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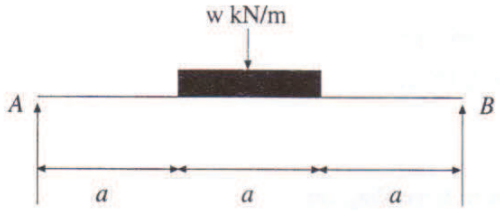
Written Examinations for Technical Officers (Civil / Mechanical) in Public Service and Provincial Public Service - From 2005 to 2009 (3rd Exam) - 2010

(41) Civil Engineering - I

Three hours

Answer **five** questions only. Calculators can be used.

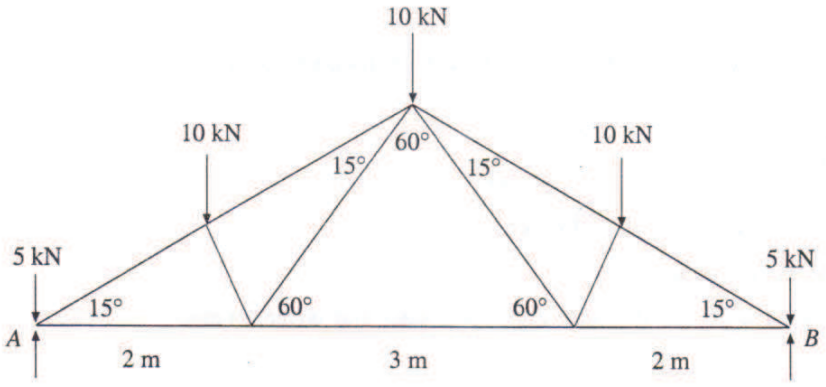
1. A beam of span *3a* is simply supported at its ends and loaded as shown in the figure given below. If $wa = W$, find the deflection at *"a"* distance from *A*.



2. A beam of I section 400 mm deep has a flange 150 mm wide and 30 mm thick and a web of thickness 20 mm. Compare the moment of resistant of this section with that of a beam of rectangular section of the same area whose depth is twice its breadth.

3. A girder of I section has a web 400 mm × 20 mm, and a flange 200 mm × 40 mm. Determine what precentage of the shearing force is carried by the web and what precentage of the bending movement is carried by the flange at any section of the beam.

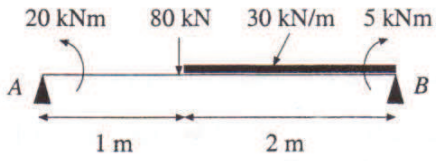
4.



The truss is loaded as shown above. Find the forces of each member. Assume horizontal reactions at *A* and *B* are zero and pin joint.

[See page two

5.



A simple supported beam is subjected to a concentrated force of 80 kN together with a distributed load of 30 kN/m length applied as shown below. Write equations for the shearing force and bending moment at any point along the length of beam. Also draw bending moment and shear force diagrams.

6. One way continuous three spans slab shown below has a thickness 125 mm and cover 20 mm.

Properties of the slab are as follows.

Density of concrete = 24 kN/m^3

Cubic strength of concrete = 30 N/mm^2

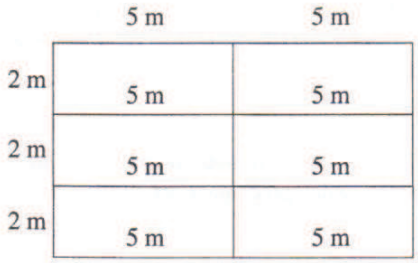
High yield stress of steel = 460 N/mm^2

Imposed load of slab = 2 kN/m^2

(Use 10 mm high yield steel)

(i) Draw bending moment and shear force diagrams.

(ii) Design main reinforcement and distribution steel.



7. The footing is required to resist characteristic axial load of 1000 kN dead and 350 kN imposed from a 400 mm × 400 mm column.

The safe bearing pressure on the soil = 200 kN / m^2

The characteristic strength of concrete = 35 N / mm^2

Characteristic strength of steel = 460 N / mm^2

Assume a footing weight of 150 kN.

Design the pad footing. Use 20 mm diameter high yield steel and cover 50 mm.

* * *

(e) Where a section is designed to resist only flexure, the lever arm should not be assumed to be greater than 0.95 times the effective depth.

In the analysis of a cross section of a beam that has to resist a small axial thrust, the effect of the design ultimate axial force may be ignored if it does not exceed 0.1 f_{cu} times the cross-sectional area.

3.4.4.2 *Design charts.* The design charts which form BS 8110 : Part 3 include charts, based on figure 2.1, figure 2.2 and the assumptions of **3.4.4.1**, which may be used for the design of beams reinforced in tension only or in tension and compression.

3.4.4.3 *Symbols.* For the purposes of **3.4.4** the following symbols apply.

A_s area of tension reinforcement
A_s' area of compression reinforcement
b width or effective width of the section or flange in the compression zone
b_w average web width of a flanged beam
d effective depth of the tension reinforcement
d' depth to the compression reinforcement
h_f thickness of the flange
M design ultimate resistance moment
x depth to the neutral axis
z lever arm
β_b the ratio:

$$\frac{\text{(moment at the section after redistribution)}}{\text{(moment at the section before redistribution)}}$$

from the respective maximum moments diagram

3.4.4.4 *Design formulae for rectangular beams.* The following equations, which are based on the simplified stress block of figure 3.3, are also applicable to flanged beams where the neutral axis lies within the flange:

$K' = 0.156$ where redistribution does not exceed 10 % (this implies a limitation of the neutral axis depth to $d/2$); or

$K' = 0.402(\beta_b - 0.4) - 0.18(\beta_b - 0.4)^2$ where redistribution exceeds 10 %

and $K = M/bd^2 f_{cu}$

If $K \leqslant K'$, compression reinforcement is not required and:

$$z = d\left\{0.5 + \sqrt{\left(0.25 - \frac{K}{0.9}\right)}\right\}$$

but not greater than $0.95d$

$x = (d - z)/0.45$

$A_s = M/0.87 f_y z$

If $K > K'$, compression reinforcement is required and:

$$z = d\left\{0.5 + \sqrt{\left(0.25 - \frac{K'}{0.9}\right)}\right\}$$

$x = (d - z)/0.45$

$A_s' = (K - K')f_{cu} bd^2/0.87 f_y (d - d')$

$A_s = K' f_{cu} bd^2/0.87 f_y z + A_s'$

If d'/x exceeds 0.43, the compression stress will be less than $0.87 f_y$ and should be obtained from figure 2.2.

