ROYAL CIVIL SERVICE COMMISSION
BHUTAN CIVIL SERVICE EXAMINATION (BCSE) 2016
EXAMINATION CATEGORY: TECHNICAL

PAPER III: SUBJECT SPECIALISATION PAPER FOR CIVIL ENGG

Date:	2 October 2016
Total Marks:	100
Examination Time:	150 minutes (2.5 hours)
Reading Time:	15 minutes *(prior to examination time)*

GENERAL INSTRUCTIONS

1. Write your Registration Number clearly and correctly on the Answer Booklet.
2. The first 15 minutes is being provided to check the number of pages, printing error, clarify doubts and to read instructions in Question Paper. You are NOT permitted to write during this time.
3. This paper consists of **TWO Sections, namely Section A and Section B.**

   Section A has two parts: Part I - **30 Multiple Choice Questions.**
   Part II - **4 Short Answer Questions.**

   All questions under **Section A** are **COMPULSORY**.

   Section B consists of 2 case studies. Choose only **ONE** case study and answer the questions under your choice.
4. All answers should be written on the Answer Booklet provided to you. Candidates are not allowed to write anything on the question paper. If required, ask for additional Answer Booklet.
5. All answers should be written with correct numbering of Section, Part and Question Number in the Answer Booklet provided to you. Note that any answer written without indicating correct Section, Part and Question Number will NOT be evaluated and no marks would be awarded.
6. Begin each Section and Part in a fresh page of the Answer Booklet.
7. You are not permitted to tear off any sheet(s) of the Answer Booklet as well as the Question Paper.
8. Use of any other paper including paper for rough work is not permitted.
9. You are required to hand over the Answer Booklet to the Invigilator before leaving the examination hall.
10. The Question paper has 11 pages including this Instruction Page.

GOOD LUCK!

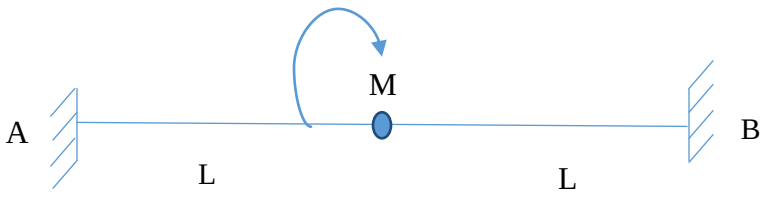
SECTION A

PART I – Multiple Choice Questions (30 Marks)

Choose the correct answer and write down the letter of the correct answer chosen in the Answer Booklet against the question number. E.g. 31 (c). Each question carries ONE mark. Any double writing, smudgy answers or writing more than one choice shall not be evaluated.

1. The cable resists external load by
   a. Tension
   b. Compression
   c. Bending
   d. Compression & Bending

2. The fixed end moment $\mathbf{M}_{FAB}$ for the given beam is



   a. Zero
   b. $\frac{M}{2}$
   c. $\frac{M}{4}$
   d. $\frac{M}{8}$

3. Strength of concrete is directly proportional to
   a. Cement water ratio
   b. Water cement ratio
   c. Sand cement ratio
   d. Water aggregate ratio

4. The workability of concrete can be improved by
   a. more sand.
   b. more cement.
   c. more fine aggregate.
   d. fineness of coarse aggregate.

5. For protection from frost, concrete should be
   a. dense
   b. free from cracks.
   c. adhesion between mortar and aggregate should be perfect.
   d. All of the above.

6. The pH value of water for quality concrete shall not be less than
   a. 2
   b. 4
   c. 6
   d. 12

7. Deep beams are designed for
   a. shear force only.
   b. bending moment only.
   c. both shear force & bending moment.
   d. None of the above.

8. Loss of stress with time at constant strain in steel is called
   a. Relaxation
   b. Creep
   c. Shrinkage
   d. Ductility

9. In-case of 2-way slab, the limiting deflection of the slab is
   a. primarily a function of the long span.
   b. primarily a function of the short span.
   c. independent of long or short span.
   d. dependent on both long and short spans.

