Ref No. –Ex/PG/CE/T/128E/2017

M.E. CIVIL ENGINEERING EXAMINATION, 2017

(2^{nd} Semester)

SUBJECT: Process Design in Environmental Engineering

Time: Three hours | Full Marks 100

Use separate Answer-Scripts for each part

No. of Questions	Part I (40 marks for this part)	Marks
	Answer any two questions. Assume relevant data if necessary.	
Q1. a)	Discuss algae bacteria symbiosis with a neat sketch in waste water treatment for a stabilisation pond.	5
b)	Explain the effects of the following factors on the design of a facultative stabilization pond: (i) Solar radiations at different latitudes corrected for sky clearance factor (ii) Dispersion number (iii) Oxygen production	3×3
c)	It has been found that the observed die off coefficient for E-coli in waste stabilization pond can be described adequately by first order kinetics. Assume that the bacteria die off rate is 1.1 per day at 20°C. Check the whether the effluent obtained from the stabilization pond is suitable for irrigation (1000/100ml) with initial concentration 10^6/100ml at 25°C. The surface area of the pond is 4 ha, depth is 1.5m and daily flow rate is 5000 m^3/day. Assume dispersion number is 0.5. Use the figure attached. If the coliform concentration is required to reduce further what measures you will recommend other than chlorination?	4+2
Q2. a)	Write a short note on facultative aerated lagoon with a neat schematic diagram.	5+2
b)	Determine the surface area of the aerated lagoon if the pond water temperature is to be maintained 20°C. Given waste water temperature 25°C, ambient temperature 15°C, heat exchange coefficient is 0.5 m/day and inflow rate 3000 m^3/day.	3
c)	Design an earthen sedimentation basin for an aerated lagoon to separate solids for the given information: • Flow to the sedimentation basin = 3500 m^3/day • Suspended solids in the influent to the basin = 200mg/L • Suspended solids in the effluent from the basin = 200mg/L • Volatile fraction of the total solids discharged to the sedimentation basin =70% • The cleaning interval of the basin = 4years • The volatile solids available at the end of the t years of operation assuming linear decomposition of the volatile solid, VSS_t=[0.7+0.4(t-1)]× VSS deposited per year • Hydraulic detention time = 2 days • The liquid level above the sludge layer at its maximum layer of accumulation = 1.5 m Assuming the deposited solids will compact to an average value of 15%, with the specific density of	10

Ref No. –Ex/PG/CE/T/128E/2017

M.E. CIVIL ENGINEERING EXAMINATION, 2017

(2nd Semester)

SUBJECT: Process Design in Environmental Engineering

Time: Three hours

Full Marks 100

Use separate Answer-Scripts for each part

No. of Questions	Part I (40 marks for this part)
	the accumulated solids determine:
	▪ Volume of the sedimentation basin
	▪ Surface area of the sedimentation basin
	▪ Depth required for storage of sludge
Q3.a)	Write the basic difference between oxidation ditch and aerated lagoon.
b)	Why oxidation ditch is considered as a low cost treatment method?
c)	Draw a complete flow sheet of waste water treatment using oxidation ditch.
d)	Determine the oxygenation capacity of a cage rotor for an oxidation ditch in kg per day with the following information:
	(i) Population served = 30,000
	(ii) Waste water flow = 200Lpercapita per day
	(iii) Percapita BOD_5 contribution = 40g/capita per day
	(iv) Desired effluent BOD_5=20 mg/L
	(v) TKN concentration in the influent = 45mg/L
	(vi) Mixed liquor suspended solid concentration = 3500mg/L
	(vii)Volatile fraction of MLSS = 0.55
	(viii)Suspended solid in the effluent = 20mg/L
	(ix) 65% of the suspended solid of the effluent is biodegradable
	(x)Sludge yield coefficient = 0.6
	(xi) Sludge decay coefficient = 0.12/day
	(xii)Food to micro-organism ratio=0.25
	(xiii) Liquid temperature in the lagoon =10°C
	(xiv)Elevation of the area = 1000m
	(xv) α = 0.98; β= 1
	(xvi)C_s = 9.17mg/L at 20°C
	(xvii)C_w at 10°C = 11.27mg/L
	(xviii) Altitude correction factor for 1000m elevation = 0.95

