Bharatiya Vidya Bhavan's

SARDAR PATEL COLLEGE OF ENGINEERING

(Government Aided Autonomous Institute)

Munshi Nagar, Andheri (W) Mumbai – 400058

End Semester **November 2025** / ~~Re Examination~~ January 2026

Third Year

Program: B.Tech. in Civil Engineering Sem V **Duration: 3 Hours**

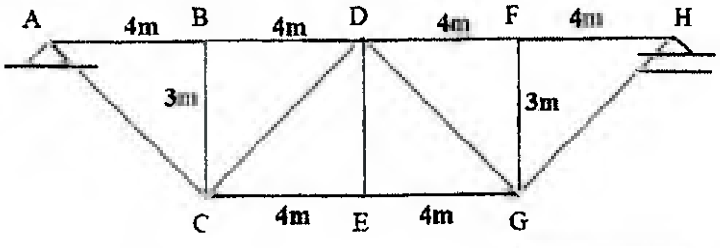
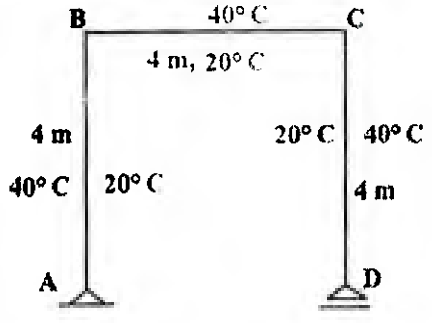
Course Code: PC-BTC 501 **Maximum Points: 100**

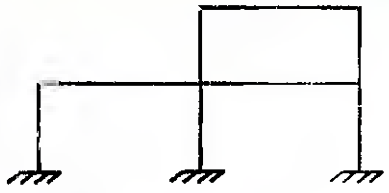
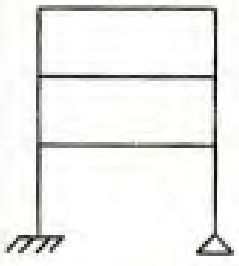
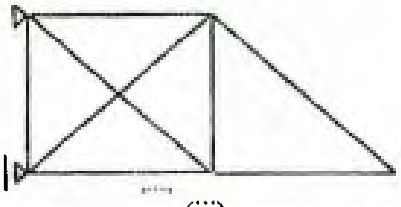
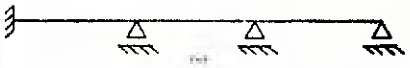
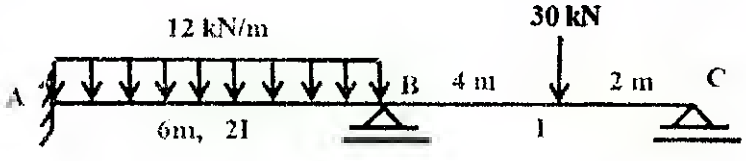
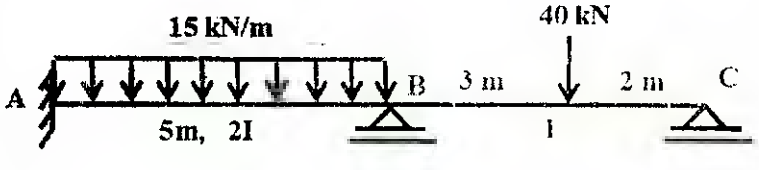
Course Name: Structural Analysis **Semester: V**

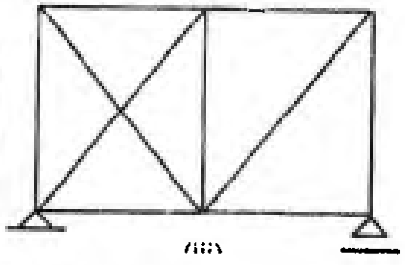
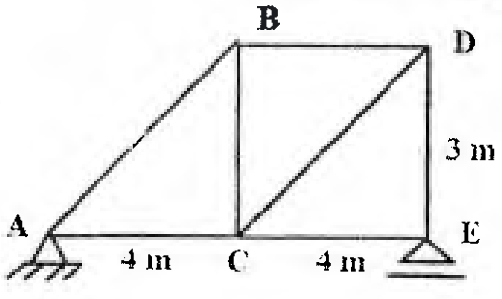
21/11/25

1. Attempt any FIVE questions out of SEVEN questions.
2. **Answers to all sub questions should be grouped together.**
3. Figures to the right indicate full marks.
4. Assume suitable data if necessary and state the same clearly.

Q.No.	Questions	Points	CO	BL	Module
Q.1(a)	**A symmetrical three hinged segmental arch of span 42 m and central rise of 7 m is subjected to a udl of 20 kN/m on the right half horizontal span of the arch and a concentrated load of 120 kN at 12 m from the left support. Determine** **(a) the support reactions** **(b) radial shear, normal thrust and BM just to the right of 120 kN load** **(c) draw BMD** **(d) Show the above internal forces acting on the given section.**	15	1	4	1
Q.1(b)	**Define flexibility coefficient f_{ij} and state the important properties of the flexibility matrix.**	05	4	2	6
Q.2(a)	**A suspension cable of span 50 m is supported at A and B. The support A is 3m above the lowest point C of the cable and B is 4 m above C. The cable is connected to a three hinged stiffening girder. The third hinge of the girder is just below the lowest point C of the cable. The dead load of the girder is 15 kN/m. The girder is subjected to a point load of 160 kN at a distance of 10 m from support A and another point load of 120 kN at a distance of 12 m from support B.** **(a) Determine the intensity of the total udl transferred from the girder to the cable.** **(b) State the location of the maximum and minimum tension in the cable and determine the magnitude of the maximum and minimum tension in the cable.** **(c) Draw SFD and BMD for the girder.**	16	1	3,4	2

Q.2(b)	**Explain the advantages and disadvantages of indeterminate structures over determinate structures.**	04	1	2	5,6,7
Q.3(a)	**A point load of 50 kN traverses a simply supported beam of span 10 m. By drawing suitable ILDs find** **i) the maximum reaction at the left support A** **ii) the maximum positive SF at a section C, 4 m from left support A.** **iii) the maximum BM at section C, 4 m from left support A.**	10	2	3,4	3
Q.3(b)	**For the pin jointed frame (used in deck type bridge) shown in figure below draw influence line diagram for axial force in members BD, CD and CE.**	10	2	3,4	4
					
Q.4(a)	**For the frame shown in figure below, calculate the horizontal deflection of C due to change in temperature as indicated in figure. Take $\alpha = 12 \times 10^{-6}/°C$ and depth of all members as 300 mm.**	12	3	3,4	5
					

Q.4(b)	**Determine the degree of static and kinematic indeterminacy of the structures shown in figures below.**	08	3	3,4	5
	 (i)  (ii)				
	 (iii)  (iv)				
Q.5(a)	**Analyse the continuous beam shown in figure using force method of analysis only and find the reactions at B and C.**	16	4	3,4	6
					
Q.5(b)	**Write a note on the types of arches based on the profile of the arch and degree of static indeterminacy.**	04	2	2,3	1
Q.6(a)	**Analyse the beam shown in figure by slope deflection method only and find the end moments.**	14	4	3,4	7
					

Q.6(b)	**Name different components of suspension cable with three hinged stiffening girder and the internal forces carried by each one of them.**	06	2	2	2
Q.7(a)	**For the structure shown in figures below determine the degree of static external and internal indeterminacy.**	02	3	3,4	5
					
Q.7(b)	**For the structure shown in figure below determine** **(a) the degree of static external and internal indeterminacy** **(b) kinematic indeterminacy considering and neglecting axial deformations.**	04	3	3,4	5
					
Q.7(c)	**The members of the truss shown in figure are subjected to temperature increase of 30^0 C. Calculate the vertical deflection of C due to the increase in temperature. Take $\alpha = 12x10^{-6}/^oC$.**	14	4	3,4	5
					

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SARDAR PATEL COLLEGE OF ENGINEERING

(Government Aided Autonomous Institute)

Munshi Nagar, Andheri (W) Mumbai – 400058

~~End Semester November 2025~~ / Re Examination January 2026

Third Year

Program: B.Tech. in Civil Engineering **Duration: 3 Hours**

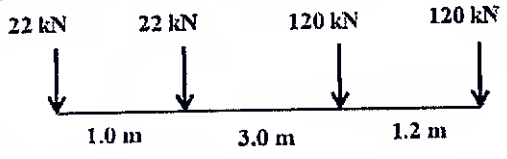
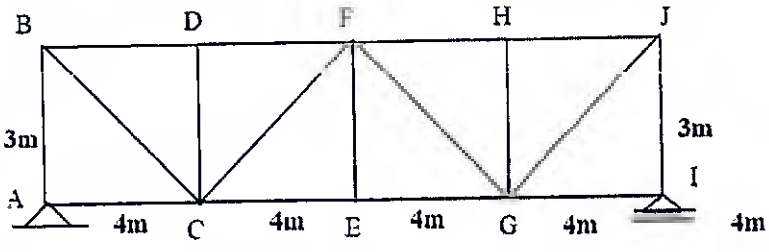
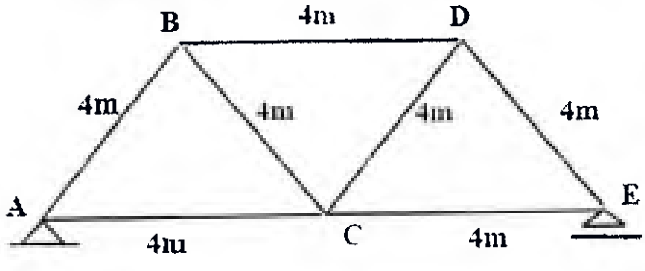
Course Code: PC-BTC 501 Maximum Points: 100