10. Given that '$\emptyset$' is the angle of internal friction, 'P' is the safe bearing capacity and 'γ' is the unit weight of soil, the minimum depth of the foundation of a masonry footing is given by
    a. $\frac{P}{\gamma}\left[\frac{1+\sin\emptyset}{1-\sin\emptyset}\right]$
    b. $\frac{P}{\gamma}\left[\frac{1-\sin\emptyset}{1+\sin\emptyset}\right]$
    c. $\frac{P}{\gamma}\left[\frac{1+\sin\emptyset}{1-\sin\emptyset}\right]^2$
    d. $\frac{P}{\gamma}\left[\frac{1-\sin\emptyset}{1+\sin\emptyset}\right]^2$

11. In an RCC beam, side face reinforcement is provided if its depth exceeds
    a. 300 mm
    b. 500 mm
    c. 700 mm
    d. 750 mm

12. The purpose of reinforcement in pre-stressed concrete is to
    a. provide adequate bond stress.
    b. resist tensile stresses.
    c. impart initial compressive stress in concrete.
    d. All of the above.

13. The bond strength between steel and concrete is due to
    a. friction.
    b. adhesion.
    c. both friction & adhesion.
    d. None of the above.

14. The efficient and economical section used as a beam is
    a. I section
    b. Circular section
    c. Angles
    d. H section

15. Generally the purlins are placed at the panel points so as to avoid
    a. axial force in rafter.
    b. shear force in rafter.
    c. deflection of rafter.
    d. bending moment in rafter.

16. Which of the following is true for the discharge through a triangular notch:
    a. Q = 8/15 C_d x tan $\frac{\theta}{2}$ x $\sqrt{2g}$ $H^{5/2}$
    b. Q = 2/3 C_d x tan $\frac{\theta}{2}$ x $\sqrt{2g}$ $H^{3/2}$
    c. Q = 2/3 Cd x tan $\frac{\theta}{2}$ x $\sqrt{2gH}$
    d. None of the above

17. For a laminar flow through a circular pipe,
    a. the maximum velocity = 9.8 times the average velocity.
    b. the maximum velocity = specific gravity of water times the average velocity.

c. the maximum velocity = 1.5 times the average velocity.
d. the maximum velocity = 2.0 times the average velocity.

18. The aggregate is called coarse aggregate if it is completely retained on

a. 4.75 mm sieve
b. 10 mm sieve
c. 15mm sieve
d. 29 mm sieve

19. If a rectangular section has dimension of 10 cm x 20 cm. What would be the ratio of moment of inertia about x-axis passing through its centroid to the moment of inertia about y-axis passing through its centroid?

a. 2
b. 4
c. 6
d. 8

20. A simply supported beam PQ carries a u.d.l of ω throughout the span. What concentrated load should be applied at the center to cause the same bending magnitude of moment as u.d.l?

a. $\omega l / 2$
b. $\omega l /4$
c. $\omega l /8$
d. ωl

21. Torsional formula is valid if the shearing stress are

a. zero throughout the cross-section.
b. uniform throughout the cross-section.
c. caused due to twisting moment applied only at the free end.
d. within the shearing proportional limit.

22. In case of T-Section the maximum bending stress will occur at
a. neutral axis.
b. junction of web and flange.
c. extreme fiber in the web.
d. extreme fiber in the flange.

23. The 4 h unit hydrograph of a basin can be approximated as a triangle with base period of 48 h and a peak ordinate of 200 m^3/s. The area of the basin would be

a. 864 km^2
b. 1728 km^2
c. 3456 km^2
d. 5184 km^2

24. For a given storm, the average depth of rainfall over an area
    a. decreases with increase in area.
    b. increases with increase in area.
    c. has no relation with area.
    d. None of the above.

25. If the resultant falls outside the middle third for reservoir full condition the gravity dam may fail due to
    a. crushing
    b. tension
    c. sliding
    d. over turning

26. The maximum water content at which a reduction in water content does not cause a decrease in volume of soil is known as
    a. Ductile limit
    b. Liquid limit
    c. Plastic limit
    d. Shrinkage limit

27. The Terzghi's bearing capacity factors are function of
    a. cohesion.
    b. internal friction angle.
    c. friction angle between footing and soil.
    d. None of the above.