3.4.4.5 *Design ultimate moments of resistance (flanged beams where the neutral axis falls below the flange).* Provided that the design ultimate moment is less than $\beta_f f_{cu} bd^2$ and that not more than 10 % of redistribution

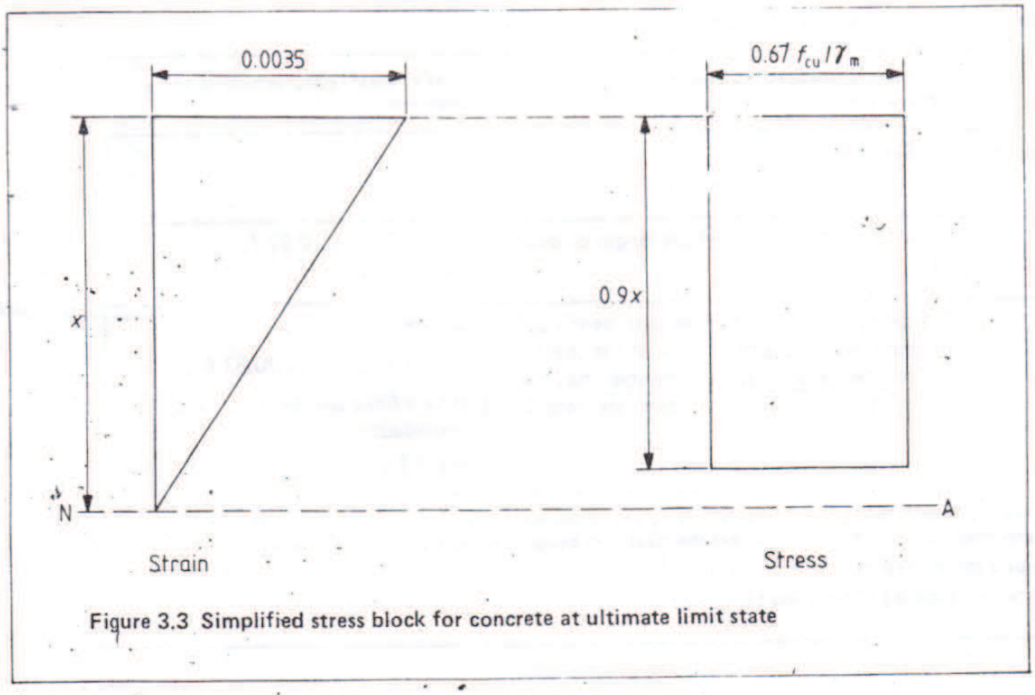


Figure 3.3 Simplified stress block for concrete at ultimate limit state

Table 3.6 Design ultimate bending moments and shear forces

	At outer support	Near middle of end span	At first interior support	At middle of interior spans	At interior supports
Moment	0	0.09Fl	-0.11Fl	0.07Fl	-0.08Fl
Shear	0.45F	–	0.6F	–	0.55F

NOTE. l is the effective span;

F is the total design ultimate load ($1.4G_k + 1.6Q_k$).

No redistribution of the moments calculated from this table should be made.

Equation 1 is only applicable when $h_f < 0.45d$.

Table 3.7 Values of the factor β_f

b/b_w	d/h_f					
	< 2	3	4	5	6	∞
1	0.15	0.15	0.15	0.15	0.15	0.15
2	0.15	0.14	0.12	0.12	0.11	0.08
4	0.15	0.13	0.11	0.10	0.09	0.04
6	0.15	0.13	0.11	0.09	0.08	0.03
8	0.15	0.13	0.10	0.09	0.08	0.02
∞	0.15	0.13	0.10	0.08	0.07	0

The values in table 3.7 are calculated from the following equation:

$$\beta_f = 0.45 \frac{h_f}{d}\left(1 - \frac{b_w}{b}\right)\cdot\left(1 - \frac{h_f}{2d}\right) + 0.15\frac{b_w}{b}$$

equation 2

Table 3.8 Form and area of shear reinforcement in beams

Value of v (N/mm^2)	Form of shear reinforcement to be provided	Area of shear reinforcement to be provided
Less than 0.5 v_c throughout the beam	See note 1	
$0.5\,v_c < v < (v_c + 0.4)$	Minimum links for whole length of beam	$A_{sv} \geq 0.4\, b_v s_v / 0.87\, f_{yv}$ (see note 2)
$(v_c + 0.4) < v < 0.8\sqrt{f_{cu}}$ or 5 N/mm^2	Links or links combined with bent-up bars. Not more than 50 % of the shear resistance provided by the steel may be in the form of bent-up bars (see note 3)	*Where links only provided:* $A_{sv} \geq b_v s_v (v - v_c)/0.87\, f_{yv}$ *Where links and bent-up bars provided:* see 3.4.5.6

NOTE 1. While minimum links should be provided in all beams of structural importance, it will be satisfactory to omit them in members of minor structural importance such as lintels where the maximum design shear stress is less than half v_c.

NOTE. Minimum links provide a design shear resistance of 0.4 N/mm^2.

NOTE 3. See 3.4.5.5 for guidance on spacing of links and bent-up bars.

$\frac{100 A_s}{b_v d}$	Effective depth (in mm)							
	125	150	175	200	225	250	300	≥ 400
	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²	N/mm²
≤ 0.15	0.45	0.43	0.41	0.40	0.39	0.38	0.36	0.34
0.25	0.53	0.51	0.49	0.47	0.46	0.45	0.43	0.40
0.50	0.67	0.64	0.62	0.60	0.58	0.56	0.54	0.50
0.75	0.77	0.73	0.71	0.68	0.66	0.65	0.62	0.57
1.00	0.84	0.81	0.78	0.75	0.73	0.71	0.68	0.63
1.50	0.97	0.92	0.89	0.86	0.83	0.81	0.78	0.72
2.00	1.06	1.02	0.98	0.95	0.92	0.89	0.86	0.80
≥ 3.00	1.22	1.16	1.12	1.08	1.05	1.02	0.98	0.91

NOTE 1. Allowance has been made in these figures for a γ_m of 1.25.

NOTE 2. The values in the table are derived from the expression:

$$0.79 (100 A_s/(b_v d))^{1/3} (400/d)^{1/4} / \gamma_m$$

where

$\frac{100 A_s}{b_v d}$ should not be taken as greater than 3;

$\frac{400}{d}$ should not be taken as less than 1.

