse effects of Wastewater, the estimation of sanitary sewage flow and storm runoff with the different factors affecting the characteristics and composition of sewage (**CO1) (BTL-K2) (Nov/Dec-17)**

7) Determine the diameter of a separate sewer section running half full at maximum discharge for a town with a population of 100000. Water is supplied at a rate of 200 lpcd. Assume 80% of water supply turns as sewage. Take peak factor = 2.25 and n = 0.013 at all depth. Permissible slope is 1 in 600. (**CO1) (BTL-K5) (May/Jun-16)**

8) Tell about the various types of pumps used for lifting the sewage. (**CO1) (BTL-K1) (May/Jun-16)**

9) What are the systems of plumbing? With help of a neat sketch discuss various systems of plumbing used for drainage. (**CO1) (BTL-K1) (Nov/Dec-15)**

10) i) List the problems faced during pumping of sewage. Under what circumstances pumping of sewage is needed. (**CO1) (BTL-K4) (May/Jun-14, Nov/Dec-12)**
ii) Describe the one pipe and two pipe plumbing systems. Compare them. (**CO1) (BTL-K2) (Nov/Dec-14, Nov/Dec-11, Nov/Dec-12)**

11) List and explain the various sewer appurtenances with neat sketches. (**CO1) (BTL-K4) (Nov/Dec-14)**

12) Design a sewer running 0.7 times full with a town having a population of 100,000 persons with a per capita water supply of 200 lpcd. Take n = 0.013 and slope 1 in 500 and a peak factor of 3. Assume 85% of water supply turns into sewer**. (CO1) (BTL-K6) (May/Jun-14)**

13) i) Determine the diameter and slope of sewer (n=0.013) carrying 0.125m^3/sec of peak sewage flow at half full depth **(CO1) (BTL-K5) (Nov/Dec-11)**

ii) What do you understand by pipe appurtenances? Discuss with the neat sketch a drop manhole and indicate where it is used (**CO1) (BTL-K1) (Nov/Dec-12)**

14) Design a sewer running 0.7 times full at maximum discharge for a town provided with the separate system serving a population of 1,00,000. Water is supplied from the water works at the rate of 200 litres per capita per day. Take the constant value of n=0.013 at all depths of flow. The permissible slope is 1 in 600. Take peak factor of 2.25. Assume 80% of water turns as sewage. (**CO1) (BTL-K6) (Apr/May-17)**

15) i) Explain in detail the working of pressure filter with a neat sketch. (**CO1) (BTL-K2) (Nov/Dec-17)**

ii) Explain the different types of storm water inlets used in collection system? (**CO1) (BTL-K2) (Apr/May18)**

16) A Combined sewer was designed to serve an area of 60 sq.km with an average population density of 185 persons/hectare. The average rate of sewage flow is 350L/capita/day. The maximum flow is 50% in excess of the average sewage flow. The rainfall equivalent of 12 mm in 24h can be considered for design, all of which is contributing to surface runoff. What will be the discharge in the sewer? Find the diameter of the sewer if running full at maximum discharge (**CO1) (BTL-K1) (Apr/May-18)**

17) Explain the procedure for a new Sewer line laying, testing and joining of sewer line. (**CO1) (BTL-K2)** (**Apr/May-18)**

UNIT-2
PRIMARY TREATMENT OF SEWAGE
PART - B

1) Relate about the component parts of septic tank, its advantages and disadvantages with neat sketches. (**CO2) (BTL-K1) (May/Jun-16,May/Jun-12, Nov/Dec-17, Apr/May-18)**

2) A grit chamber is designed to remove particles with a diameter of 0.2 mm. Specific gravity = 2.65. Settling velocity for these particles has been found to be range from 0.016 to 0.22 m/s, depending on the shape factor, a flow through velocity of 0.3 m/s will be maintained by proportioning weir, determine the channel dimensions for a maximum waste water flow of 10,000 cum/day. (**CO2) (BTL-K5) (May/Jun-16)**

3) i) Explain the designing procedure of a screen chamber. (**CO2) (BTL-K2) (Nov/Dec 15)**

ii) Explain the objectives of primary treatment. Discuss about the grit chambers which is adopted in sewage treatment. (**CO2) (BTL-K2) (May/Jun-12)**

4) Explain in detail the Sedimentation tank with neat sketches. (**CO2) (BTL-K2) (Nov/Dec-15)**

5) Explain the objectives of treatment processes and what are the treatments processes, explain? Discuss the various types of screens adopted in sewage treatment with neat sketch. (**CO2) (BTL-K2) (May/Jun-15, Apr/May-18)**

6) Assuming suitable criteria design a screen chamber with 20mm spacing of bar for a proposed STP expected to treat 30 ML/d maximum flow. Draw a neat sketch of the unit. (**CO2) (BTL-K4) (Apr/May-19)**