28. Type of shear failure that is expected for a dense sand or a stiff clay is
    a. punching shear failure.
    b. local shear failure.
    c. general shear failure.
    d. All of the above.

29. If the Froude number in open channel flow is equal to 1, the flow is called
    a. Super critical
    b. Sub critical
    c. Critical
    d. Streaming flow

30. Water hammer in penstock is caused by
    a. sudden change in the water level in the reservoir.
    b. sudden change in discharge.
    c. sudden change in the temperature.
    d. very gradual change in the discharge.

PART II – Short Answer Questions (20 Marks)

Answer ALL the questions. Each question carries 5 marks. Mark for each sub-question is indicated in the brackets.

1. A saturated undisturbed sample from a clay strata has moisture content of 22.22% and specific weight of 2.70. Assuming $\gamma_w = 10$ KN/m^3, calculate

   a) The void ratio (e) (2.5 marks)

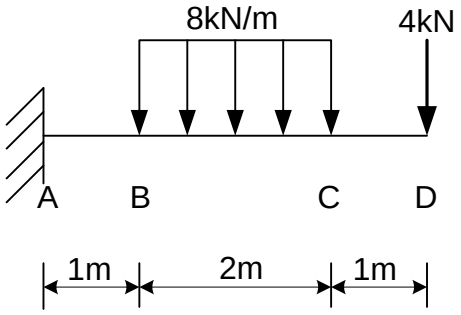
   b) The saturated unit weight of the clay (γ_{sat}) (2.5 marks)

2. Design a plain concrete footing for a 450 mm wall carrying 300 KN per metre length. Assume grade 20 concrete and the bearing capacity of the soil to be 200 KN/m^2. (5 marks)

3. A developer is considering two projects. Project A has a capital cost of $ 1,490,000.00 and a life of 20 years. Income for the project will be $ 430,000.00 per year. At the end of 20 years the project can be sold for $ 500,000.00. The project's discount rate is 20%. What is the Net Present Value for Project A? (Answer to the nearest dollar) (2.5 marks)

   Project B has a capital cost of $ 960,000.00 and a life of 10 years. Income for the project will be $ 195,000.00 per year. At the end of 10 years the project can be sold for $ 500,000.00. The project's discount rate is 11%. What is the Net Present Value for Project B? (Answer to the nearest dollar) (2.5 marks)

4. Study the cantilever subjected to imposed load as shown by the figure below and answer questions a and b.



   a) Draw the free body diagram and determine the support reactions. (2 marks)

   b) Determine the values and draw the diagrams for shear force and bending moment due to the imposed load on cantilever. (3 marks)

SECTION B

Case Study

Choose either Case 1 or 2 from this section. Each case study carries 50 marks. Marks for each sub-question is indicated in the brackets.

Case 1

A private construction firm in Bhutan has recruited you as a project engineer and as a part of your first assignment, answer the following questions.

a) A road embankment is 12 m wide at the formation level with side slopes of 2:1. The average height of the embankment is 4.0 m with an average gradient of 1 in 30 from a 210 m contour to 330 m contour. Find the length of the road and the quantity of earthwork. (5 marks)

b) Use the unit hydrograph for a 170 km^2 catchment, together with the excess rainfall hyetograph to calculate the resulting surface runoff hydrograph. (15 marks)

Time (hours)	**Half hour Unit hydrograph (m^3/sec)**	**Excess Rainfall Intensity (mm/hour)**
0	0	4
0.5	2.0	12
1	5.0	0
1.5	8.0	4
2	12.0	
2.5	15.0	
3	14.0	
3.5	12.0	
4	8.4	
4.5	5.9	
5	4.1	
5.5	2.9	
6	2.0	
6.5	1.4	
7	1.0	
7.5	0.6	
8	0	

