

**B.E. CIVIL ENGINEERING FOURTH YEAR SECOND SEMESTER – 2022**  
**Subject: ADVANCED FOUNDATION ENGINEERING**

Time: Four hours

Full Marks:70

*Instructions: Use Separate Answer scripts for each Part**Answer all questions**Assume reasonable values of data if it is not supplied.**No code is allowed*

No. of Question	Part I (35 Marks)	Marks
Q.1	<p>A 4.5m wide, 13.5m long and 9m deep trench is to be excavated in a clayey soil for the foundation of a multistoried building with basement. The sides of the trench are supported with sheet pile walls fixed in place by struts and wales. The first row of strut is located at 2.0m below GL and bottom of cut is located at 2.0m below bottommost row of strut. The remaining struts are equally spaced in vertical direction. In each row horizontal spacing of strut is 3.0 m centre to centre. The soil parameters are as follows:  <math>\gamma = 18.5 \text{ kN/m}^3</math>, <math>c = 35 \text{ kN/m}^2</math> and <math>\phi = 0^\circ</math>            Determine: (i) The pressure distribution on the walls with respect to depth and (ii) the strut loads. (iii) Factor of safety against bottom heaving if <math>N_c = 7.4</math> for <math>H/B = 2</math> and <math>L/B = 3</math></p>	12
Q.2 a)	<p>i) Why ground improvement is needed? ii) What are two ground improvement techniques for sandy soil?</p>	1+2=3
b)	<p>A 20m diameter x 12.5m high steel oil storage tank is proposed to be placed at a site upon a 1m thick sand pad with projection of 1m on each side at base of the tank. The side slope of sand pad is 1:1. The subsoil profile at the site consists of soft grey silty clay (<math>\gamma = 18 \text{ kN/m}^3</math>, <math>C_u = 25 \text{ kN/m}^2</math>, <math>C_c/1+e_0 = 0.14</math>) down to 12m below GL followed by stiff layer of bluish grey silty clay (<math>\gamma = 19 \text{ kN/m}^3</math>, <math>C_u = 100 \text{ kN/m}^2</math>, <math>C_c/1+e_0 = 0.08</math>) down to 15m below GL. The ground water table is near the ground surface. The ground is to be treated with preloading and installation of sand drains. Justify the need of ground improvement from bearing capacity consideration. Design a suitable pre loading scheme and find the settlement at tank centre at the end of hydrotest for target degree of consolidation of 90%. Find the expected bearing capacity of the treated ground, if the ratio of increase of undrained shear strength of the clay to the increment of surcharge load is 0.28..</p>	20

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**PAPER ××××**

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 (35 marks for Part I and 35 Marks for Part II)

Use separate Answer-Script for each part

No. of  
Question

**Part II**

Marks

- **Maintain neatness.**
- **Each of the MCQ (within all of the MCQ in this part) is mandatory.**
- **Some MCQ question may have more than one correct alternative, so examine each alternative of each MCQ before giving your choice of the concerned MCQ.**
- **Giving all alternatives of any MCQ as your choices as correct answers of the concerned MCQ, will lead to zero marking for the concerned MCQ.**
- **All the other questions (apart from the MCQ questions in this part) are mandatory.**
- **Assume reasonable data if it is not supplied.**
- **All drawings-must be drawn by pencil.**
- **No code etc. will be needed to answer the questions.**

**Instructions (with examples) for giving answers to MCQ in this part:**

**Suppose you have to answer following MCQ in your answer script:**

MCQ 1) Name of the present prime minister of the India

- a) Jawaharlal Nehru,
- b) Narendra Modi,
- c) Manmohan Singh,
- d) None of the above.

MCQ 2) Virat Kohli is

- a) Captain of the Indian Cricket team,
- b) Husband of Anuska Sharma,
- c) President of the BCCI,
- d) All of the above.

MCQ 3) Within the last few months

- a) Russia attacked Ukraine,
- b) The economic condition of Srilanka became very bad,
- c) China attacked India,
- d) All of the above.

.....