For characteristic concrete strengths greater than 25 N/mm², the values in table 3.9 may be multiplied by $(f_{cu}/25)^{1/3}$. The value of f_{cu} should not be taken as greater than 40.

Table 3.12 Modification factor for compression reinforcement

$\frac{100 A'_{s,\,prov}}{bd}$	Factor
0.00	1.00
0.15	1.05
0.25	1.08
0.35	1.10
0.50	1.14
0.75	1.20
1.0	1.25
1.5	1.33
2.0	1.40
2.5	1.45
≥ 3.0	1.50

NOTE 1. The values in this table are derived from the following equation:

Modification factor for compression reinforcement =

$$1 + \frac{100 A'_{s,\,prov}}{bd} \Big/ \left(3 + \frac{100 A'_{s,\,prov}}{bd}\right) \leq 1.5$$

equation 3

NOTE 2. The area of compression reinforcement $A'_{s,\,prov}$ used in this table may include all bars in the compression zone, even those not effectively tied with links.

Table 3.10 Basic span/effective depth ratios for rectangular or flanged beams

Support conditions	Rectangular sections	Flanged beams with $\frac{b_w}{b} \leq 0.3$
Cantilever	7	5.6
Simply supported	20	16.0
Continuous	26	20.8

Service stress		M/bd²								
		0.50	0.75	1.00	1.50	2.00	3.00	4.00	5.00	6.00
	100	2.00	2.00	2.00	1.86	1.63	1.36	1.19	1.08	1.01
	150	2.00	2.00	1.98	1.69	1.49	1.25	1.11	1.01	0.94
(f_y = 250)	156	2.00	2.00	1.96	1.66	1.47	1.24	1.10	1.00	0.94
	200	2.00	1.95	1.76	1.51	1.35	1.14	1.02	0.94	0.88
	250	1.90	1.70	1.55	1.34	1.20	1.04	0.94	0.87	0.82
(f_y = 460)	288	1.68	1.50	1.38	1.21	1.09	0.95	0.87	0.82	0.78
	300	1.60	1.44	1.33	1.16	1.06	0.93	0.85	0.80	0.76

NOTE 1. The values in the table derive from the equation:

$$\text{Modification factor} = 0.55 + \frac{(477 - f_s)}{120 \left(0.9 + \frac{M}{bd^2}\right)} \leq 2.0$$

equation 7

where

M is the design ultimate moment at the centre of the span or, for a cantilever, at the support.

NOTE 2. The design service stress in the tension reinforcement in a member may be estimated from the equation:

$$f_s = \frac{5 f_y A_{s,\,req}}{8 A_{s,\,prov}} \times \frac{1}{\beta_b}$$

equation 8

NOTE 3. For a continuous beam, if the percentage of redistribution is not known but the design ultimate moment at mid-span is obviously the same as or greater than the elastic ultimate moment, the stress, f_s, in this table may be taken as $5/8 f_y$.

Table 3.13 Ultimate bending moment and shear forces in one-way spanning slabs

	At outer support	Near middle of end span	At first interior support	Middle of interior spans	Interior supports
Moment	0	$0.086Fl$	$-0.086Fl$	$0.063Fl$	$-0.063Fl$
Shear	$0.4F$	—	$0.6F$	—	$0.5F$

NOTE. F is the total design ultimate load ($1.4G_k + 1.6Q_k$)
l is the effective span

Table 3.14 Bending moment coefficients for slabs spanning in two directions at right-angles, simply-supported on four sides

l_y/l_x	1.0	1.1	1.2	1.3	1.4	1.5	1.75	2.0
α_{sx}	0.062	0.074	0.084	0.093	0.099	0.104	0.113	0.118
α_{sy}	0.062	0.061	0.059	0.055	0.051	0.046	0.037	0.029

Reinforcement: Cross-sectional areas of bars at specific spacings

Table 79

Bar size in mm	Bar spacing in millimetres 75	100	125	150	175	200	225	250	275	300
6	377	283	226	188	162	141	126	113	103	94
8	670	503	402	335	287	261	223	201	183	168
10	1,047	785	628	524	449	393	349	314	286	262
12	1,508	1,131	905	754	646	565	503	452	411	377
16	2,681	2,011	1,608	1,340	1,149	1,005	894	804	731	670
20	4,189	3,142	2,513	2,094	1,795	1,571	1,396	1,257	1,142	1,047
25	6,545	4,909	3,927	3,272	2,805	2,454	2,182	1,963	1,785	1,636
32	—	8,042	6,434	5,362	4,596	4,021	3,574	3,217	2,925	2,681
40	—	—	10,053	8,378	7,181	6,283	5,585	5,027	4,570	4,189

Cross-sectional areas of metric bars in mm²/m width

Reinforcement: Cross-sectional areas of specific numbers of bars (and perimeters)

Table 80

Size in mm	Number of bars 1	2	3	4	5	6	7	8	9	10	Perimeter (mm)
6	28.3	56.5	84.8	113.1	141.4	169.6	197.9	226.2	254.5	282.7	18.85
8	50.3	100.5	150.8	201.1	251.3	301.6	351.9	402.1	452.4	502.7	25.13
10	78.5	157.1	235.6	314.2	392.7	471.2	549.8	628.3	706.9	785.4	31.42
12	113.1	226.2	339.3	452.4	565.5	678.6	791.7	904.8	1,018	1,131	37.70
16	201.1	402.1	603.2	804.2	1,005	1,206	1,407	1,608	1,810	2,011	50.27
20	314.2	628.3	942.5	1,257	1,571	1,885	2,199	2,513	2,827	3,142	62.83
25	490.9	981.7	1,473	1,963	2,454	2,945	3,436	3,927	4,418	4,909	78.54
32	804.2	1,608	2,413	3,217	4,021	4,825	5,630	6,434	7,238	8,042	100.5
40	1,257	2,513	3,770	5,026	6,283	7,540	8,796	10,053	11,310	12,566	125.7

Areas are given in square millimetres

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Written Examinations for Technical Officers (Civil/ Mechanical) in Public Service and Provincial Public Service - from 2005 to 2009 (2nd Exam) - 2010

(42) Civil Engineering II

Three hours

Answer only **five** questions. Calculators can be used.