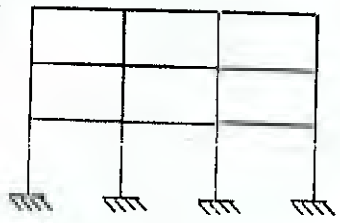
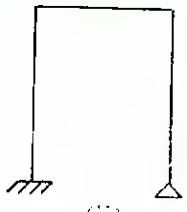
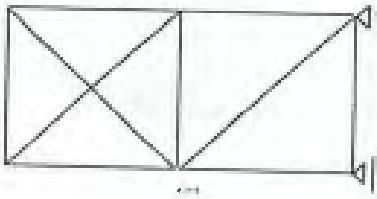
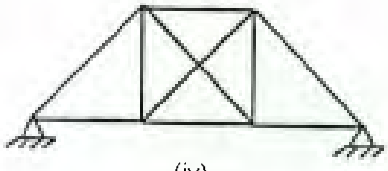
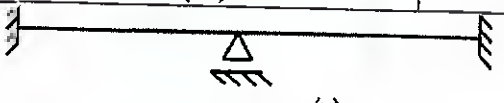
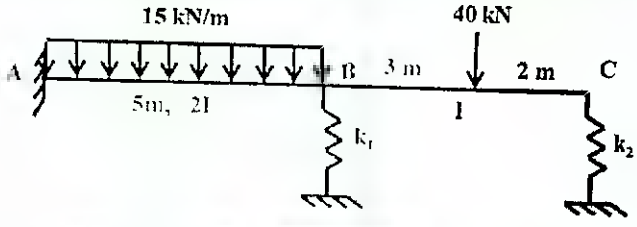
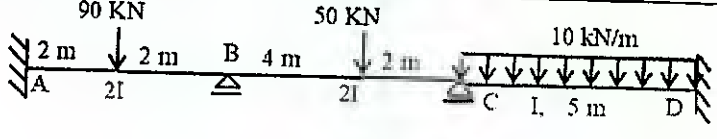
Course Name: Structural Analysis Semester: V

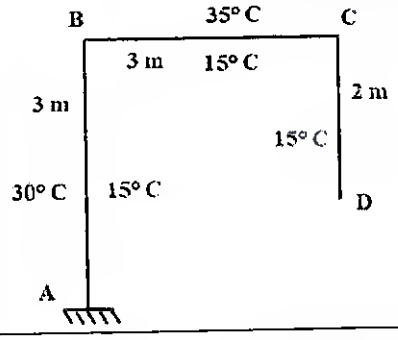
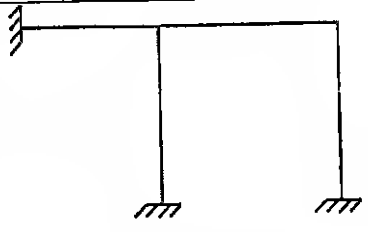
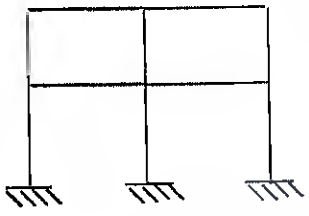
06/01/26

1. Attempt any FIVE questions out of SEVEN questions.
2. **Answers to all sub questions should be grouped together.**
3. Figures to the right indicate full marks.
4. Assume suitable data if necessary and state the same clearly.

Q.No.	Questions	Points	CO	BL	Module
Q.1(a)	**A symmetrical three hinged parabolic arch of span 30 m and central rise of 5 m is subjected to two concentrated loads of 90 kN and 70 kN acting at 8 m and 22 m respectively from the left support. Determine** **(a) the support reactions** **(b) radial shear, normal thrust and BM just to the left of 90 kN load** **(c) draw BMD** **(d) Show the above internal forces acting on the given section.**	15	1	4	1
Q.1(b)	**Explain the difference in the structural behaviour of an arch and a beam of the same span and subjected to the same loads.**	05	1	2	1
Q.2(a)	**A suspension cable of span 75 m and a central dip of 10 m is supporting a three hinged stiffening girder. The dead load of the girder is 15 kN/m. Two point loads of 200 kN and 150 kN act on the girder at distances of 18 m and 55 m from the left support.** **(a) Determine the intensity of the total udl transferred from the girder to the cable.** **(b) Determine the maximum and minimum tension in the cable** **(c) Draw SFD and BMD for the girder** **If the suspension cable passes over a smooth pulley on the top of a pier of height 18m and the anchor cable is at 55° to the horizontal, find the forces transmitted to the base of the pier.**	16	1	3,4	2

Q.2(b)	**What forces are transmitted to the base of the pier when a suspension cable** **(i) is connected to a saddle support on the top of a pier and the other end of the saddle support is anchored to the ground with anchor cable.** **(ii) passes over a smooth pulley and then anchored to the ground.**	04	1	2	2
Q.3(a)	**The load system shown in figure below crosses a simply supported girder of span 30 m. Determine the value of absolute maximum bending moment anywhere in the girder.**	10	2	3,4	3
					
Q.3(b)	**For the pin jointed frame shown in figure below draw influence line diagram for axial force in members DF, CF and CE.**	10	2	3,4	4
					
Q.4(a)	**The members AB, BD & DE of the truss shown in figure are subjected to temperature increase of 40^0 C. Calculate the vertical deflection of D due to the increase in temperature.** **Take $\alpha = 12x10^{-6}/°C$.**	10	3	3,4	5
					

Q.4(b)	**Determine the static and kinematic indeterminacy of the structures shown in figures below.**	**10**	**3**	3,4	5
	 (i)  (ii)				
	 (iii)  (iv)				
	 (v)				
Q.5(a)	**Analyse the continuous beam shown in figure using force method of analysis only and find the reactions at B and C. Take spring stiffnesses as k_1=8 kN/m and k_2=12kN/m.**	**16**	**4**	3,4	6
					
Q.5(b)	**What do you understand by Influence Line Diagram (ILD)? Explain.**	**02**	**2**	2	3
Q.5(c)	**Define flexibility coefficient f_{ij}.**	**02**	**4**	2	6
Q.6	**Analyse the beam shown in figure by slope deflection method and find the end moments and draw SFD.**	**20**	**4**	3,4	7
					

Q.7(a)	**For the frame shown in figure calculate the vertical deflection of D due to change in temperature as indicated in figure. Take $\alpha = 12x10^{-6}/°C$ and depth of all members as 400 mm.**	**12**	**4**	3,4	5
					
Q.7(b)	**For the structure shown in figures below determine the degree of (a) static external and internal indeterminacy and (b) kinematic indeterminacy considering and neglecting axial deformations.**	**08**	**3**	3,4	5
	 (i)  (ii)				

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END SEM/~~RE-EXAM~~ EXAMINATION NOV/DEC 2025-26

Program: Civil Engineering End Sem Exam Nov-25 **Duration:3hr**

Course Code: PC-BTC502 Third Year B.tech Civil **Maximum Points: 100**

Course Name: Hydrology & Water Resources Engineering Sem V **Semester: V**

24/11/25

Instructions:

1. Attempt any 5 questions.
2. Draw neat and labelled diagram wherever necessary.
3. Assume Suitable data if necessary and state it clearly.

Q No.	Questions	Points	CO	BL	Mod
1 a	Explain types of precipitations.	6	CO1	1	1
1 b	Derive an expression for steady state discharge through a tube well fully penetrating a confined aquifer.	8	CO3	2	4
1 c	The gross command area for an irrigation canal is 20,000 hectares out of which 75% is culturable command area. The intensity of irrigation is 40% for rabi and 10% for rice. If kor period is 4 weeks for rabi and 2.5 weeks for rice, determine the outlet discharge. Outlet factors for rabi and rice may be assumed as 1800 hectares/cumec and 775 hectares/cumec. Also calculate delta for each case.	6	CO2	3	5
2a	Design an irrigation channel based on Kennedy's theory. To carry A discharge of 45 cumecs. Take N=0.0225 and m= 1.05 the channel bed slope 1 in 5000.	10	CO4	4	5
2b	Discuss in detail classification of dam along with their sketches.	10	CO4	2	6
3a	Discuss in detail factors affecting duty of a crop.	8	CO2	2	5
3b	A sub basin has six numbers of rain gauges. Annual rainfall recorded by rain gauges are given below, considering 10% error in the estimation of mean annual rainfall, calculate optimum number gauges required for sub-basin and check if present network is sufficient.	6	CO1	3	1
3c	Calculate the total infiltration depth for a storm lasting 6 hours. Assuming the infiltration rate of 10mm/hr and final infiltration rate of 5 mm/hr and the constant value (describing the rate of decay of difference between the initial and final infiltration rates) as 0.95 per hour. Calculate the total infiltration depth for a storm lasing 6 hour.	6	CO1	4	2
4 a	Differentiate Lacey's theory and Kennedy's theory	5	CO4	1	5
4b	Estimate rainfall excess and ϕ index. (use graph paper)	10	CO1	4	3

Rain gauge name	A	B	C	D	E	F
Annual rainfall (cm)	110.3	82.6	98.8	136.7	180.3	102.9

Rainfall of magnitude 4.0cm and 3.0 cm occurring on two consecutive 4-h duration on a catchment a catchment area 25 km^2 produced the following hydrograph of flow at the outlet of the catchment.

Time from the start of rainfall (hr)	-6	0	6	12	18	24	30	36	42	48	54	60	66
Observed flow (m^3/sec)	7	5	13	26	21	16	12	9	7	5	5	4	4

4c	Determine the rate of evaporation from an evaporation pan of 1.9 m diameter. The drop in water level in evaporation pan during 24 hr is 15 mm. the precipitation recorded during this period is 25mm.	5	CO1	3	2
5a	Draw typical cross section of concrete gravity dam with neat labels. Explain various modes of failure of concrete gravity dam and various factors of safety.	10	CO4	2	1
5b	State different types of spillways and point out suitability and salient features of each types.	10	CO4	2	7
6a	Discuss the reservoir sedimentation and its control	7	CO4	2	7
6 b	Determine reservoir capacity if the culturable commanded area is 40000 hectares, canal losses are 20% and reservoir losses are 10%	8	CO2	4	5

Crop	Base period days	Duty of water at the field (ha/cumecs)	Intensity of Irrigation %
Wheat	120	1800	20
Sugarcane	360	1700	20
Cotton	180	1400	10
Rice	120	800	15
Vegetables	120	700	15

6 c	Explain elementary profile and practical profile of concrete gravity dam.	5	CO4	2	6
7 a	The location coordinates in km of five rain gauges w.r.t P are as follows	8	CO1	4	1

Station	P	Q	R	S	T
Precipitation (mm)	0,0	25,20	-45,17	-35,215	35,-16

Annual average precipitation at the station P was missing for the year 2025.The average annual precipitation at the other stations for the year 2025 is as follows:

Station	P	Q	R	S	T
Precipitation (mm)	?	2735	2800	2831	2655

Evaluate the missing precipitation at P for the year 2025.

7 b	Discuss in detail base flow and different methods of base flow separation.	8	CO1	2	3
7 c	Define and explain (i) Field capacity (ii) Phreatic line	4	CO1	2	5 &6

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Third Year B.Tech — ~~END SEM~~/RE-EXAM EXAMINATION ~~NOV/DEC 2025-26~~ January 2026

Program: Civil Engineering — **Duration:3hr**

Course Code: PC-BTC502 — **Maximum Points: 100**

Course Name: Hydrology & Water Resources Engineering — **Semester: V**

07/01/26

Instructions:

1. Attempt any 5 questions.
2. Neat diagrams must be drawn wherever necessary.
3. Assume Suitable data if necessary and state it clearly.