7) i) Design a bar screen for a peak average flow of 30 million litres per day. (**CO2) (BTL-K6) (May/Jun-15)**

ii) Estimate the screen requirement for a plant treating a peak flow of 60 million litres per day of sewage. (**CO2) (BTL-K6) (May/Jun-13)**

8) Design a circular primary sedimentation tank to treat an average sewage flow of 5000 m^3/day, suitably assuming the design criteria. Draw a neat sketch of the designed tank. (**CO2) (BTL-K6) (Nov/Dec 14)**

9) Explain in detail about i) grey water harvesting (**CO2) (BTL-K2) (Nov/Dec-17)** ii) on-site sanitation. (**CO2) (BTL-K2) (Nov/Dec-14)**

10) Design a septic tank with dispersion pit for a hostel with a population of 150 and peak discharge of 205 LPM. Take desludging period as one year. Assume suitable design criteria and draw a neat sketch of the designed tank. (**CO2) (BTL-K6) (May/Jun-13, Nov/Dec-12)**

11) i) Explain the objectives of preliminary treatment. Discuss the various types of screens adopted in sewage treatment. (**CO2) (BTL-K2) (Nov/Dec-12)**

ii) Name various types of settling and discuss the significance of surface over flow rate in design of sedimentation tanks (**CO2) (BTL-K1) (May/Jun-12)**

12) i) Explain the velocity control devices in grit channel (**CO2) (BTL-K2) (Apr/May-17)**

ii) Design a septic tank for a hostel of 150 persons. Let the desludging period be taken as one year and length to breadth ratio as 2.5:1. Adopt peak discharge of 205 LPM surface area @ 0.92m^2 for every 10LPM of peak flow rate. Also design a soil absorption system dispersion trench for the disposal of the septic tank effluent, assuming the percolation rate as 100L/ m^2/d. Assume data wherever necessary. (**CO2) (BTL-K6) (Apr/May-17)**

13) Explain the process of Preliminary Treatment of sewage with the help of neat sketch. (**CO2) (BTL-K2) (Nov/Dec-17)**

UNIT-3
SECONDARY TREATMENT OF SEWAGE
PART – B

1. Explain in detail about the UASB reactor with neat sketch, advantages and dis advantages (**CO3) (BTL-K2) (May/Jun-16)**.
2. Summarize about the oxidation ditches with neat sketch, advantages and disadvantages. (**CO3) (BTL-K2) (May/Jun-16)**
3. Explain with neat sketches about the trickling filters. (**CO3) (BTL-K2) (Nov/Dec-15, Nov/Dec-17, Apr/May-18)**
4. (i) Discuss the operational principles of activated sludge process. (**CO3) (BTL-K6) (Nov/Dec-15, May/Jun- 13)**

   (ii) Compare the advantages and disadvantages of ASP and Tricking Filters. (**CO3) (BTL-K5) (Nov/Dec-14)**
5. What do you understand by waste stabilization ponds? Explain in detail. (**CO3) (BTL-K1) (May/Jun-15, May/Jun-12, Apr/May-18)**
6. Explain the working principle of a UASB reactor and draw the typical

process flow diagram for UASB reactor. (**CO3) (BTL-K2) (Apr/May-19)**

7. Determine the size of standard rate trickling filter to treat 6 million litres of sewage per day having BOD of 160 mg/l. Take hydraulic loading of $6m^3/m^2/d$ and organic loading of 0.35 $kg/m^3/d$. (**CO3) (BTL-K5) (May/Jun-15)**
8. Determine the size of a high rate trickling filter for the following data (**CO3) (BTL-K5) (Nov/Dec 14, Apr/May-17)**
   Sewage flow = 4.5 million litres per day Recirculation ratio = 1.5
   BOD for raw average = 230 mg/l
   BOD removal in PST = 30 %
   BOD of treated effluent required = 25 mg/l
9. Design an oxidation ditch for a community of 7500 with a per capita sewage contribution of 90 lpcd and BOD 250 mg/l. The desired BOD of the treated sewage is 30 mg/l. (**CO3) (BTL-K6) (May/Jun-13)**
10. Explain in detail the activated sludge process with neat diagram. (**CO3) (BTL-K2) (May/Jun-13, Apr/May-18)**
11. Explain the basic operation, principles, functions and design of an activated sludge process with flow diagram. Also mention its operational troubles with remedial suggestions. (**CO3) (BTL-K2) (Apr/May-17,Nov/Dec-17)**
12. Explain the process of Reclamation and Reuse of Sewage. With the help of neat sketch explain the sewage recycle plant for a residential complex (**CO3) (BTL-K2)** (**Nov/Dec-17)**
13. It is proposed to treat 18 ML/d of primary treated sewage with the help of a ASP system. The BOD of raw sewage is 280 mg/l. Design the various components of ASP system by assuming the following parameters. (**CO3) (BTL-K6)** (**Apr/May 2019)**
    MLVSS in the reactor = 2500 mg/L
    Return sludge concentration (VSS) = 8000mg/L
    MCRT = 8 d
    Yield coefficient = 0.45
    Decay coefficient = 0.05 d^{-1}