1. (i) Name the different type of water sources used for water supply schemes. Describe any **one** of above water source with the help of a neat sketch. *(06 marks)*

   (ii) Give a sketch of a sanitary dug well used for rural areas. *(06 marks)*

   (iii) If the water obtained from a deep borehole is found that contained iron and manganese, describe the method of removing them. *(06 marks)*

   (iv) Name **two** types of water seal toilets used in Sri Lanka. *(02 marks)*

2. (i) Compare rapid sand filters and slow sand filters used in water supply schemes under the following activities.

   (a) Rate of filtration

   (b) Quantity of wash water

   (c) Effective size of sand

   (d) Depth of bed for gravel and sand

   (e) Method of cleaning *(05 marks)*

   (ii) Calculate the area of rapid sand filter producing 6000 m^3/d when operating at 5 m/h. How much of back wash water will be required for this filter, if the filter wash is at 1 m/minute and continues for 5 minutes. *(05 marks)*

   (iii) Explain the functions of

   (a) Gate valve

   (b) Scour valve

   (c) Air valve

   (d) Non return valve

   (e) Ball valve *(05 marks)*

   (iv) Explain how to find "Yield of a well." *(05 marks)*

3. (i) Water is pumped from a shallow well in to a service tank supplying water to a housing scheme at the rate of 10 cubic meters per hour (10 m^3/h). The pump is operated for 5 hours each day and chlorine is added to the water at the inlet of the service tank. If chlorine is added at the rate of 1 mg/l using a solution of Bleaching powder. Estimate the quantity of bleaching powder required for a period of 3 months.

   (Bleaching powder has 33% available chlorine by weight) *(06 marks)*

   (ii) Draw a flow diagram of a water supply scheme based on the pumping of water from a river showing all major units from the source to consumer in their correct sequence. *(06 marks)*

   (iii) Name the common water borne diseases. *(04 marks)*

   (iv) Calculate the water needed per day for a housing scheme consist with 30 houses.

   (Assume number of consumers in a house is 10) *(04 marks)*

[See page two

4. (i) Explain the term "water distribution" *(04 marks)*

(ii) What are the factors to be considered when designing a water supply scheme. *(04 marks)*

(iii) Destinguish between gravity water supply system and pumping water suply system by drawing flow diagrams. *(08 marks)*

(iv) Why it is necessary to store water in residential buildings. *(04 marks)*

5. (i) Write short notes on "wastage of water" in the distribution system. *(04 marks)*

(ii) The population statistics pertaining to a town area are given below. Estimate the population expected in 2010 by incremental increase method. *(08 marks)*

Year	1960	1970	1980	1990	2000
Population	14 000	19 000	25 000	35 000	40 000

(iii) There are wide variations in the use of water in different hours of the day. Explain it. *(04 marks)*

(iv) Explain why centrifugal pumps are widely used in water supply schemes. *(04 marks)*

6. (i) Draw a flow diagram of an activated sludge sewage treatment plant. *(06 marks)*

(ii) Name traps used for sanitary fittings. *(03 marks)*

(iii) State how water seal in traps could be broken. *(05 marks)*

(iv) A drain of internal diameter of 150 mm is laid to a fall of 1 in 100 (0.01) and has a chazy coefficient of 58. The flow in the drain is assumed to be full bore.

(a) Determine the anticipated velocity of flow of water in the drain in m/s.

(b) Determine the discharge of water in m^3/s. *(06 marks)*

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Written Examinations for Technical Officers (Civil/Mechanical) in Public Service and Provincial Public Service - From 2005 to 2009 (3rd Exam) - 2010

(43) Road Construction & Maintenance
(Civil Engineering Works - II C)

Three hours

Answer **all** questions.

1. (i) Write down **five** types of macadam bases.
   (ii) Describe **one** of the above macadam bases.

2. Write short notes on the followings:
   (i) Cut back bitumen.
   (ii) Bitumen emulsion
   (iii) Types of bituminous surfacing.

3. (i) What are the tests carried out in road construction?
   (ii) Explain **two** of the above tests.

4. (i) Briefly explain the following and write down the equations using usual notations.
      (a) Bulk density
      (b) Dry density
      (c) Moisture content
      (d) Optimum moisture content
      (e) Maximum compaction
   (ii) What is the test you carried out to find the bulk density in field?

5. (i) What are the types of road construction equipments?
   (ii) Explain the road compaction procedure using a roller.

* * *

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Written Examinations for Technical Officers (Civil / Mechanical) in Public Service and Provincial Public Service - From 2005 to 2009 (3rd Exam) - 2010

(44) Civil Engineering III

Three hours

Answer **four** questions including **question No. 1**.
Provide answers relavant to each question using clear sketches wherever possible.

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1. Figure 1 shows a front elevation of the reinforced cement concrete members of the 7th floor proposed to the corected in a building with reinforced concrete frames. Most of the concrete members of this building are produced by using ready of mix concrete. Those concrete members are transported from a ready mix concrete batch mixing plant situated about 02 km away from the worksite. Some of the descriptions contained in the delivery ticket of readymix concrete sent by the company that owns the plant are given below. Answer the questions below with the help of the following details.

✻	(A)	Grade of concrete	: 20 N
✻	(B)	Slump in mm	: 130 ± 2
✻	(C)	Type of cement	: Ordinary Portland Cement
✻	(D)	Maximum size of aggregate	: 20 mm
✻	(E)	Water : Cement Ratio	: 0.45
✻	(F)	Admixture type	: Conflast 11
✻	(G)	Departure from plant	: 14.25
✻	(H)	Arrival at worksite	: 15.15
✻	(J)	Pouring start	: 15.18

(i) Describe what cement concrete are. Mention **four** types of them and state their
   (a) Proportions of materials.
   (b) Grades.
   (c) Where they are used.

(ii) Explain what is indicated in "A".

(iii) Describe with the help of diagrams how you would test at your worksite whether the value indicated in "B" is correct.

(iv) In addition to the type of portland cement mentioned in C name three other types of cement, and state their initial setting times and the final setting times according to British Standards (B.S.S.), and explain what is meant by "Setting Time".

(v) In the concrete mixture brought to the worksite according to what is mentioned in "D", it appears that there are aggregate elements of size less than 20 mm. Draw a rough sketch of the sizes of those elements and their percentages. If there were no elements of varying sizes, but only 20 mm size was available, describe the state of the strength of concrete.