Q no.	Questions	Points	CO	BL	Mod
1a	Explain in detail hydrological cycle.	6	1	2	1
1b	Derive an expression for steady state discharge through a tube well fully penetrating an unconfined aquifer.	8	3	2	4
1c	A tube well of 300 mm diameter penetrates fully a confined aquifer.	6	3	3	4
	The length of strainer is 25m. Calculate the yield from the well under a drawdown of 4 m. the coefficient of permeability of aquifer is 50m/day. Assume radius of influence is equal to 200m.				
2a	Design a regime channel for a discharge of 60 cumecs and silt factor of 1.2 use Lacey's theory.	10	4	4	5
2b	Discuss the causes of failure of earth dam and their precautionary measures	10	4	2	6
3a	Discuss the factors affecting shape of a hydrograph.	8	1	2	3
3b	Estimate the storm precipitation at station S	6	1	3	1
	A 3-hour storm occurred at a location, and the precipitation measurements at neighboring rain-gauge stations were recorded as follows: Station P: 3.8 cm, Q: 4.1 cm, Station R: 4.5 cm. The precipitation at Station S could not be measured due to a broken rain-gauge bottle. The normal annual precipitation values for the four stations, as per the IMD Bulletin, are: Station P=45 cm, Station Q=48cm Station R=53cm and Station S=50 cm.				
3c	It was found that the rate of evaporation from a 1.5m pan having a pan coefficient of 0.9 was 1.5 mm/m^2/hr.	6	1	4	2
	Compute the total evaporation from a reservoir in a week having water so read of 3 ha.				
4a	A catchment of area 300 km^2 receives a uniform rainfall of 30 mm in one day.	10	1	4	3
	During the next few days, the discharge is observed in the river that drains the catchment. The readings are given below:				

T (days)	0	1	2	3	4	5
Q m3/sec	2	5	10	8	4	2

The base flow is constant equal to 2 m^3/sec during the discharge period.

(a) How much was the direct runoff during the period (answer in m^3/sec)

(b) How much was the total direct runoff during the period (answer in mm)

(c) How much was the total losses for the rainfall (mm).

	(d) What was the maximum discharge in the water course during the period?				
4b	Discuss the different ways to prevent the ways to prevent evaporation from reservoir.	5	1	2	2
4c	Explain elementary profile and practical profile of concrete gravity dam.	5	CO4	2	6
5a	Draw labelled diagram of concrete gravity dam. Discuss in detail different forces acting on the gravity dam.	10	4	2	6
5 b	A storm over a catchment of area 5 km^2 had a duration of 14 hours. The mass curve of rainfall of the storm is as follows:	10	1	4	3

Time from start of storm (hr)	0	2	4	6	8	10	12	14
Accumulated rainfall (cm)	0	0.6	2.8	5.2	6.7	7.5	9.2	9.6

If ϕ index for the catchment is 0.4 cm/hr, determine the effective rainfall hyetograph and the volume of direct runoff from the catchment due to the storm.

6 a	Discuss the factors to be considered while selecting a site for a dam.	6	4	2	6
6 b	Define spillway and brief about their classification	5	4	2	7
6 c	The following is the set of observed data for successive 15 minutes period of 105 minutes storm in a catchment	9	1	3	2

Duration (min)	Rainfall (cm/hr)
15	2.0
30	2.0
45	8.0
60	7.0
75	1.25
90	1.25
105	4.5

If the value of ϕ-index is 3 cm/hr, estimate the net runoff, total rainfall and the value of W- index

7 a	A watercourse commands an irrigated area 1000 hectares.	5	2	3	5
	The intensity of irrigation of rice in this area is 70%. The transplantation of rice crop takes 15 days and during the transplantation period the total depth of water required by the crop on the field is 500 mm. During the transplantation period the useful rain falling on the field is 120mm. Find the duty of irrigation water for the crop on the field during transplantation at the head of the field and also at the head of the water course assuming losses of water to be 20% in the water course. Also calculate the discharge required in the water course.				
7 b	Following are the rates of rainfall for successive 20 minutes storm in mm/hr	6	1	4	2 &3

Rainfall mm/hr	22	22	95	72	12.5	12.5	50

Taking the value of ϕ index of 31 mm/hr, find out the net runoff in mm and total rainfall.

7 c	Discuss evaporation along with the various types of evaporimeters.	9	1	2	2

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END SEMESTER November 2025 / ~~RE - EXAM~~ January 2026

Program: Civil Egineering TY. B. Tech Civil Engg. **Duration: 3 hr.**

Course Code: PC – BTC – 504 Sem – V **Maximum Points: 100**

Course Name: Highway Engineering **Semester: V**

28/11/25

Notes:

i. **Question 1 is Compulsory**
ii. **Solve any 4 Questions from remaining 6 Questions**
iii. **Assume suitable data if required**

Q.No.	Questions	Points	CO	BL	Module No.
Q.1	Solve Any Four (5 x 4 = 20)				
a	Construction of Cement Concrete Road	05	03	01	05
b	Joints in Rigid Pavement	05	03	02	05
c	Necessity of Drainage System	05	02	02	05
d	Jaykar Committee and its recommendation	05	01	01	01
e	Assumptions in Burmister Layer Theory	05	02	01	04
Q.2.					
a	Discuss the important features of Samrudhi Expressway	05	02	02	01
b	Equivalent Wheel Load Factor or Vehicle Damage Factor	05	02	02	04
c	Following are the data collected for Road Development Programme of one of the District of Maharashtra. The number of town and villages having different population and other required data is given below. If the length of existing surface road = 350 km and unsurfaced road = 500 km. calculate the additional length of surface and unsurfaced road required as per Nagpur plan using following data; Total area of District = 9000 km², agriculture area = 3500 km², length of railway track = 150 km Population: < 500 | 500 to 1000 | 1000 to 2000 | 2000 to 5000 | > 5000 Number of Villages: 650 | 300 | 140 | 42 | 06	10	02	03	01
Q.3.					
a	What is geometric design of Highway. Enlist the different geometric elements to be design.	07	01	02	02

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END SEMESTER November 2025 / ~~RE – EXAM~~ January 2026

b	Derive the expression for stopping sight Distance	06	01	02	02
c	An ascending gradient of 1:25 meets another ascending gradient of 1:100. Find the length of summit curve to be provided for required SSD. Assume design speed = 80 km/hr. (Assume suitable data if required)	08	02	03	02
Q.4.					
a	Why the extra widening required on horizontal curve. Draw the neat sketch showing extra widening on curve road.	07	01	02	02
b	Calculate the extra widening of pavement required on horizontal curve of radius 450 m on three lane highway. Assume design speed = 80 km/hr, wheel base = 6.2 m.	07	01	03	02
c	Discuss with neat sketch, Overturning and skidding of vehicle on curve portion of road	06	01	02	02
Q.5.					
a	Design a pavement section by triaxial method using following data: Wheel load = 4100 Kg, Radius of contact area = 15 cm, traffic coefficient = 1.5, rainfall coefficient = 0.9, design deflection = 0.25 cm, E- Value for subgrade = 60 kg/cm^2, E- value for base = 225 kg/cm^2, assume 7.5 cm thickness bituminous layer to be provided at the top of base course having E- value 1100 kg/cm^2. Also, draw a section of Pavement	10	02	03	04
b	Calculate the wheel stress at edge and corner region of cement concrete slab using Westargard stress equation and modified Westargard stress equation Wheel load = 5100 Kg., E- Value = 3 * 10^5, Pavement Thickness = 20 cm, Poisson's Ratio = 0.15, Modulus of subgrade reaction = 6 kg/cm^3, Radius of contact area = 15 cm.	10	02	03	04
Q.6.					
a	Preparation of subgrade	07	02	02	05
b	Construction Procedure of Built up Spray Grouting Base course	07	02	02	05
c	Differentiate between flexible pavement and rigid pavement	06	02	02	04
Q.7.					
a	Discuss How you will conduct Preliminary survey for road projects. Also, explain about preparation of Drawing of L – section and Cross section	10	01	02	01
b	Discuss with neat sketch different types of camber	06	01	02	02
c	Classification of terrains	04	01	02	02

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~~END SEMESTER November 2025~~ / RE - EXAM January 2026

Third year B.Tech

Program: Civil Egineering **Duration: 3 hr.**

Course Code: PC – BTC – 504 **Maximum Points: 100**

Course Name: Highway Engineering **Semester: V**

12/01/26

Notes:

i. **Question 1 is Compulsory**
ii. **Solve any 4 Questions from remaining 6 Questions**
iii. **Assume suitable data if required**

Q.No.	Questions	Points	CO	BL	Module No.
Q.1.	Solve Any Four (5 x 4 = 20)				
a	Advantage of Road Transportation	05	01	01	01
b	Ist 20 years Road Development Plan	05	01	01	01
c	Construction of Gravel Roads	05	03	02	05
d	Informatory signs	05	02	02	03
e	Spot speed study	05	02	02	03
Q.2.					
a	Discuss basic requirement of an ideal alignment of Roads	06	02	01	01
b	Discuss factors affecting alignment of roads	06	02	01	01
c	The area of state is 1, 80,000 km^2, the number of towns as per census 2011 is 125 and road density is 95 km 100 km^2 area. Calculate the length of various category road as per third 20 years road development plan	08	01	03	01
Q.3.					
a	Explain the importance of camber	05	01	02	02
b	What is transition curve? Draw the neat sketch showing transition curve at intersection of road	05	01	02	02
c	The speed of overtaking and overtaken vehicles are 80 km/hr and 50 km/hr respectively. If the accereration of overtaking vehicle is 0.99 km/sec^2 calculate: (i) Overtaking sight distance (ii) Minimum length of overtaking zone (iii) Desirable length of overtaking zone (iv) Neat sketch showing overtaking zone and position of sign post.	10	01	03	02

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Q.4.					
a	What is super elevation. Draw a neat sketch showing various forces acting on vehicle while moving on curve portion of road. Also, Derive the expression for equilibrium super elevation.	10	01	03	02
b	Calculate the super elevation to be provided for a horizontal curve of radius 400 m and design speed of 100 km/hr.	10	01	03	02
Q.5.					
a	Explain with the aid of neat sketch the elimination of camber and introduction of super elevation on curve portion of road.	10	01	03	02
b	Design the single lane undivided type flexible pavement. The total number of commercial vehicles plying on both direction is 700 and rate of growth of traffic is 7 %. Assume CBR Value of subgrade soil = 4 %, VDF = 2.5, LDF = 1. design life of the pavement is 15 years and three years required for construction after last count. Use IRC 37 – 1984 guideline for the design of pavement.	10	02	03	04
Q.6.	**write short notes on (Solve any Four)**				
a	Discuss the steps involved for Preparation of subgrade	07	02	02	05
b	Explain the procedure for construction of WBM type road.	08	02	02	05
c	Enlist at least 10 types of distresses observed in flexible pavement	05	02	02	04
Q.7.	Write short notes on				
a	Surface drainage system.	08	02	02	05
b	Temperature stress	06	02	02	04
c	Joints in rigid pavement	06	03	02	04