**Then during giving answer in your answer scripts, you have to give the answers of the above MCQ in the following style only:**

**Part-II**

Answer to MCQ 1) : b) Narendra Modi,

Answer to MCQ 2) : b) Husband of Anuska Sharma,

Answer to MCQ 3) : a) Russia attacked Ukraine,

b) The economic condition of Srilanka became very bad,

.....

**Note:**

**(A) In MCQ 2, if anyone give alternative "a)" as one of the correct alternative, he/ she is wrong as Virat Kohli was (not "is") Captain of the Indian Cricket team. So, read each word of the alternatives very carefully before giving your answer.**

**(B) In MCQ 3, if anybody either alternative "a)" or alternative "b)" as the correct alternative, he/ she will get 0.5 marks as there were two correct alternatives.**

**(C) There is no negative marking for choosing wrong alternative as your choice in any MCQ.**

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**Group- A**

**Choose the correct alternative/ alternatives from the following MCQ:**

- MCQ (1) An open, unsaturated and partly unstable fabric of soil helps in 1  
(a) Making the soil metastable,  
(b) Making the soil to be collapsible,  
(c) Both (a) and (b),  
(d) None of the above.
- MCQ (2) Pretreatment technique of soil is being applied for 1  
(a) Stabilizing the soil only,  
(b) Collapsing the soil deposit to some degree,  
(c) Both (a) and (b),  
(d) None of the above.
- MCQ (3) The collapse of the soil is associated with 1  
(a) Localized shear failure of the soil mass,  
(b) Overall shear failure of the soil mass,  
(c) Both (a) and (b),  
(d) None of the above.
- MCQ (4) Most economical method of dewatering is: 1  
(a) Open sump method,  
(b) Deep Well method,  
(c) Well point method,  
(d) Both (a) and (b),  
(e) Both (b) and (c).
- MCQ (5) When well yield is low, then more reliable test is: 1  
(a) Well yield test,  
(b) Pumping test,  
(c) Both (a) and (b),  
(d) None of the above.
- MCQ (6) In metastable soils: 1  
(a) Large loss of shear strength occurs at small changes in stress,  
(b) Large loss of shear strength occurs at small changes in deformation,  
(c) Great increase in compressibility occurs at small changes in stress,  
(d) Great increase in compressibility occurs at small changes in deformation,  
(e) Both (a) and (b),  
(f) Both (c) and (d),  
(g) All from the (a) to (d),  
(h) None of the above.
- MCQ (7) Under Triaxial stress-state, the magnitude of volumetric strain originating from a change in stress state depends on: 1  
(a) Principal stress ratio,  
(b) Mean normal total stress,

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- (c) Both (a) and (b),
- (d) None of the above.

- MCQ (8) To maximize the amount of drawdown for the pumping test, the pump is normally placed: 1
- (a) Below the well screen,
  - (b) At the level of the well screen,
  - (c) Above the well screen,
  - (d) All the above.
- MCQ (9) "Any type of soil compacted at \_\_\_\_\_ of optimum conditions and at a \_\_\_\_\_ dry density may develop a collapsible fabric." - in this statement the blank spaces should be filled by the following two words: 1
- (a) "wet" and "low",
  - (b) "dry" and "high",
  - (c) "dry" and "low",
  - (d) "wet" and "high".
- MCQ (10) "A compacted and metastable soil structure is supported by \_\_\_\_\_ of the shear strength that is \_\_\_\_\_, which are highly dependent upon capillary action." - in this statement the blank spaces should be filled by the following two words: 1
- (a) "macro-forces " and "bonds",
  - (b) "micro-forces " and "bonds",
  - (c) "micro-forces " and "attraction",
  - (d) "macro-forces" and "attraction".
- MCQ (11) "On the basis of the crystalline arrangement, clays are divided in to \_\_\_\_\_ general groups."- in this statement the blank space should be filled by the following word: 1
- (a) two,
  - (b) three,
  - (c) four,
  - (d) five.
- MCQ (12) The cussions are of some specific types and in fact cussions are of: 1
- (a) two types,
  - (b) three types,
  - (c) four types,
  - (d) five types.
- MCQ (13) A well foundation has some components, some of the component/s is/are: 1
- (a) Well Cap,
  - (b) Staining,
  - (c) Well Shoe,
  - (d) All of the above.