(vi) According to "G", "H" and "J" the time taken from mixing the concrete to pouring is 53 minutes. However, this exceeds the intial setting time of normal portland cemment. Explain this. Here take into consideration what is mentioned in "F"

(vii) It has been proposed to pump concrete to the slab in the 7th floor from the concrete truck that comes to the worksite. Taking this into consideration, state in order all the steps of manufacturing of this slab.

(viii) Explain what is ment by "E". That value should not be more or less than the value given there. Explain this too.

(ix) In addition to the details mentioned in the delivery ticket of readymix concrete mentioned above, there are other details. Mention them.

(40 marks

[See page two

2. (i) Indicate how reinforcing bars are fitted for C_1, C_2, C_3, C_4, B_1, B_2, S_1, S_2, and W in figure 1, and draw the same figure again clearly and show all the details in it. (10 marks)

(ii) Mention the functions performed by reinforcements you fitted. (04 marks)

(iii) Show by means of diagrams the laps that should be kept for reinforcing bars in C_1 and C_3. (02 marks)

(iv) Mention the damage that may occur to the concretes if the laying of concretes and compaction are not done according to the specifications provided. *(04 marks)*

3. (i) Describe briefly with the use of diagrams how ordinary Portland cement is manufactured. *(08 marks)*

(ii) Indicate what is required for setting the cement mentioned in (i) above, and briefly describe the setting process of cement. *(03 marks)*

(iii) State the field tests you perform in order to check whether the cement brought to your worksite is suitable for use, and describe them separately. *(06 marks)*

(iv) Describe by means of diagrams, how the stock of cement mentioned in (iii) above, is stored safely. *(03 marks)*

4. (i) Mention **three** instances when rocks other than concrete are used in civil Engineering constructions, and indicate the reasons for such use. *(02 marks)*

(ii) In the manufacture of concrete what is mostly used as coarse aggregate is granite. What is the parent rock of granite? Mention **two** other parent rocks apart from this. State the reasons for using granite as a coarse aggregate over other types of rock in the manufacture of concrete. *(04 marks)*

(iii) What are the properties that should be present in the coarse aggregates used for concrete? *(03 marks)*

(iv) One method of extracting these rocks from hill or rocks where they are found, is blasting the rocks using explosives. Mention **three** other ways of extracting them. *(03 marks)*

(v) Mention **three** types of blasting materials (explosives) used in blasting rocks and state the materials that help in blasting those explosives. (blasting materials) *(03 marks)*

(vi) State the stages in the process of blasting rocks. Draw rough sketches where necessary. *(05 marks)*

5. (i) Briefly explain how soil is formed and mention **four** types of soil. *(03 marks)*

(ii) Explain the followings.

(a) Disturbed soil sample.

(b) Un - disturbed soil sample.

(c) Bore hole

(d) Trial pit

(04 marks)

(iii) Mention **four** engineering properties of soil. *(02 marks)*

(iv) The wash boring method is resorted to, in extracting a soil sample to send the soil of that layer for a test to the laboratory for testing, a soil layer situated at a very deep level of earth and cannot be extracted with an anger. Describe this method with the help of a rough sketch. *(07 marks)*

(v) According to the size of soil particles too, grading and identification of soil is done. Write the grades of soil particles according to the British Standard, and write the soil types too. *(04 marks)*

6. (i) Draw the cross section of the trunk of an externally growing plant and indicate all its details. *(03 marks)*

(ii) Felling trees for timber should be done at the commencement of the basic growing stage of a tree. If the trees are felled after or before this stage, briefly describe what happens to the timber sawn with such trees. *(02 marks)*

[*See page three*

(iii) Figure 2.1 and 2.2 show the diagrams of a tree with a large perimeter and of one with a small perimeter. To fell the tree shown in 4.1, an axe and a power-saw are used, while only the power-saw is needed to fell the tree shown in 2.2. Showing how cuts are made so as to fell the trees towards the direction indicated in Figure 2.1, and how cuts are made so as to fell the tree towards the direction indicated in Figure 2.2, and the technological measures that should be adopted, redraw both these figures and mention all the details. *(03 marks)*

(iv) Briefly describe what happens to the timber when it is seasoned. *(02 marks)*

(v) To make the slab shown in Figure 03, the timber is used for one to lean against the another and for the plants to be levelled properly. When after 02 days it is dismantled the concrete surface appeared in the manner indicated is Figure 03 and the shaping planks had warped. Mention the causes for this and briefly explain the measures you would adopt to prevent the occurance of such a situation in future. *(04 marks)*

(vi) Figure 04. shows some of the timber members expected to be used for structural works. Write the answers for the following questions using the figures of those timber members.

(a) Out of the timber members given in the Figure 4.1, which, out of A, B, and C are the most suitable and suitable members? *(02 marks)*

(b) For beams in the timber upper floors

I. Which is the most suitable timber member out of D and E? *(01 marks)*

II. Which is the most suitable timber member out of F and G? *(01 marks)*

(c) Which are the most suitable and suitable members out of H, J, K for floor boards? Give reasons for your choice. *(02 marks)*