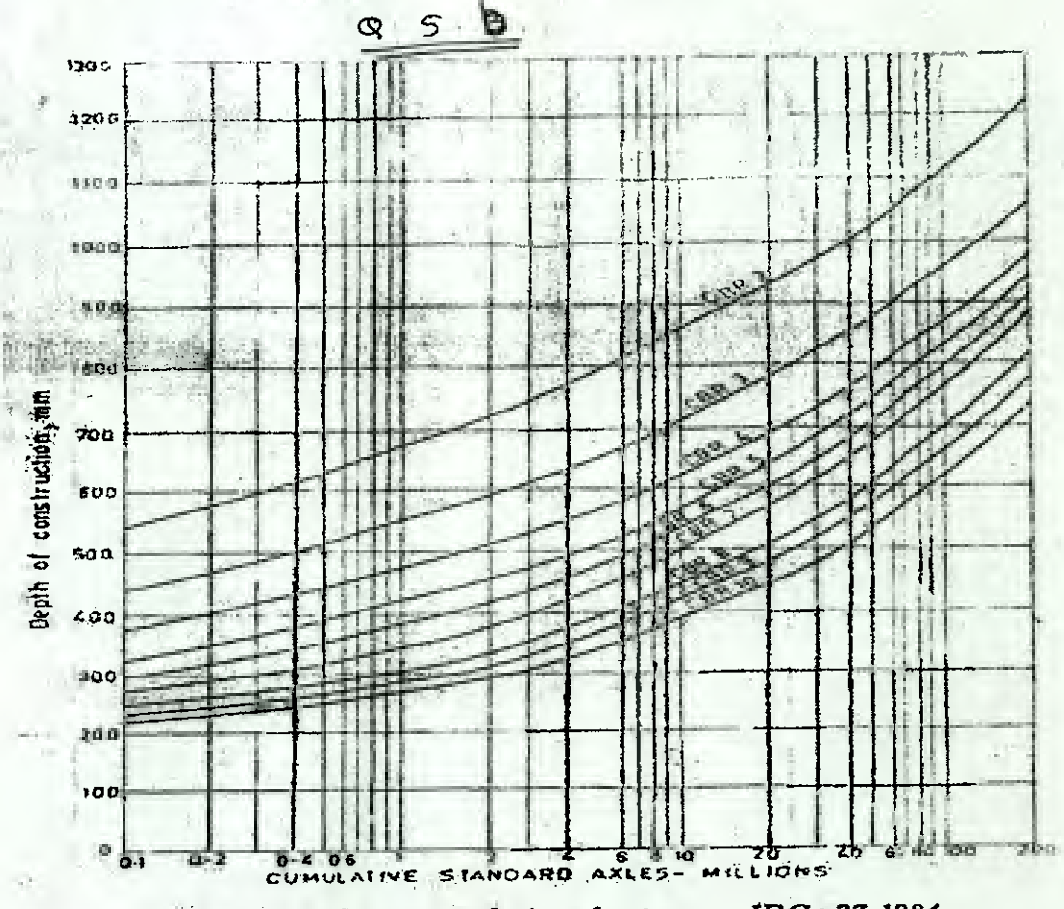

Fig. 16.13. Pavement design chart as per IRC : 37-1984.

Composition of pavement as per IRC – 37 – 1984

Design traffic in msa	Minimum thickness of layers in mm		
	Surface	Base	Subbase
0.50	20 mm PC or 2 coats of SD	150 mm	T – 50, minimum thickness of 100 mm on subgrade of CBR less than 20 %
0.5 – 2	20 mm PC or MS	225 mm	T – 225, minimum thickness of 150 mm on subgrade of CBR less than 20 %
2 – 5	20 mm PC/MS/SDC over 50 mm/75 mm BM	250 mm	T – 300/325, minimum thickness of 750 mm on subgrade of CBR less than 30 %
5 – 10	20 mm BC/SDC over 60 – 80 DBM	250 mm	T – 335 to 355, minimum thickness of 750 mm on subgrade of CBR less than 30 %
10 – 15	40 mm BC over 65 – 80 DBM	250 mm	T – 335 to 370, minimum thickness of 750 mm on subgrade of CBR less than 30 %
15 – 20	40 mm BC over 80 – 100 DBM	250 mm	T – 370 to 390, minimum thickness of 750 mm on subgrade of CBR less than 30 %
20 – 30	40 mm BC over 100 – 115 DBM	250 mm	T – 390 to 405, minimum thickness of 750 mm on subgrade of CBR less than 30 %

Note: SD – Surface Dressing, PC – Pre mix Carpet, MS – Mix Seal, SDC – Semi Dense Carpet, BC – Bituminous Concrete, BM – Bituminous Macadam, DBM – Dense Bituminous Macadam.

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End Semester Exam- Set A
Nov-Dec 2025

Max. Marks: 100 **Duration: 3 Hrs**

Class: T.Y B. Tech Civil Engineering **Semester: V**

Name of the Course: Wastewater Engineering and Air Pollution Control **Program: Civil**

Course Code: BTC505

1/12/25

Instructions:

- **Question 1 is compulsory. Solve 4 questions of remaining 6**
- **Draw neat sketches/diagrams wherever required**
- **Assume suitable data if necessary and state them clearly**
- Figure on right indicate maximum points for the given question, course outcomes attained and Bloom's Level
- **Table 1** related to data for 66 engineers and question number is given at the end of the question paper

QN	Questions	Marks	BL	CO	M.N
Q1	**Answer the following questions:**	**(20)**			
(a)	Maharashtra state sanitation department has come up with demarcation of a particular Maharashtra region in 33 areas. Each area is allotted to two engineers (mentioned in table 1) with specific details (mentioned in table 1). The Run off coefficient is 0.7 on an average for various areas. The time of concentration is 40 min, find max runoff using intensity of rainfall as I= {1060/(t+60)}. The population and water supply rate is as given in the table. Design the combined sewer line flowing full giving checks.	**(06)**	**3**	**2**	**2**
(b)	Design engineers need to design wastewater treatment plant for a sewage generating from population as mentioned in table 1. The domestic wastewater to be treated has initial BOD of 240mg/L and S.S. concentration of 260 mg/L. Find the BOD loading and Suspended solids loading considering water supply rate as mentioned in table 1. Illustrate the basic flowsheet of wastewater treatment plant that can be proposed with function of each unit and expected reduction in BOD. Will the efficiency of the plant be as required.	**(10)**	**3**	**3**	**1**
(c)	Convert the Air Pollutant values as asked	**(04)**	**2**	**4**	**7**
	Convert 80$\mu g/m^3$ of SO_2 to ppm at 30 degree Celsius and 1 atm				
	Convert 30 ppm of HC to $\mu g/m^3$ at STP				
Q2	**Answer the following questions:**	**(20)**			
(a)	Explain 1st and 2nd stage BOD demand. As an environmental engineer, which stage (1st or second stage) BOD will you want to reduce and why ? The dilution water (CONTROL) has initial DO of 9.5 mg/L and the diluted sample from a river from Maharashtra has DO 8.0 mg/L. The dilution for BOD sample is as mentioned in Table 1 for various regions. After 5 days at 20°C DO in diluted sample falls to 4 mg/L and that of Control is 9.3 mg/L. Find BOD_5 of sample at 20°C. The K_{10} value is 0.1/days. Find the BOD of same sample at 40°C at the end of 2 days. Θ= 1.056	**(10)**	**3**	**1**	**3**
(b)	Give difference in design of PST with respect to SST and design SST for the population and water supply rate of your area.	**(10)**	**3**	**3**	**5**

Q3	**Answer the following questions:**	**(20)**			
(a)	Design a grit chamber to remove particle of size 0.2 mm and sp gr 2.6. Wastewater flow rate is as per the population and wsr given and settling velocity of particles is to be taken 0.016 – 0.02 m/s. Take detention time as 40 sec. Horizontal velocity given is 0.28 m/sec (0.15-0.4 m/sec)	**(10)**	**3**	**2**	**4**
(b)	Estimate the bar screen area requirement for a plant treating a peak flow using the population and water demand as given in Table 1. Velocity through screen to be assumed as 0.8 m/s. Screen is provided at 60 degree from horizontal. (take the width of bar as 1 cm and distance between two bars 5 cms). Give checks for head loss.	**(10)**	**3**	**2**	**4**
Q4	**Answer the following questions**	**(20)**			
(a)	In the wastewater treatment plant for your area, trickling filter/s is used as the secondary treatment. As a consultant do you think it is better option to opt for trickling filter rather activated sludge process. Elaborate with reasoning Determine the size (dia and depth) and numbers of single stage high rate trickling filter to be provided for the following data. Give your take on disposal of wastewater. Also calculate hydraulic loading and organic loading. (i) Sewage flow = Table 1 data to be used (ii) Recirculation ratio = 2 (iii) BOD_5 of raw sewage = 200 mg/lit (iv) BOD_5 removal in PST = 30% (v) Final effluent BOD_5 desired = 20 mg/lit	**(10)**	**4**	**4**	**5**
(b)	A hostel is provided near Mumbai and has population as mentioned in table 1 residential graduates. Design septic tank with sewage disposal rate as 120 lpcd. Design trenches (no and size) considering percolation rate as 20 min per cm (use any one method for septic tank design)	**(10)**	**3**	**3**	**6**
Q5	**Answer the following questions:**	**(20)**	**3**	**3**	**4-5**
(a)	Explain problems in activated sludge process, reasons and how it can be solved. Design a continuous flow completely mixed activated sludge process with following data. Sewage flow calculate from Table 1; Influent BOD to aeration tank =200mg/L; Effluent BOD= 20 mg/L; Effluent SS =20 mg/L; MLSS= 3200mg/L; MLVSS/MLSS=0.8; Return sludge concentration as SS= 15000mg/L; Y=0.7; k_d=0.05d^{-1}; Θ_c=12 days. Compute oxygen requirement also. Give all checks with air requirement for the aeration units				
(6)	**Answer the following questions:**	**(20)**			
(a)	For your area, design a conventional digester for mixed primary and activated sludge from the flow as calculated from Table 1. Data given is Raw effluent SS= 210 mg/L SS removal efficiency = 80% SS concentration in primary sludge = 35 kg/m^3 Excess activated sludge = 3000 kg/day SS concentration in activated sludge = 15 kg/m^3 VM in Mixed sludge = 65%	**(15)**	**4**	**3**	**6**
(b)	Explain methodology for wastewater treatment you would recommend for rural areas and give reasoning for the same	**(05)**	**3**	**3**	**6**
Q7	Answer the following questions		**3**	**3**	**7**

A	Explain the concept of AQI and why the values go high in winter season in northern areas of India	(05)				
B	Deliberate impact of ambient air pollution on humans, material and vegetation in short	(05)				
C	Ennumerate control methods for air pollution. Explain any 4 methods in detail (1 should be gaseous pollutant control and remaining particulate control measure)	(10)				
ALL THE BEST						

Table 1.