Ref No. –Ex/PG/CE/T/128E/2017

M.E. CIVIL ENGINEERING EXAMINATION, 2017

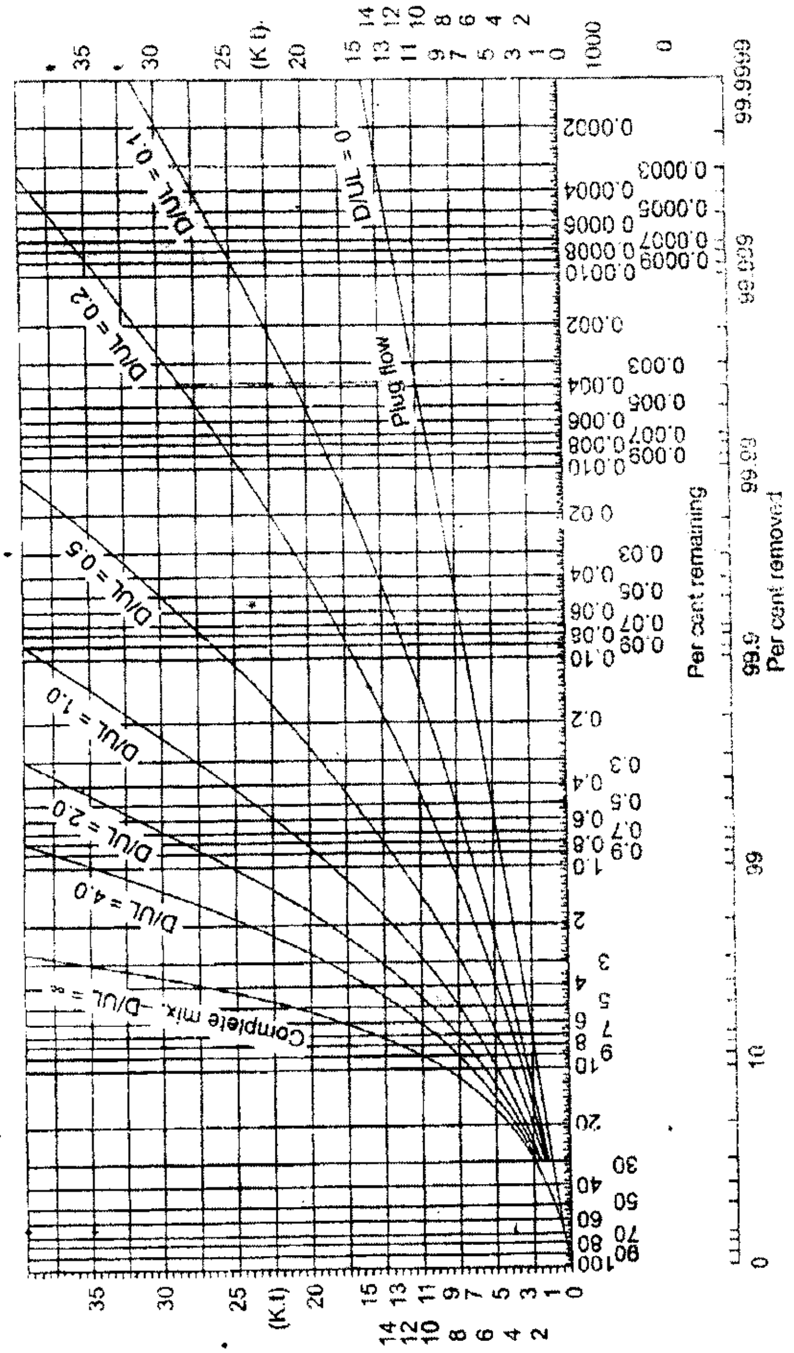
(2nd Semester)

SUBJECT: Process Design in Environmental Engineering

Time: Three hours | Full Marks 100

Use separate Answer-Scripts for each part

No. of Questions	Part I (40 marks for this part)	Marks



Ref No. –Ex/PG/CE/T/128E/2017

MASTER OF CIVIL ENGINEERING EXAMINATION, 2017
2^{nd} Semester

SUBJECT: **PROCESS DESIGN IN ENVIRONMENTAL ENGINEERING**

Full Marks ~~30~~/100

Time: ~~Two hours~~/Three hours/~~Four hours/ Six hours~~

Use a separate Answer-Script for each part

No. of Questions	**Part II (Marks:60)**

Answer any 4 (four) questions .
Assume relevant data if required.

Q1.

a) How do you analysis settling data of flocculent particles?

b) A settling column analysis is run on a Type 2 suspension with following results as supended solid concentration. Determine the theoretical efficiency of the settling chamber with a depth of 3.5m with a volume of 1400 m3 and a inflow of 11,200m3/day. Calculate also the percentage removal matrix in tabular form.

Depth, m	0	40	80	120	160	200	240	280
0.5	820	369	238	164	107	66	41	33
1.0	820	442	368	278	213	164	115	90
1.5	820	631	476	361	287	230	180	148
2.0	820	672	558	426	353	287	238	187
2.5	820	713	590	492	402	344	262	230
3.0	820	722	615	533	460	394	320	262
3.5	820	738	656	574	492	418	360	303

Q.2.

a) Draw a typical flow diagram of Two stage trickling filter with recirculation of effluent.

b) A typical trickling filter treats sewage with a flow of 5 MLD having influent BOD5 equals to 160 mg/L. The desired effluent BOD5 is 20mg/L. The recirculation ratio is 3.0. F1 and F2 are 2.2. The depth of the tank is 2.3m. Compute the size of the units. Check the hydraulic loading and organic loading of the units. Design also the rotary distributor system considering 4 segments and size of central feeding duct. Assuming relevant data.