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- MCQ (14) The depth of the bottom of the well below the maximum scour level, is known as: 1  
 (a) Well grip,  
 (b) Grip length,  
 (c) Well Shoe,  
 (d) Shoe length.
- MCQ (15) A pumping test is a practical, reliable method of estimating 1  
 (a) well performance,  
 (b) well yield,  
 (c) the zone of influence of the well,  
 (d) aquifer characteristics,  
 (e) All of the above,  
 (f) (a), (b) and (c) of the above.
- MCQ (16) Pumping test water level measurements should be made 1  
 (a) prior to the pumping period,  
 (b) during the pumping period,  
 (c) immediately following the pumping period,  
 (d) very long time after the pumping period,  
 (e) All of the above,  
 (f) (a), (b) and (c) of the above.
- MCQ (17) Longer duration pumping tests are commonly required to: 1  
 (a) prove up water quantity under local government/ administration,  
 (b) determine the minimum sustainable well yield,  
 (c) assess impacts on neighbouring wells or water bodies,  
 (d) All of the above,  
 (e) (a), (c) of the above.
- MCQ (18) During pumping and recovery, natural variations in water levels caused by 1  
 (a) tidal changes,  
 (b) changes in river,  
 (c) barometric changes,  
 (d) All of the above,  
 (e) (a), (b) of the above.
- MCQ (19) There are several factors to consider when determining the type of pump to use. 1  
 Some of the factors are:  
 (a) desired pumping rate,  
 (b) reliability of power source,  
 (c) well diameter,  
 (d) All of the above,  
 (e) (a), (b) of the above.
- MCQ (20) The duration of the pumping test depends on: 1  
 (a) the type of aquifer,  
 (b) any potential boundary conditions,

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- (c) the purpose of the well,
- (d) All of the above,
- (e) (a), (b) of the above.

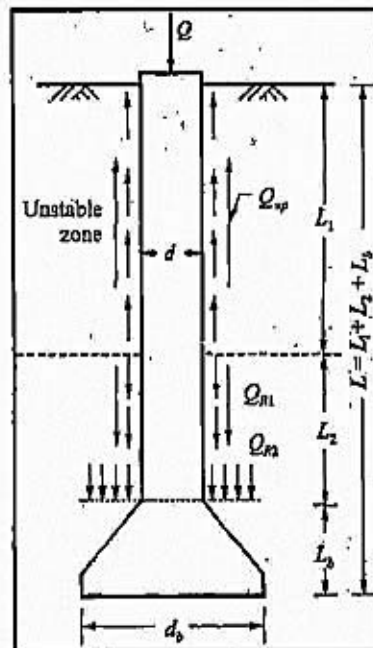
**Group- B**

**Answer all the following questions:**

- (21) What are the key things to consider when designing and planning a pumping test? 6
- (22) (a) What is the equation for uplift force  $Q_{up}$  for pier as per Chen (1988)? 1+8  
 (b) Here the figure shows a drilled pier [refer to Fig. shown] with a belled bottom in expansive soil. The water table is not encountered. The details of the pier and soil are:  
 $L_1 = 3.10$  m,  $L_2 = 3.15$  m,  $L_b = 0.760$  m,  $d = 0.305$  m,  $d_b = 0.9$  m,  $p_s = 480$  kN/m<sup>2</sup>,  $c_u = 96$  kN/m<sup>2</sup>,  $\gamma = 17.3$  kN/m<sup>3</sup>,

Required:

- (a) Total uplift force  $Q_{up}$
- (b) Total resisting force  $Q_R$ ,
- (c) Factor of safety for  $Q = 0$  at the top of pier,
- (d) Factor of safety for  $Q = 100$  kN at the top of pier (assume  $\alpha = 0.57$ )



**End of the Part-II of the ADVANCED FOUNDATION ENGINEERING question.**