			Question 1	Question 2 (a)	Question 1(b),1(c) ,2(b), Q3(a) (b), 4, Q5 (a), Q6 (a)		Question 4 (b)
Area Nos	Reg No	Reg No	Area (Hectares)	% dilution	Population	Water supply rate (lpcd) 80% conversion to sewage	Hostel Population
1	C2310001	C2310041	100	1	26,000	100	150
2	C2310002	C2310043	140	1.2	31,000	120	200
3	C2310003	C2310044	160	1.4	36,000	140	250
4	C2310004	C2310048	180	1.6	41,000	160	300
5	C2310005	C2310050	200	1.8	46,000	180	150
6	C2310006	C2310051	220	2	51,000	100	200
7	C2310008	C2310052	250	2.2	56,000	120	250
8	C2310009	C2310054	280	2.4	61,000	140	300
9	C2310011	C2310056	300	2.6	66,000	160	150
10	C2310012	C2310060	320	2.8	71,000	180	200
11	C2310013	C2310061	340	3	76,000	100	250
12	C2310014	C2310062	80	3.2	81,000	120	300
13	C2310015	C2310067	120	3.4	86,000	140	150
14	C2310016	C2110066	150	3.6	91,000	160	200
15	C2310017	C2210018	170	3.8	96,000	180	250
16	C2310018	C2210036	190	4	1,01,000	100	300
17	C2310019	C2210052	90	4.2	1,06,000	120	150
18	C2310021	C2110002	130	4.4	1,11,000	140	200
19	C2310022	C2110009	110	4.6	1,16,000	160	250
20	C2310023	C2110062	130	4.7	2,10,000	100	300
21	C2310024	C2420001	180	4.8	1,21,000	180	150
22	C2310025	C2420002	200	5	1,26,000	100	200
23	C2310026	C2420003	220	1.3	1,31,000	120	250
24	C2310027	C2420004	250	1.55	1,36,000	140	300
25	C2310028	C2420005	210	1.8	1,41,000	160	150
26	C2310029	C2420006	100	2.1	1,46,000	180	200
27	C2310032	C2420007	140	2.3	1,51,000	100	250
28	C2310033	C2420008	160	2.55	1,56,000	120	300
29	C2310034	C2420009	180	2.8	1,61,000	140	150
30	C2310035	C2420010	200	3.1	1,66,000	160	200
31	C2310036	C2420012	220	3.3	1,71,000	180	250
32	C2310039	C2420013	250	3.55	1,76,000	100	300
33	C2310040	C2420014	280	3.8	1,81,000	120	150

Formula sheet and Parameter Sheet

$V_S = \frac{p_w g (Ss-1)d^2}{18\mu}$

Or $V_S = \frac{g (Ss-1)d^2}{18\upsilon}$

Or $V_S = 418(Ss-1)d^2(T+10)/60$

$V_c = 3$ To $4.5\sqrt{(g\ d\ (Ss-1))}$

$v_c = \sqrt{\frac{8\beta g(S_s-1)d}{f}}$ $E_2 = \frac{100}{1+\frac{0.4432}{1-E_1}\sqrt{\frac{w_2}{VF}}}$

$\cos\frac{\theta}{2} = \left(1-\frac{2d}{D}\right)$

$I=a/t^n$; $I=a/(t+b)$

$Y=0.5\sqrt{B}$

$R=A/P$

$Q=A.V$

$\frac{W_s}{S_s} = \frac{W_f}{S_f} + \frac{W_w}{S_w}$

$Q_{max} = \left(1+\frac{14}{4+P^{0.5}}\right)Q_{av}$ $Qw = \frac{VX}{\theta_c Xr}$ $F = \frac{1+R}{(1+(1-f)R)^2}$

$\frac{1}{\theta_c} = \frac{Q}{V}(1+r-r\frac{Xr}{X})$ $U = \frac{Q*(So-S)}{V*X}$ $T = \frac{La}{20}1$

$A=0.00622.q/V_r$; $h_L=0.0729(V^2-v^2)$ $v=Q/W*d$ $\frac{W_s}{S_s} = \frac{W_f}{S_f} + \frac{W_w}{S_w}$

$Q = C.I.A / 360$

$I = 760 / (t+10)$ $V = \frac{1}{n} * R^{\frac{2}{3}} * S^{\frac{1}{2}}$

$I = 1\ 020 / (t+10)$

$V = 0.849 C_H R^{0.63} S^{0.54}$ $\frac{F}{M} = \frac{S}{\theta * X}$

$t_0 = \frac{d^2(0.011d+0.785H)}{Q}$ $PE = \frac{BOD\ load\ from\ industry\ \left[\frac{kg}{day}\right]}{0.054\ \left[\frac{kg}{inhab\cdot day}\right]}$ $U = \left(\frac{F}{M}\right)*\left(\frac{E}{100}\right)$

$E = \left(\frac{S_o-S}{S_o}\right)*100$

$Vs = [0.707(Ss-1)d^{1.6}\ \upsilon^{-0.6}]^{0.714}$

$\eta = 1-\left(1+\frac{n(v_s)}{Q/A}\right)^{-\frac{1}{n}}$ $q = \frac{Q}{A}$

$BHP = (w.Q.H)/(75.\eta_p.\ \eta_m)$

$\frac{Qr}{Q} = \frac{x_t}{\left(\frac{10^6}{svi} - x_t\right)}$

Conc ($\mu g/m^3$)=ppm*MW*1000 / 22.4

$E_1 = \frac{100}{1+0.4432\sqrt{\frac{w_1}{VF}}}$ $L_t = L_o(10^{-Kt})$ x=xa+xe+xi

Q= 130/√t (lpd/m^2)

$\theta_c = \frac{V*x}{Q_w x_w + Q_e x_e}$

$h_f = flv^2/(2gD)$

$BOD5 = (DO_{1s} - DO_{5s})*dilutionfactor - (DO_{1b} - DO_{5b})$

$V_{sl} = \frac{W_s}{Y_w S_{sl} P_s}$

$U = \frac{Q*(So-S)}{V*X}$

$O_2\ (g/d) = \frac{Q(So-S)}{f} - 1.42\ Q_w X_r$

$\theta_C = \frac{V.x}{(Q+Q_r)x - Q_r x_r}$

$V = \frac{YQ(S_0-S)\theta_c}{x(1+k_d)\theta_c}$ $\theta_s = \frac{V_s}{Q}$ $\frac{f}{m} = \frac{So*Q}{V*X} = \frac{So}{\theta*X}$ $y_t = L_o(1-10^{-Kt})$

$Volume = \left[Vf - \frac{2}{3}[V_f - V_d]\right]T_1 + V_d T_2$

$Volume = \frac{1}{2}[V_f + V_d]T_1 + V_d T_2$

Concentration (ppb) = 22.4 x concentration (µg/m3) ÷ molecular weight at STP

P1V1/T1= P2V2/T2

4-8 hrs	n=0,1/8,1/4,1/2,1	1.8-3m; 1 to 4 $m^3/d/m^2$; 0.08-0.32kg/m^3/d
50 – 150 ml/gm	ML= 90 m MW= 30 m L:W= 1.5:1 to 7.5:1 L:D= 5:1 to 25:1 D= 3 to 50 m 7.5-10% D= 2.5 or 3.5	0.9-2.5m; 10-40$m^3/m^2/d$; 0.32-1 kg/m^3/d 0.6-1.6kg/d/m^2 6-35 m 1.6-6.4 kg/d/m^2 1 in 6 to 1 in 10 10-20 days 1.2 to 2 m 30- 40 day 4.5 to 6 m and maximum 9m
0.7-1.2 m/s 0.2-0.4/day 0.3-0.6kg/m^3/d 5-15 days	125m^3/d/m 185m^3/d/m 25-35 $m^3/m^2/d$; 50-60$m^3/m^2/d$ 15-35 $m^3/m^2/d$; 40-50$m^3/m^2/d$	0.1 to 0.15per capita with dry solid loading of 80 to 120 kg/m^2/year 0.2 0.175 -0.2 m^2/c/yr area or 60-120 kg/m^2/yr

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Re-exam 2026
~~End Semester Exam- Set B~~
~~Nov-Dec 2025~~ January 26

Max. Marks: 100 **Duration: 3 Hrs**

Class: T.Y B. Tech Third Year B. Tech Civil **Semester: V**

Name of the Course: Wastewater Engineering and Air Pollution Control **Program: Civil**

Course Code: BTC505

06/01/26

Instructions:

- **Question 1 is compulsory. Solve 4 questions of remaining 6**
- **Draw neat sketches/diagrams wherever required**
- **Assume suitable data if necessary and state them clearly**
- Figure on right indicate maximum points for the given question, course outcomes attained and Bloom's Level
- Table 1 related to data for 66 engineers and question number is given at the end of the question paper