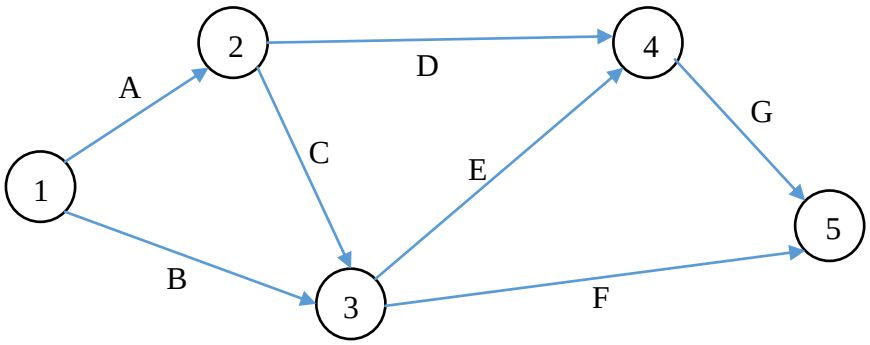
c) The table below presents the optimistic, pessimistic and most likely times for a group of activities.

Activity	Optimistic Time	Most Likely Time	Pessimistic Time
A	7	15	22
B	8	13	21
C	3	7	13
D	18	29	41
E	5	10	14
F	10	15	22
G	6	14	21

Enter the mean and variance of the duration of these activities in the table below assuming that they fit beta probability distribution. (5 marks)

Activity	Mean	Variance
A		
B		
C		
D		
E		
F		
G		

d) The network relating all of these activities is given in the diagram below:



Enter the values in the table below and also display all values in the network diagram. (10 marks)

Event	Earliest Event Time		Latest Event Time		Float	
	Mean	**Variance**	**Mean**	**Variance**	**Mean**	**Variance**
1						
2						
3						
4						
5						

e) Design a concrete masonry dam (considering unit length) with the following data: (10 marks)
   i. The total height of the dam = 7 m
   ii. Top width of the section = 1.8 m
   iii. Bottom width of the section = 6 m
   iv. Height of the water filled/stored = 7 m
   v. Assume the weight of concrete masonry = 24 KN/m^3
   vi. Assume the unit weight of water = 10 KN/m^3
   vii. Assume the coefficient of friction between concrete masonry & soil = 0.6
   viii. Allowable factor of safety (FoS) against sliding = 1.50
   ix. Assume tensile and compressive stresses of concrete masonry are 20 kg/cm^2 & 400 kg/cm^2 respectively.
   x. Neglect earthquake force.

Hint: *Water is stored at vertical side of a dam*

f) Design a simple beam for a clear span of 5.10 m with the following data: (5 marks)
   i. Length of bearing at each end = 150 mm.
   ii. Superimposed dead load = 18 KN/m.
   iii. Live load = 12 KN/m.
   iv. Concrete grade: M 15 & Steel grade: Fe 415.
   v. Calculate the sectional dimensions of the beam and the reinforcement area. Keep b/d = 0.5.

Case 2

Suppose you are working as a civil engineer for a consulting firm. You have been assigned to come up with the design for the following works:

a) The floor of a hall 12 m by 6 m to the centres of the supporting walls consists of 3 beams spaced at 3 m apart, the thickness of the slab being 130 mm. Design an intermediate beam. Allow a live load of 3500 N/m^2. The dead load of the floor finish may be taken as 500 N/m^2. Use M 15 concrete and Fe 250 steel. (25 marks)

b) Design a cantilever retaining wall with the following requirements: (15 marks)

i. Overall height of wall = 5 m
ii. Weight of soil = 16000 N/m^3
iii. Top surface of backing is level
iv. Angle of repose of soil = 30^0
v. Foundation shall not project on the retained side
vi. Safe bearing capacity of the soil = 200 KN/m^2
vii. Coefficient of friction (μ) = 0.45

Use M 20 concrete and Fe 250 steel.

c) A rectangle channel is to carry 1.30 m^3/s at a slope of 0.009. If the channel is lined with galvanized iron, n = 0.0011, what is the minimum of square meters of metal needed for each 100 m of channel? Neglect free board. (5 marks)

d) A short column of square section is to be designed to carry an axial load of 1023 KN. Design the column as per I.S code. Permissible stresses in concrete and steel are 4 N/mm^2 & 130 N/mm^2. (5 marks)