* * *

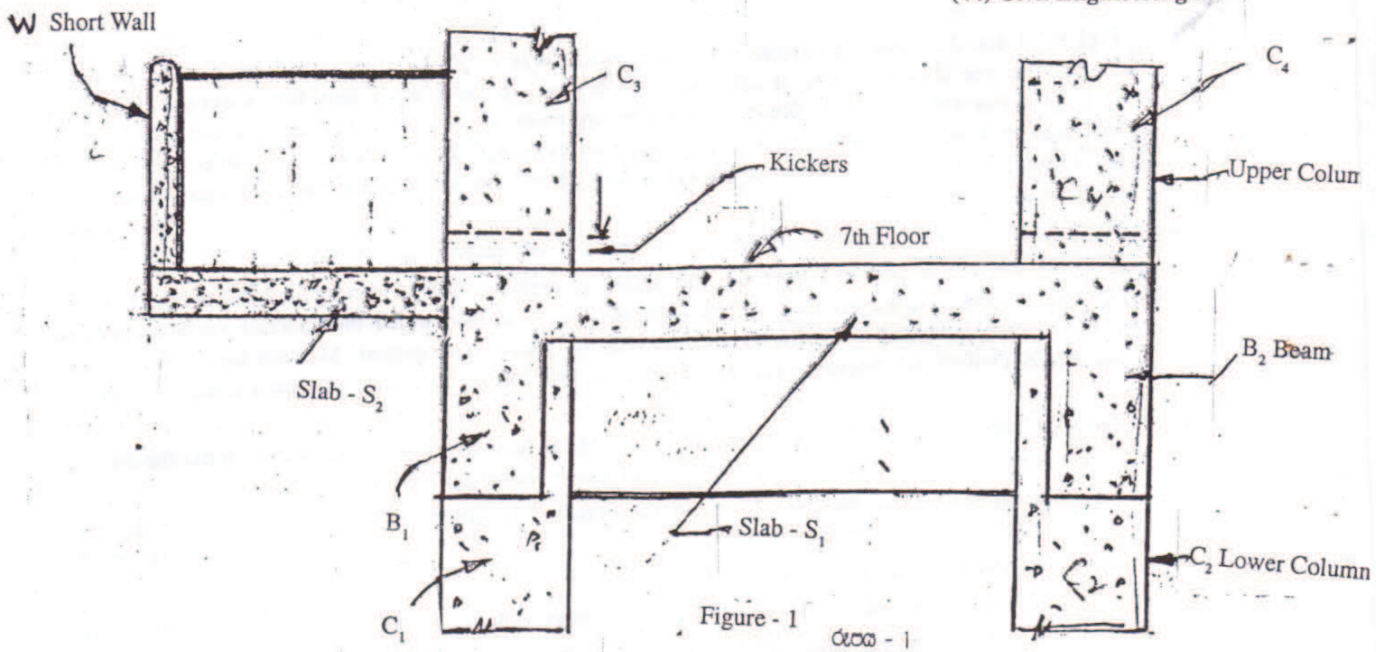

Figure - 1

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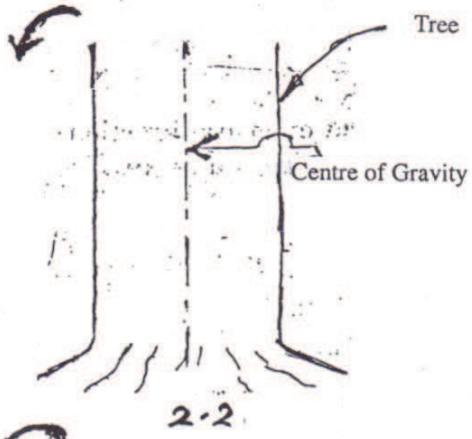

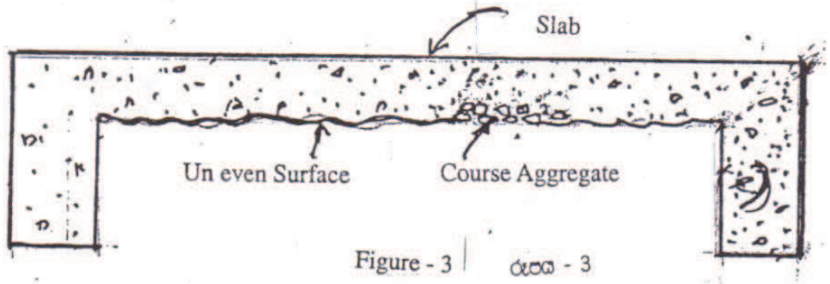

Figure - 3

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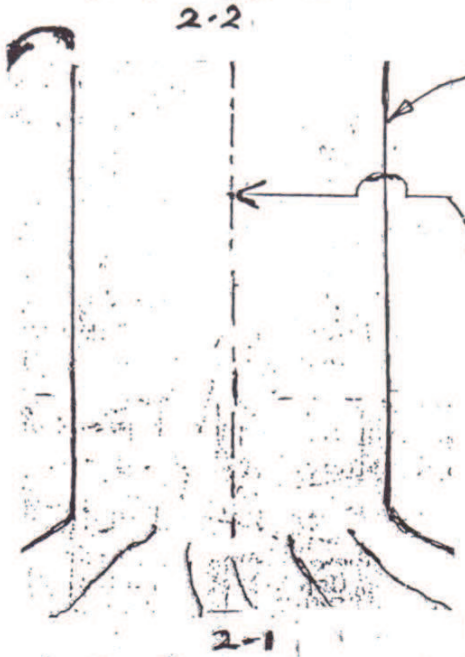

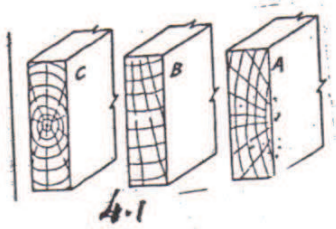

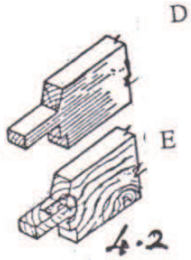

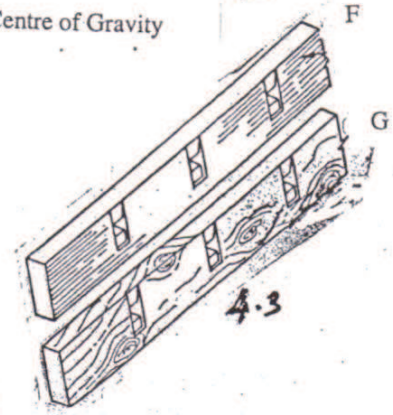

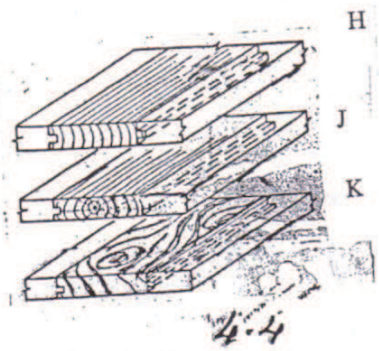

Figure - 2

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Figure - 4

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உரு - 4

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Written Examination for Technical Officers (Civil / Mechanical)
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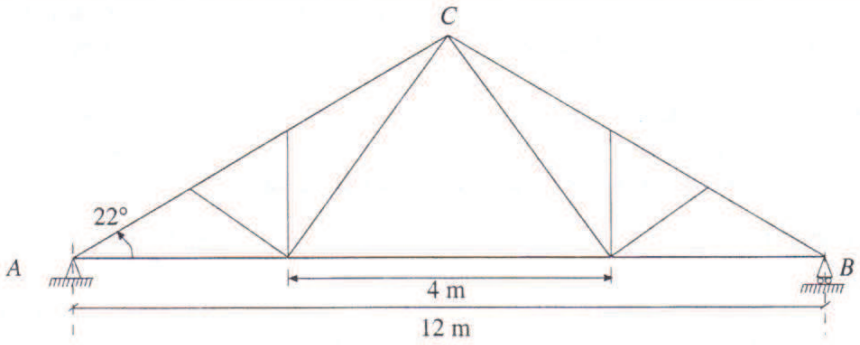
(45) Civil Engineering IV *Four hours*

Answer **only one** question.