QN	Questions	Marks	BL	CO	M. N
Q1	**Answer the following questions:**	**(20)**			
(a)	Convert the Air Pollutant values as asked	(04)	2	4	7
	(a) Convert 100µg/m^3 of SO_2 to ppm at 30 degree Celsius and 1 atm				
	(b) Convert 40 ppm of HC to µg/m^3 at STP				
(b)	Maharashtra state sanitation department has come up with demarcation of a particular Maharashtra region in 33 areas. Each area is allotted to two engineers (mentioned in table 1) with specific details (mentioned in table 1). The Run off coefficient is 0.6 on an average for various areas. The time of concentration is 30 min, find max runoff using intensity of rainfall as I= {900/(t+60). The population and water supply rate is as given in the table. Design the combined sewer line flowing full giving checks.	(06)	3	2	2
(c)	Headline in Indian Express in September states Mumbai, an island city surrounded hy the Arabian Sea, has long struggled with managing its wastewater. In the past, wastewater was simply pumped back into the sea, and early attempts to address the issue with rudimentary Sewage Treatment Plants (STPs) in the 1980s were insufficient. For years, the city's effluent management system remained underdeveloped. What is the solution of this problem. Explain with a flowsheet of wastewater treatment plant of a city explaining functions of each element and reductions of quantity. What should be the way forward Disposal or Reuse? Explain additional units to be employed if reuse is considered.	(10)	4	1, 3	1, 3
Q2	**Answer the following questions:**	**(20)**			
(a)	Explain 1st and 2nd stage BOD demand. As an environmental engineer, which stage (1st or second stage) BOD will you want to reduce and why ? The dilution water (CONTROL) has initial DO of 8.5 mg/L and the diluted sample from a river from Maharashtra has DO 7.0 mg/L. The dilution for BOD sample is as mentioned in Table 1 for various regions. After 5 days at 20^{n}C DO in diluted sample falls to 4	(10)	3	1	3

	mg/L and that of Control is 8.3 mg/L. Find BOD_5 of sample at 20°C. The K_{10} value is 0.1/days. Find the BOD of same sample at 40°C at the end of 4 days. Θ= 1.056				
(b)	Estimate the bar screen area requirement for a plant treating a peak flow using the population and water demand as given in Table 1. Velocity through screen to be assumed as 0.8 m/s. Screen is provided at 60 degree from horizontal. (take the width of bar as 1 cm and distance between two bars 5 cms). Give checks for head loss.	**(10)**	**3**	**2**	**4**
Q3	**Answer the following questions:**	**(20)**			
(a)	Design a grit chamber to remove particle of size 0.4 mm and sp gr 2.8. Wastewater flow rate is as per the population and wsr given and settling velocity of particles is to be taken 0.016 – 0.02 m/s. Take detention time as 40 sec. Horizontal velocity given is 0.3 m/sec (0.15-0.4 m/sec)	**(10)**	**3**	**2**	**4**
(b)	Give difference in design of PST with respect to SST and design SST for the population of 2,00,000 and water supply rate as 135lpcd. Suspended solids are 2000mg/L in aerated sludge.	**(10)**	**3**	**3**	**5**
Q4	**Answer the following questions**	**(20)**			
(a)	In the wastewater treatment plant for your area, trickling filter/s is used as the secondary treatment. As a consultant do you think it is better option to opt for trickling filter rather activated sludge process. Elaborate with reasoning Determine the size (dia and depth) and numbers of single stage high rate trickling filter to be provided for the following data. Also calculate hydraulic loading and organic loading. Give your take on disposal of wastewater (i) Sewage flow = Table 1 data to be used (ii) Recirculation ratio = 1.5 (iii) BOD_5 of raw sewage = 220 mg/lit (iv) BOD_5 removal in PST = 35% (v) Final effluent BOD_5 desired = 25 mg/lit	**(10)**	**4**	**4**	**5**
(b)	A hostel is provided near Mumbai and has population as mentioned in table 1 residential graduates. Design septic tank with sewage disposal rate as 120 lpcd. Design trenches (no and size) considering percolation rate as 20 min per cm (use any one method for septic tank design)	**(10)**	**3**	**3**	**6**
Q5	**Answer the following questions:**	**(20)**	**3**	**3**	**4-5**
(a)	Explain problems in activated sludge process, reasons and how it can be solved. Design a continuous flow completely mixed activated sludge process with following data. Sewage flow calculate from Table 1; Influent BOD to aeration tank =220 mg/L; Effluent BOD= 20 mg/L; Effluent SS =20 mg/L; MLSS= 3200mg/L; MLVSS/MLSS=0.8; Return sludge concentration as SS= 15000mg/L; Y=0.8; k_d=0.06d^{-1}; Θ_c=15 days. Compute oxygen requirement also. Give all checks with air requirement for the aeration units				
(6)	**Answer the following questions:**	**(20)**			
(a)	For your area, design a conventional digester for mixed primary and activated sludge from the flow as calculated from Table 1. BOD is 310 mg/L. Data given is Raw effluent SS= 300 mg/L SS removal efficiency = 80% SS concentration in primary sludge = 35 kg/m^3 Excess activated sludge = 3000 kg/day SS concentration in activated sludge = 15 kg/m^3 VM in Mixed sludge = 65%	**(15)**	**4**	**3**	**6**

(b)	Explain methodology for wastewater treatment you would recommend for rural areas and give reasoning for the same	(05)	3	3	6
Q7	Answer the following questions	(20)	3	3	7
A	Explain the concept of AQI and why the values go high in winter season in northern areas of India	(05)			
B	Deliberate impact of ambient air pollution on humans, material and vegetation in short	(05)			
C	Ennumerate control methods for air pollution. Explain any 4 methods in detail (1 should be gaseous pollutant control and remaining particulate control measure)	(10)			
	ALL THE BEST				

Table 1.

			Question 1	Question 2 (a)	Question 1(b),1(c) ,2(b), Q3(a) (b), 4, Q5 (a), Q6 (a)		Question 4 (b)
Area Nos	Reg No	Reg No	Area (Hectares)	% dilution	Population	Water supply rate (lpcd) 80% conversion to sewage	Hostel Population
1	C2310001	C2310041	120	3	30000	100	150
2	C2310002	C2310043	190	3.2	32000	120	200
3	C2310003	C2310044	500	2	40000	140	250
4	C2310004	C2310048	600	4	45000	160	300
5	C2310005	C2310050	200	3.5	60000	180	150
6	C2310006	C2310051	210	10	65000	100	200
7	C2310008	C2310052	250	12	80000	120	250
8	C2310009	C2310054	280	5	100000	140	300
9	C2310011	C2310056	300	4	150000	160	150
10	C2310012	C2310060	320	2.5	120000	180	200
11	C2310013	C2310061	280	8	25000	100	250
12	C2310014	C2310062	700	8	64000	120	300
13	C2310015	C2310067	120	1	84000	140	150
14	C2310016	C2110066	150	1.2	89000	160	200
15	C2310017	C2210018	170	1.4	95000	180	250
16	C2310018	C2210036	190	1.6	26,000	100	300
17	C2310019	C2210052	100	1.8	31,000	120	150
18	C2310021	C2110002	140	2	36,000	140	200
19	C2310022	C2110009	160	2.2	41,000	160	250
20	C2310023	C2110062	180	2.4	46,000	100	300
21	C2310024	C2420001	200	2.6	51,000	180	150
22	C2310025	C2420002	220	2.8	56,000	100	200
23	C2310026	C2420003	250	3	61,000	120	250
24	C2310027	C2420004	280	3.2	66,000	140	300
25	C2310028	C2420005	300	1.8	71,000	160	150
26	C2310029	C2420006	320	2.1	76,000	180	200
27	C2310032	C2420007	340	2.3	81,000	100	250
28	C2310033	C2420008	80	2.55	86,000	120	300
29	C2310034	C2420009	120	2.8	91,000	140	150
30	C2310035	C2420010	150	3.1	96,000	160	200
31	C2310036	C2420012	170	3.3	126,000	180	250
32	C2310039	C2420013	190	3.55	1,76,000	100	300
33	C2310040	C2420014	280	3.8	1,81,000	120	150

Formula sheet and Parameter Sheet

$V_S = \frac{\rho_w g (S_s-1) d^2}{18\mu}$

Or $V_S = \frac{g (Ss-1) d^2}{18\upsilon}$

Or $V_S = 418(Ss-1)d^2(T+10)/60$

$V_c = 3$ To $4.5 \sqrt{(g\, d\, (Ss-1))}$

$v_c = \sqrt{\frac{8\beta g(S_s-1)d}{f}}$ $E_2 = \frac{100}{1+\frac{0.4432}{1-E_1}\sqrt{\frac{w_2}{VF}}}$

$\cos\frac{\theta}{2} = \left(1-\frac{2d}{D}\right)$

$I=a/t^n$; $I=a/(t+b)$

$Y=0.5\sqrt{}$ B

$R=A/P$

$Q=A.V$

$\frac{W_s}{S_s} = \frac{W_f}{S_f} + \frac{W_w}{S_w}$

$Q_{max} = \left(1+\frac{14}{4+P^{0.5}}\right)Q_{av}$ $F = \frac{1+R}{(1+(1-f)R)^2}$ $Qw = \frac{VX}{\theta_c Xr}$

$\frac{1}{\theta_c} = \frac{Q}{V}(1+r-r\frac{Xr}{X})$ $U = \frac{Q*(So-S)}{V*X}$ $T = \frac{La}{20}-1$

$A=0.00622.q/V_r$; $h_L=0.0729(V^2-v^2)$ $v=Q/W*d$ $\frac{W_s}{S_s} = \frac{W_f}{S_f} + \frac{W_w}{S_w}$

$Q = C.I.A / 360$

$I = 760 / (t+10)$ $V = \frac{1}{n} * R^{\frac{2}{3}} * S^{\frac{1}{2}}$

$I = 1\,020 / (t+10)$

$V = 0.849 C_H R^{0.63} S^{0.54}$ $\frac{F}{M} = \frac{S}{\theta * X}$

$t_0 = \frac{d^2(0.011d+0.785H)}{Q}$ $PE = \frac{BOD\ load\ from\ industry\ \left[\frac{kg}{day}\right]}{0.054\ \left[\frac{kg}{inhab\cdot day}\right]}$ $U = \left(\frac{F}{M}\right)*\left(\frac{E}{100}\right)$

$E = \left(\frac{S_o-S}{S_o}\right)*100$

$Vs = [0.707(Ss-1)d^{1.6}\,\upsilon^{-0.6}]^{0.714}$

$\eta = 1-\left(1+\frac{n(v_s)}{Q/A}\right)^{-\frac{1}{n}}$ $q = \frac{Q}{A}$

$BHP = (w.Q.H)/(75.\eta_p.\eta_m)$

$\frac{Qr}{Q} = \frac{x_t}{\left(\frac{10^6}{svi} - x_t\right)}$

Conc ($\mu g/m^3$)=$\frac{ppm*MW*1000}{22.4}$

$L_t = L_o(10^{-Kr})$ $x=xa+xe+xi$

$E_1 = \frac{100}{1+0.4432\sqrt{\frac{w_L}{VF}}}$ $Q = 130/\sqrt{t}$ (lpd/m^2)

$\theta_c = \frac{V*x}{Q_w x_w + Q_e x_e}$

$h_f = flv^2/(2gD)$

$V_{sl} = \frac{W_s}{\gamma_w S_{sl} P_s}$

$U = \frac{Q*(So-S)}{V*X}$

$BOD5 = (DO_{1s} - DO_{5s})*dilutionfactor - (DO_{1b} - DO_{5b})$

O_2 (g/d) = $\frac{Q(So-S)}{f}$ - 1.42 $Q_w X_r$

$\theta_C = \frac{V.x}{(Q+Q_r)x - Q_r x_r}$

$V = \frac{YQ(S_0-S)\theta_c}{x(1+k_d\theta_c)}$ $\theta_s = \frac{V_s}{Q}$ $\frac{f}{m} = \frac{So*Q}{V*X} = \frac{So}{\theta*X}$ $y_t = L_o(1-10^{-Kt})$