UNIT-4
DISPOSAL OF SEWAGE
PART – B

1. A large stream has a rate of reaeration constant, kr = 0.24 per day (to base 10) and deoxygenation constant, kd = 0.1 per day (to the base 10). The initial deficit of the mixture of stream and waste water at the point of reference Do = 4 mg/l and the ultimate 5 day BOD, Lo = 35 mg/l. Find the DO deficit and critical time. (**CO4) (BTL-K4) (May/Jun-16, Nov/Dec-12)**
2. Outline about (a) Wastewater reclamation (b) Sewage disposal to sea water. (**CO4) (BTL-K2) (May/Jun- 16)**
3. List the various actions involved in the self-purification process of a stream and explain briefly. (**CO4) (BTL-K4) (Nov/Dec-15)**
4. Explain the methods available and limitations of land disposal of sewage. (**CO4) (BTL-K2) (May/Jun-15)**
5. (i) Solve the Streeter Phelps equation and show its application. (**CO4) (BTL-K3) (May/Jun-15)**
   (ii) A town discharges 14 million litres per day sewage at a temperature of 23^0 C into a river having flow of 1.7 m^3/sec and water temperature of 20^0 C. BOD at 20^0 C for the waste water is 160 mg/l and k (base 10) is 0.1 per day. If R is 0.2 per day what is the critical oxygen deficit and the distance at which it occurs. Assume the stream as 92% saturated with oxygen before sewage addition the

solubility of oxygen at 20^0 C as 0.9 mg/l and river flow velocity as 0.12m/s. (**CO4) (BTL-K1) (Nov/Dec-14)**

6. (i) Explain the principle of the self-purification process of stream and factors influencing the process. (**CO4) (BTL-K2) (Nov/Dec-14,May/Jun-12, Apr/May-17, Apr/May-18)**
7. (i) Draw a typical oxygen sag curve and explain its meaning. (**CO4) (BTL-K2) (Nov/Dec-14, May/Jun-12, Apr/May-17, Apr/May-18)**
   (ii) Determine the BOD of river water at the discharge point of the treated sewage from a town having a BOD of 30 mg/l discharged at the rate of 5 m^3/s into a river having a flow of 30 m^3/s and no BOD. (**CO4) (BTL-K5)**
8. Summarize about lagooning dumping landfilling and incineration of solid wastes. (**CO4) (BTL-K2) (Nov/Dec-18)**

UNIT-5
SLUDGE TREATMENT AND DISPOSAL
PART – B

1. (i) Explain the mechanism of biogas recovery from sludge. (**CO5) (BTL-K2) (Nov/Dec-15)**
   (ii) A wastewater treatment plant produces sludge of 1000 kg dry solids per day with a moisture content of 97%. The solids are 65% volatile with specific gravity 1.05 and inorganic solids of specific gravity 2.55. Determine the sludge volume of raw sludge, after dewatering to 70% and after incineration. **(CO5) (BTL-K5)**
2. (i) Explain various process involved in sludge treatment and disposal with the help of flow chart. (**CO5) (BTL-K2) (Nov/Dec-17)**
   (ii) Explain the mechanism of anaerobic and aerobic sludge digestion with their relative merits and demerits. (**CO5) (BTL-K2) (May/Jun-13, Nov/Dec-12)**
3. (i) Explain the various process involved in sludge treatment and disposal. (**CO5) (BTL-K2)**
4. (i) Explain the mechanism of anaerobic and aerobic sludge digestion with their relative merits and demerits. (**CO5) (BTL-K2) (May/Jun-13, Nov/Dec-12)**
   (ii) Explain the anaerobic sludge digestion process and also the effects of pH and temperature on it. (**CO5) (BTL-K2) (May/Jun-13 Apr/May-18)**
5. Explain the working of a standard rate sludge digester with the help of a neat diagram.(**CO5) (BTL-K2) (Apr/May-17)**
6. Explain the characteristics of sludge and how biogas can be converted (**CO5) (BTL-K2)** (**Nov/Dec-17)**
7. Explain the various advances in the treatment of sludge and mode of disposal (**CO5) (BTL-K2)** (**Nov/Dec-17)**
8. With the help of flow chart explain various process involved in dairy industry sludge treatment and disposal. (**CO5) (BTL-K2)**
9. Draw a neat sketch of a high rate two – stage anaerobic sludge digester and explain its working principle. (**CO5) (BTL-K2) (Apr/May-19)**