Q3

a) A municipal wastewater with a flow of 17550 m3/d and with BOD5 of 150 mg/L is to be treated in a biotower with plastic modular medium. Pilot plant analysis has established a treatability constant of $0.05d^{-1}$ for the system at 20^0 C. The maximum temperature is expected is 25° C and the minimum temperature is expected is 12° C for a 2:1 recycle ratio and a 8.0 m depth. Determine the size of the square tower required to produce a 20mg/L.

Ref No. –Ex/PG/CE/T/128E/2017

MASTER OF CIVIL ENGINEERING EXAMINATION, 2017
2nd Semester

SUBJECT: **PROCESS DESIGN IN ENVIRONMENTAL ENGINEERING**

Full Marks ~~30~~/100

Time: ~~Two hours~~/Three hours/~~Four hours/ Six hours~~

Use a separate Answer-Script for each part

No. of Questions	Part II (Marks:60)	Mark
b)	Design a septic tank for a public auditorium for an average footfall of 100. The toilet block consists of 6 urinal, 4 closets, 2 shower, 3 ablution taps, 2 sinks, 4 wash basins,2 taps. Assume 1 FUs (eqv) for each fixtures. The minimum depth of settling is 400 mm and each FU discharges 9 lit/min. Desludging interval is 2 years. Assume following data:- Sludge storage zone- 0.0021m3/capita/day Digestion zone – 0.033m3/capita Volume of digested sludge- 75 lpcd Simultaneous discharge of fixture units= 75% Volume of suspended solids = 70g/c/day.	7
Q4.		
a)	A clean water is passed through a bed of uniform sand at a filtering velocity of 1.4×10^{-3} m/sec. The sand grains are of 0.4mm in dia and shape factor =0.85,sp .gr =2.65 with bed porosityis 0.40. Find the head loss in the bed in mm. Assume K=5.Take $v= 1.01 \times 10^{-2}$ m2/sec. Compute the head loss at 0^0 C and 20^0 C. $v_{0=}$ 1.79×10^{-2} m2/sec.	7
b)	Derive an equation for computing the head loss through filter bed under clean condition with necessary assumption and using conventional symbol of hydraulic and media parameters.	8
Q5.		
a)	Explain the concepts, merits and limitation of anaerobic biological treatment processes.	5
b)	Design an anaerobic contact reactor to remove 90% COD from 2MLD flow of poultry wastewater to be treated in a plant operating at 30^0 C. Assume following data:- i) Reactor MLVSS =3500 mg/L. ii) Influent COD = 1200mg/L iii) Ratio COD: TSS= 1.75 iv) Design SRT= 2 TIMES minimum SRT. v) Y=0.06, k_d =0.02 $d^{-1,}$ k= 5.0d^{-1}, K_s =200mg/L. vi) soluble influent COD = 900 mg/L VII) Effluent TSS= 100 mg/L viii) VSS = 85% of TSS. ix) Gas collection depth= 3.0 m x) Effective digestion depth = 5.0 m xii) Methane yield factor = 0.35.	10

Ref No. –Ex/PG/CE/T/128E/2017

MASTER OF CIVIL ENGINEERING EXAMINATION, 2017

2nd Semester

SUBJECT: PROCESS DESIGN IN ENVIRONMENTAL ENGINEERING

Full Marks ~~30~~/100

Time: ~~Two hours~~/Three hours/~~Four hours/ Six hours~~

Use a separate Answer-Script for each part

No. of Questions	Part II (Marks:60)	Marks
Q6.		
a)	Design a rapid gravity sand filter plant to treat 100 MLD capacity allowing 1.5% of filtered water for back washing . The period of backwashing is 30 min on daily basis. The rate of filtration is 5000 lit / m^2/hr. The stand by allowance is 25 %. The strainer diameter is 13 mm. Calculate the number of filter units and under drainage system. Draw also a neat sketch. Assume suitable data and guidelines.	10
b)	The desired effective size of filter bed sand is 0.45mm dia and uniformity coefficient is 1.6. The particle size distribution analysis shows that % of stock sand smaller than the d10 is 26% and % of stock sand smaller than d60 is 46%. Determine the amount of stock sand necessary to provide in filtering unit per 1000m3 basis. Also determine the % below which the stock sand is too fine and too coarse to screen out or reject.	5