$Volume = \left[Vf - \frac{2}{3}[V_f - V_d]\right]T_1 + V_d T_2$

$Volume = \frac{1}{2}[V_f + V_d]T_1 + V_d T_2$

Concentration (ppb) = 22.4 x concentration ($\mu g/m3$) ÷ molecular weight at STP

P1V1/T1= P2V2/T2

4-8 hrs	n=0,1/8,1/4,1/2,1	1.8-3m; 1 to 4 m^3/d/m^2; 0.08-0.32kg/m^3/d
50 – 150 ml/gm	ML= 90 m MW= 30 m L:W= 1.5:1 to 7.5:1 L:D= 5:1 to 25:1 D= 3 to 50 m 7.5-10% D= 2.5 or 3.5	0.9-2.5m; 10-40m^3/m^2/d; 0.32-1 kg/m^3/d 0.6-1.6kg/d/m^2 6-35 m 1.6-6.4 kg/d/m^2 1 in 6 to 1 in 10 10-20 days 1.2 to 2 m 30- 40 day 4.5 to 6 m and maximum 9m
0.7-1.2 m/s 0.2-0.4/day 0.3-0.6kg/m^3/d 5-15 days	125m^3/d/m 185m^3/d/m 25-35 m^3/m^2/d; 50-60m^3/m^2/d 15-35 m^3/m^2/d; 40-50m^3/m^2/d	0.1 to 0.15per capita with dry solid loading of 80 to 120 kg/m^2/year 0.2 0.175 -0.2 m^2/c/yr area or 60-120 kg/m^2/yr

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Munshi Nagar, Andheri (W) Mumbai – 400058

END SEMESTER EXAM NOV-DEC 2025-SET-C

Third Year

Program: Civil/Mech./Elect. [Minor] **Duration: 3 hrs.**

Course Code: MI-BT032 Sem V **Maximum Points: 100 points**

Course Name: Sustainable Design in Engineering **Semester: V**

03/12/25

- **Notes: Question 1 is compulsory. Solve any four of remaining six**
- **Use illustrations wherever required**
- **Draw neat sketches/diagrams wherever required and give reasoning wherever required**
- **Assume suitable data if necessary and state them clearly**
- Figure on right indicate **maximum points** for the given question, **course outcomes attained , Bloom's Level and Module Number**

Q.no	Question	Points	CO	BL	Mo. N
1(a)	'Sustainability transitions require social change more than technology.' Discuss.	5	3	3	2
1(b)	Using Masdar City, explain sustainable urban planning strategies.	5	3	4	1
1(c)	Compare renewable and conventional energy systems based on efficiency, cost, and life-cycle environmental impacts.	5	2	3	4
1(d)	Identify the following as cash inflows or outflows for a recycling company: a. Sale of recycled paper and plastic b. Purchase of sorting equipment c. Wages paid to workers d. Electricity bill for recycling plant e. Collection fees received from households f. Transport fuel cost g. Maintenance of the recycling machine h. Government subsidy for recycling activities	3	3	4	1
	A family that won a ₹1,50,000 prize on a TV show decided to put one-half of the money in a college fund for their child, who was responsible for the prize. If the fund earned interest at 6% per year, how much was in the account 12 years after it was started?	2			
2 (a)	An office of 500 employees consumes 40 m^3/day of potable water. Compute L/p/d and compare with the target of 45 L/p/d. Suggest three design interventions. (conversion 1 m^3= 1000l)	5	4	3	5

END SEMESTER EXAM NOV-DEC 2025-SET-C

2 (b)	Determine the difference in the present worth values of the following two commodity contracts at an interest rate of 8% per year. a. Contract 1 has a cost of ₹120,000 in year 1; costs will escalate at a rate of 3% per year for 10 years. b. Contract 2 has the same cost in year 1, but costs will escalate at 5% per year for 11 years.	5	3	3	,2
2(c)	The "RE100 initiative" encourages global companies to commit to 100%renewable electricity. Companies like Google, Apple, and Infosys have already achieved or are on track to achieve this target by adopting on-site solar generation, renewable energy purchase agreements, and carbon offset measures. Based on this scenario: (a) Analyze the role of renewable energy commitments (like RE100) in accelerating the energy transition. (b) Examine the economic and environmental impacts of such initiatives on developing countries.	10	2	2	4
3(a)	Propose sustainable design principles for a new university campus in a warm-humid region	10	1	3	5
3(b)	Examine the ethical dilemmas faced by engineers in sustainable decision-making.	10	1	3	2
4(a)	Compare BRSR and GRI standards. How are they relevant with respect to SDGs, SDTs and SDIs. Explain with an example.	10	4	4	5
4(b)	Evaluate the Eastgate Centre (Harare, Zimbabwe) as a landmark example of biomimetic and sustainable building design. Discuss: Biological inspiration (termite mounds and passive cooling) How the building reduces HVAC energy use. Design methods used (form, process, system levels). Overall sustainability benefits Lessons for future civil/environmental engineering projects	10	2	2	3
5 (a)	Describe Nature-Based Design Solutions in engineering. Explain how wetlands, mangroves, root systems, and other natural systems inspire solutions for climate resilience, disaster mitigation, and resource efficiency. Discuss relevance to SDGs and sustainable cities.	10	4	4	6
5(b)	How do climate and orientation affect sustainable building performance?	05	2	4	2
5(c)	Describe BMW's approach to circular economy in manufacturing.	05	3	4	5
6(a)	Discuss the role of morphology and biological analogues in sustainable design innovation. Explain: Morphological analysis as a method How nature-inspired forms improve efficiency	10	4	3	4

	Engineering examples such as the kingfisher-inspired Shinkansen nose, plant-tropism facades, self-healing processes, etc.				
6(b)	Discuss the challenges, feasibility considerations, and limitations in integrating SDGs into engineering design.	10	3	2	4
7 (a)	Discuss any one real life sustainable design project in detail. Your answer should include the background and importance of the project, the underlying scientific, engineering, or design principles, and the specific sustainable design concept it aligns with. Further describe the project's objectives, methodology or design approach, implementation process, outcomes, and overall sustainability impact. Finally, explain how similar strategies can be adapted or scaled in the Indian and global context, identify the Sustainable Development Goals (SDGs) that the project supports, and list suitable indicators that can be used to measure the project's impact. (Hint: Use your mini-project)	20	4	3	4

ALL THE BEST

Formulae:

Factor	Formula
F/P	$F = P(1+i)^n$
P/F	$P = \frac{F}{(1+i)^n}$
P/A	$P = A\left[\frac{(1+i)^n - 1}{i(1+i)^n}\right]$
A/P	$A = P\left[\frac{i(1+i)^n}{(1+i)^n - 1}\right]$
F/A	$F = A\left[\frac{(1+i)^n - 1}{i}\right]$
A/F	$A = F\left[\frac{i}{(1+i)^n - 1}\right]$
P/G (Arithmetic Gradient)	$P_G = G\left[\frac{(1+i)^n - in - 1}{i^2(1+i)^n}\right]$
A/G (Arithmetic Gradient)	$A_G = G\left[\frac{1}{i} - \frac{n}{(1+i)^n - 1}\right]$
F/G (Arithmetic Gradient)	$F_G = G\left[\left(\frac{1}{i}\right)\left(\frac{(1+i)^n - 1}{i}\right) - n\right]$
P/G (Geometric Gradient)	$P_G = A_1\left[\frac{1 - \left(\frac{1+g}{1+i}\right)^n}{i-g}\right]$, $g \neq i$ $P_G = \frac{nA_1}{(1+i)}$, $g = i$

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Third Year B.Tech

~~END SEMESTER EXAM NOV-DEC 2025~~ Reexam January 2026 -SET-A

Program: Civil/Mech./Elect. [Minor] **Duration: 3 hrs.**

Course Code: MI-BT032 **Maximum Points: 100 points**

Course Name: Sustainable Design in Engineering **Semester: V**

13/01/26

- **Notes: Question 1 is compulsory. Solve any four of remaining six.**
- **Use illustrations wherever required**
- **Draw neat sketches/diagrams wherever required and give reasoning wherever required**
- **Assume suitable data if necessary and state them clearly**
- Figure on right indicate **maximum points** for the given question, **course outcomes attained , Bloom's Level and Module Number**

Q.no	Question	Points	CO	BL	Mo. N
1(a)	Discuss the importance of climate-responsive design in sustainable buildings. How do orientation and passive design strategies help achieve energy efficiency?	5	4	3	5
1(b)	Analyze the role of renewable energy commitments (like RE100) in accelerating the energy transition.	5	3	4	4
1(c)	Propose three SDG-linked design priorities for your institution's campus	5	2	3	4
1(d)	You own a small engineering consulting company. If you invest ₹2,00,000 of the company's money in a natural gas well that is expected to provide income of ₹30,000 per year, how long must the well produce at that rate in order to get the money back plus a rate of return of 10% per year?	5	3	4	1
2 (a)	Compare the GRI and BRSR frameworks used for corporate sustainability reporting in India. Which are more relevant in Indian context and how do they align to SDGs?	5	3	3	2
2 (b)	An electric switch manufacturing company has to choose one of three different assembly methods. Method A will have a first cost of ₹50,000, an annual operating cost of ₹9000, and a service life of 2 years. Method B will cost ₹90,000 to buy and will have an annual operating cost of ₹6000 over its 4-year service life. Method C will cost ₹130,000 initially with an annual operating cost of ₹4000 over its 8-year life. Methods A and B will have no salvage value, but method C will have some equipment worth an estimated ₹12,000. Which method should be selected? Use present worth analysis at an interest rate of 10% per year.	5	3	3	2
2(c)	Discuss the challenges, feasibility considerations, and limitations in integrating SDGs into engineering design.	10	1	3	2