The candidates can refer to the following books.

BS 8110, CP 110-Part I and Part II, Reinforced Concrete Disigners Handbook and BS 449 Steel Designers Manual.

1.



Above figure shows a line diagram of a steel roof truss.

Construct this steel roof truss according to the following data.

⊙ **Structural Summary** :

- ✻ Type of truss = Fan Pink
- ✻ Span = 12 m
- ✻ Pitch of truss = 22°
- ✻ Spacing of the trusses = 3.0 m
- ✻ Condition of support = Left end simply supported, right end roller supported

⊙ **General loading conditions** :

- ✻ All the loading of the roof are placed on the truss across the purliness fitted to its joints.
- ✻ All the loads are axial nodal loads confined only to the joints.

⊙ **Dead loads** :

- ✻ Load from the roof, that is, weight of the roof covering and weight of purlin = 400 N/m² on slope area
- ✻ Self weight of truss = 155 N/m² on plan area

⊙ **Imposed load on the roof** = 550 N/m², on plan area

⊙ **Wind load on roof** :

- ✻ Windward slope = 300 N/m² on slope area
- ✻ Leeward slope = 400 N/m² on slope area

⊙ Matareial data = Grade 43 steel

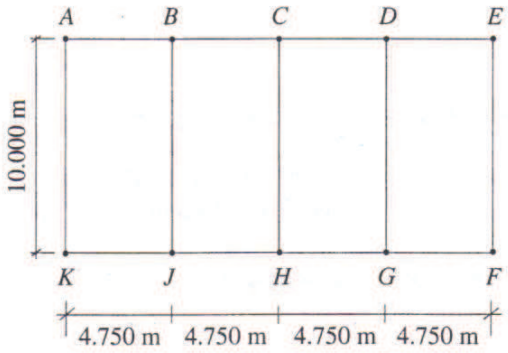
⊙ All members will be fitted with bolts and nuts

⊙ The angle iron used should be of equal angle

⊙ Inclined external members of the truss are made up of two angle irons, and all other members will be of single angle iron.

[See page two

2. (i)



Above figure shows the plan of a reinforced cement concrete slab, held by end beams and internal beams retained on reinforced cement concrete (RCC) pillars and a uniformly spread. Here the pillars, beams and slabs are attached to each other.

Construct the BCHJ internal panel of the slab with reference to the above figure and the following data.

- ❊ The density of the reinforced concrete = 24.0 kN/m^3
- ❊ Strength of the concrete = 25 N/mm^2
- ❊ Strength of the high tension steel (f_y) = 460 N/mm^2
- ❊ Load imposed on the slab = 4.0 kN/m^2
- ❊ U.D.L that occurs due to partition walls and finishes of the slab = 1.4 kN/m^3
- ❊ Fire resistance = $1\frac{1}{2}$ hrs

(ii) The size of an internal reinforced concrete cement column (RCC internal column) of a building is 225 mm × 225 mm. The ultimate load of this column is 700 kN. Taking the allowable bearing capacity of the soil as 160 kN/m^2, and taking the following details also into consideration, construct a square shaped pad foundation for the above column.

- ❊ the strength of the high tension steel = 460 N/mm^2
- ❊ the strenghth of the concrete = 25 N/mm^2
- ❊ the thickness of the reinforced concrete = 24 kN/m^3

❊ ❊ ❊

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Written Examinations for Technical Officers (Civil/ Mechanical) in Public Service and Provincial Public Service - From 2005 to 2009 (3rd Exam) - 2010

(46) Builing Quantity Surveying and Estimating of Buidling

Three hours

Answer **all** question.

N.B.

- ✻ In answering Q.1 use either the Standard Method of Measurements in building works in Sri Lanka prepared by the Buildings Departments or method of Measurements of Building works - Sri Lanka Standard published by Sri Lanka Bureau of Standards (Sheets should be prepared by candidates).
- ✻ Use taking off sheets when answering question No.01.
- ✻ If there are problems in the given drawing you should prepare a query sheet and give your own assumptions for such queries / problems and proceed with taking off quantities / measurements accordingly. The query sheet prepared should be attached to the answer script.
- ✻ Extension of measurements should be done. And all other necessary additions and subtractions also should be done. Preparation of the BOQ is to be done.
- ✻ Accuracy in taking off including computation of measurements which are not given in the drawing, descriptions of items of work with the correct abbreviations and entering measurements in the taking off sheets are very important.
- ✻ It is necessary to state the method of measurements very clearly in the answer paper.
- ✻ If the Standard Method of Measurements used is the one prepared by Buildings Department is used the taking off measurements should be in Imperial units. If the method of measurement - Sri Lanka Standard is used, the taking of measurements shall be in metric.

Assume that,

1 m (1000 mm) = 3.28 feet

(1) Using the given drawing, take off the following items of work.

(i) Excavation for pad foundation.

(ii) Excavation for strip foundation

(iii) 1:2:4 (20 mm) concrete for pad foundation

(iv) 1:2:4 (20 mm) concrete for strip foundation

(v) 1:2:4 (20 mm) concrete for column

(vi) 1:2:4 (20 mm) concrete for beam

(vii) 1:2:4 (20 mm) concrete for slab

(viii) 1/2 Brick work for the outer and interior walls separately.

(ix) Prepare a bill of quantities for the above items of work.