~~END SEMESTER EXAM NOV-DEC 2025~~-SET-A
Re exam January 2026

3 (a)	Discuss the importance of sustainability targets and indicators in project assessment	5	3	3	3
3(b)	Analyse how AI and digitalisation can both aid and threaten sustainability with regards to Harvard Business school case study	5	1	3	1
3(c)	Compare renewable and conventional energy systems based on efficiency, cost, and life-cycle environmental impacts. Discuss the advantages and disadvantages of rooftop solar energy systems in urban India.	10	2	2	4
4(a)	Reflect on a product of daily use and propose sustainable redesign using sustainability design principles (atleast 2 from each pillar of sustainability). Take a case study or an example to demonstrate the same.	10	4	4	5
4(b)	Describe Nature-Based Design Solutions in engineering. Explain how wetlands, mangroves, root systems, and other natural systems inspire solutions for climate resilience, disaster mitigation, and resource efficiency. Discuss relevance to SDGs and sustainable cities.	10	4	4	6
5 (a)	Evaluate the Eastgate Centre (Harare, Zimbabwe) as a landmark example of biomimetic and sustainable building design. Discuss: Biological inspiration (termite mounds and passive cooling) How the building reduces HVAC energy use. Design methods used (form, process, system levels). Overall sustainability benefits Lessons for future civil/environmental engineering projects	10	2	2	3
5(b)	A 1200 m^2 academic building uses 9,400 W total lighting power and 170,000 kWh annual energy. Calculate LPD and comment on compliance with ECBC target (< 10 W/m^2). Compute EUI and discuss if it meets the benchmark (< 150 $kWh/m^2 \cdot year$). Suggest three design changes to improve performance.	05	2	4	2
5(c)	Explain principles of green building and what typical changes in design are required to implement them.	05	3	4	5
6(a)	The "RE100 initiative" encourages global companies to commit to 100% renewable electricity. Companies like Google, Apple, and Infosys have already achieved or are on track to achieve this target by adopting on-site solar generation, renewable energy purchase agreements, and carbon offset measures. Based on this scenario: a) Analyze the role of renewable energy commitments (like RE100) in accelerating the energy transition.	10	4	3	4

	b) Examine the economic and environmental impacts of such initiatives on developing countries.				
6(b)	Discuss the challenges, feasibility considerations, and limitations in integrating SDGs into engineering design.	10	3	2	4
7 (a)	Discuss any one real life sustainable design project in detail. Your answer should include the background and importance of the project, the underlying scientific, engineering, or design principles, and the specific sustainable design concept it aligns with. Further describe the project's objectives, methodology or design approach, implementation process, outcomes, and overall sustainability impact. Finally, explain how similar strategies can be adapted or scaled in the Indian and global context, identify the Sustainable Development Goals (SDGs) that the project supports, and list suitable indicators that can be used to measure the project's impact. (Hint: Use your mini-project)	20	4	3	4

ALL THE BEST

Formulae:

Factor	Formula
F/P	$F = P(1+i)^n$
P/F	$P = \frac{F}{(1+i)^n}$
P/A	$P = A\left[\frac{(1+i)^n - 1}{i(1+i)^n}\right]$
A/P	$A = P\left[\frac{i(1+i)^n}{(1+i)^n - 1}\right]$
F/A	$F = A\left[\frac{(1+i)^n - 1}{i}\right]$
A/F	$A = F\left[\frac{i}{(1+i)^n - 1}\right]$
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A/G (Arithmetic Gradient)	$A_G = G\left[\frac{1}{i} - \frac{n}{(1+i)^n - 1}\right]$
F/G (Arithmetic Gradient)	$F_G = G\left[\left(\frac{1}{i}\right)\left(\frac{(1+i)^n - 1}{i}\right) - n\right]$
P/G (Geometric Gradient)	$P_G = A_1\left[\frac{1 - \left(\frac{1+g}{1+i}\right)^n}{i-g}\right], g \neq i$ $P_G = \frac{nA_1}{(1+i)}, g = i$

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B

~~END SEMESTER November 2025~~ / RE - EXAM January 2026

Third Year B. Tech Civil

Program: Civil Engineering **Duration: 3 Hours**

Course Code: PC-BTC503 **Maximum Points: 100**

Course Name: Soil Mechanics **Semester: V**

09/01/26

Note:

1. Question 1 is compulsory.
2. Attempt any four out of remaining six questions
3. Write units everywhere. Use $\gamma_w = 9.81$ kN/m^3
4. Make reasonable assumptions where required and state them clearly. See equations on Pg. 4

Q. No.		Questions	Points	CO	BL	Module No.
1	a.	Shear parameters are required to be determined in the lab for the samples collected from the site. List the shear parameters. Which test would you perform and why? Discuss the specific advantages of the test you choose and its limitations	5	3	2, 3	8
	b.	A proposed building is expected to exert a uniform pressure of 100 kPa over the clay stratum which is 5 m thick. A 20 mm sample of this clay was tested in the oedometer under double drainage conditions as per IS 2720 (Part 15) 1965, R2021, and it was determined that 50% consolidation was completed within 4 min. Determine the time required for 50% of total settlement of the building if the clay stratum extends from the ground surface and is underlain by clean sand layer of 20 m thickness.	5	2	3	5
	c.	Derive the relationship between void ratio, moisture content, and degree of saturation of soil. Based on the site visit to NHSRCL, explain the terms TBM, ADIT and shaft. Discuss at least one aspect of the visit that you considered was important from a geotechnical engineering perspective.	5	1	3	1
	d.	A constant head permeability test was conducted on a soil sample having void ratio of 0.8, diameter 10 cm, and height 15 cm. 160 ml of water was collected in 1.75 min under a head of 30 cm. Calculate the coefficient of permeability of the soil, its discharge velocity, and seepage velocity.	5	2	3	2
2	a.	What is reconnaissance in a geotechnical investigation? Discuss its significance	5	4	2	8
	b.	A light pole exerts a concentrated load of 10kN on the surface of soil. Find the vertical stress at a distance 2 m away and 5 m below the ground surface and for a point 3 m away and 4 m below.	5	2	3	4

2	c.	Determine the MDD and OMC for the soil based on the observations noted below for a light weight compaction test conducted in the lab as per IS 2720 (Part 7) 1980, R2021. Assume 1000cc volume of mould and G=2.72. Draw the ZAV line and explain its significance Moisture content (%) / Mass of wet soil (g): 7.7 / 1739; 11.5 / 1919; 14.6 / 2081; 17.5 / 2033; 19.7 / 1986	10	2	3	3
3	a.	Undrained triaxial tests conducted on specimens of NC clay gave following results. Determine effective strength parameters. Cell pressure (kPa) / Deviator stress at failure (kPa) / Pore water pressure at failure (kPa): 150 / 102 / 80; 300 / 200 / 164; 450 / 304 / 264; 600 / 405 / 325	10	3	3	7
	b.	A hostel building proposed in your college campus. The building is proposed to be G+6 and covering an area of 3,000 sq. m. The contractor has constructed another building on the campus, just 100 feet away from the proposed hostel. The authorities want to complete the construction in a short time and with minimum expenses. The contractor suggests that time and money can be saved by skipping the geotechnical investigation as he knows the site soil. As a Civil Engineer and an alumnus of the college, you are asked your opinion. Would you recommend saving time and money by not doing the geotechnical investigation? Justify your answer.	10	4	3	8
4	a.	Illustrate with a neat sketch a finite slope with inclined backfill and show the crest, toe, face, and height of the slope. Explain a face failure, toe failure and base failure with neat sketches.	5	3	2	7
	b.	A partially saturated soil sample has water content of 17.5 % and void ratio of 0.87. Determine its degree of saturation, bulk unit weight, and dry unit weight. If its specific gravity is 2.69, calculate the volume of water (in liters) that needs to be added to 10 cubic meter of the soil to make it saturated.	5	1	3	1

B

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4	c.	The total primary consolidation settlement of a structure constructed on a 10 m thick saturated clay layer is estimated to be 50 mm. After 300 days of construction, the settlement was noted as 10 mm. Determine the additional time required for 50% of the primary consolidation settlement of the clay under the structure.	10	2	3	5
5	a.	What is Taylor's stability number? Discuss its uses and limitations.	5	3	2	7
	b.	What are isobars? Draw a typical isobar and explain its importance in civil engineering projects.	5	2		4
	c.	Classify the soil as per IS14998 (1970) R2021, based on the following observations in the laboratory: Sieve analysis performed on soil of mass 3000 g. Cumulative soil retained on 75μ sieve was 900 g. Liquid limit of soil passing 425 μ was determined as 72% and plastic limit was 26%. Draw the typical GSD curve for a uniformly graded soil and a gap graded soil	6+4	1	3	1
6	a.	Describe in detail how the CD traixial test is performed in the laboratory with reference to the following: i) Phases of the test ii) Line diagram showing application of stresses iii) Drainage conditions during each phase iv) Typical graphs v) Soil parameters and how to obtain them	10	3	2	6
	b.	An underground tunnel is to be constructed for which a trench is excavated in fine sand up to a depth of 4 m. The excavation is carried out by providing necessary side supports and by pumping out ground water. The water levels at the sides and bottom of the trench are shown in Figure 1 (Page 4). Determine if quick sand condition will occur at the bottom of the trench if G = 2.64 and e = 0.7. Discuss the solution if the bottom is unsafe.	10	1	3	2
7	a.	Determine the relative density of the soil in the field if its dry density is 1.64 g/cc. The observations as per IS2720 (Part 14) 1983, R2025 were as below: Diameter of mould (cm) 15 Height of mould (cm) 17 Weight of soil in mould (g) 4321 Height of soil after vibration (cm) 14.6	5	1	3	1

	b.	Discuss the advantages and disadvantages of the direct shear test	5	3	2	6
7	c.	Explain the mechanistic model (spring analogy) for 1D consolidation. Illustrate with neat sketches	10	2	2	5

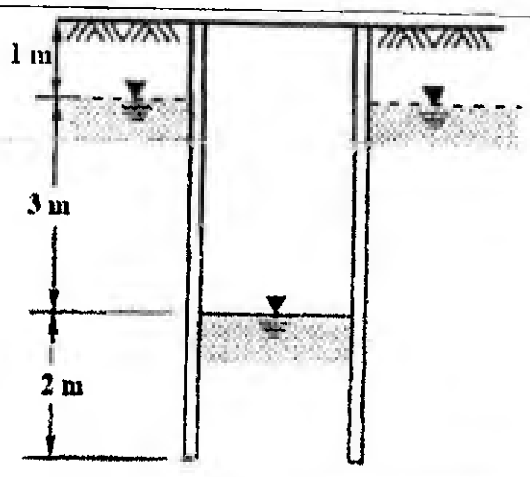

Figure 1

Equations:

K_{B_c} = Boussinesq influence coefficient for uniform load on circular area.

$$K_{B_c} = \left[1 - \frac{1}{\{1 + (a/z)^2\}^{3/2}}\right]$$

For point load

$$\sigma_z = \frac{3Qz^3}{2\pi(r^2 + z^2)^{5/2}}$$

For line load:

$$\sigma_z = \frac{2qz^3}{\pi(x^2 + z^2)^2}$$

For strip load:

$$\sigma_z = \frac{q}{\pi}[\beta + \sin\beta\cos(\beta + 2\delta)]$$

Time factor for consolidation:

For $U \leq 60\%$: $T_v = \frac{\pi}{4}\left(\frac{U}{100}\right)^2$

For $U > 60\%$: $T_v = 1.781 - 0.933\log_{10}(100 - U\%)$