(80 marks)

(2) Estimate the cost of 1:2:4 (20 mm) concrete per m^3 for 1st floor slab. To prepare the rate use present labour wages and reasonable material prices. *(20 marks)*

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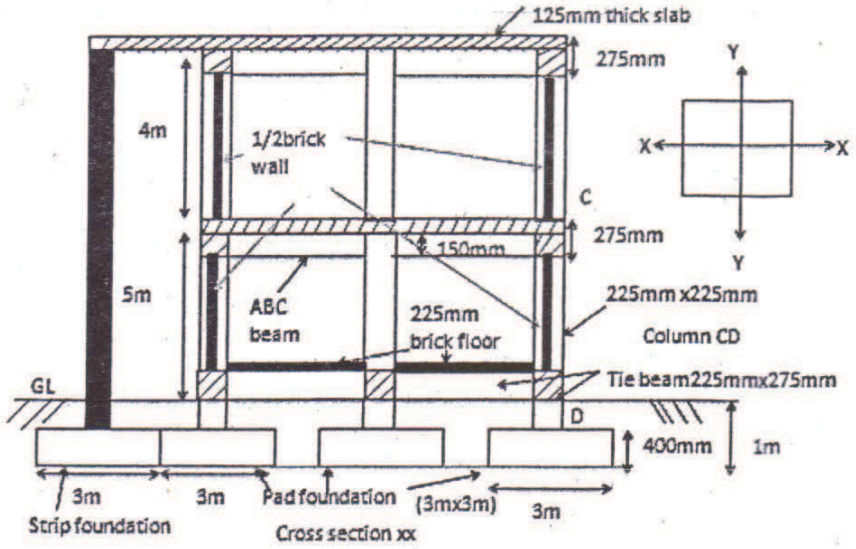
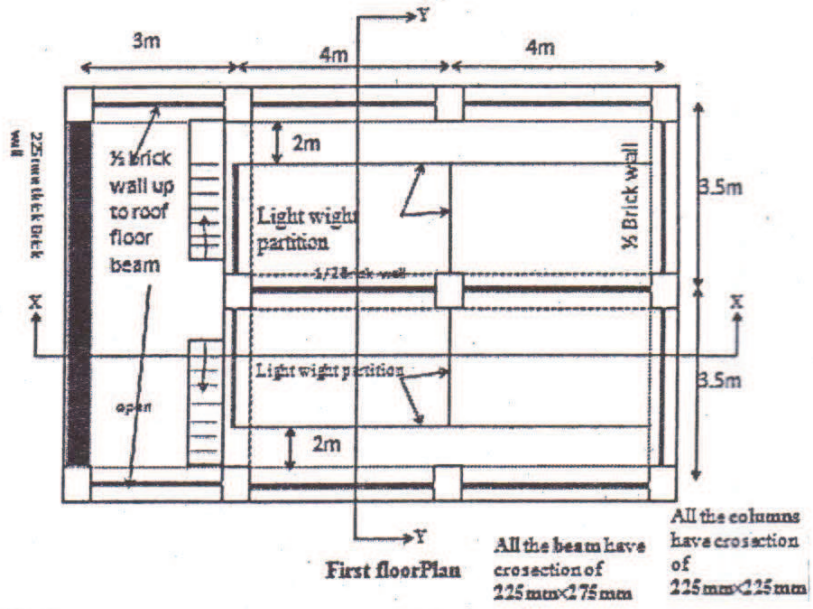
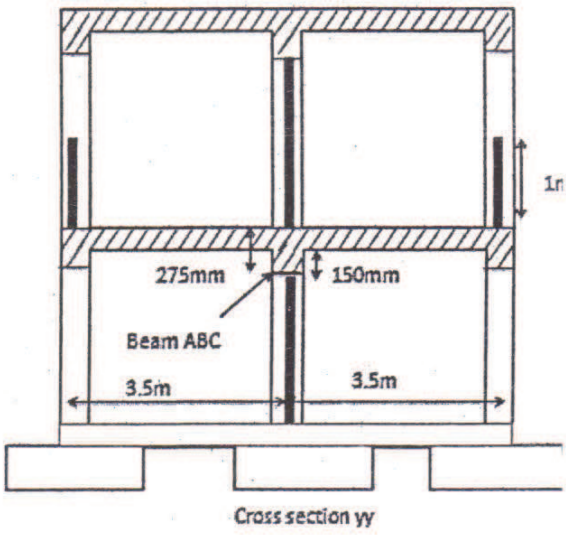
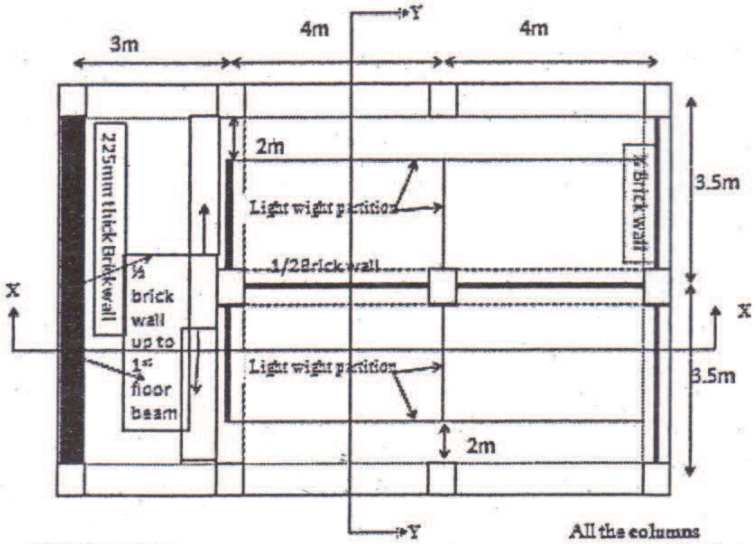

125mm thick slab
275mm
4m
1/2brick wall
C
275mm
150mm
5m
ABC beam
225mm brick floor
225mm x225mm
Column CD
GL
Tie beam225mmx275mm
D
400mm
1m
3m
3m
Pad foundation
(3mx3m)
3m
Strip foundation
Cross section xx
Y
X
X
Y

Figure 1


3m
4m
4m
Y
225mm thick brick wall
½ brick wall up to roof floor beam
2m
Light wight partition
½ Brick wall
3.5m
1/2Brick wall
X
X
Light wight partition
3.5m
open
2m
Y
First floorPlan
All the beam have crosection of 225mm×275mm
All the columns have crosection of 225mm×225mm


275mm
150mm
Beam ABC
3.5m
3.5m
Cross section yy


3m
4m
4m
Y
225mm thick Brick wall
2m
Light wight partition
½ Brick wall
3.5m
1/2Brick wall
X
½ brick wall up to 1st floor beam
X
Light wight partition
3.5m
2m
Y
All the beam have crosection of 225mm×275mm
ground floor plan
All the columns have crosection of 225mm×225mm

0314

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(47) Architectural Drawing

Three hours

Answer **four** questions including the compulsory question No. **1**.

---

1. The given drawing carries ground and upper floor layout plans and the schedule of doors and windows prepared for a Post Office building. Draw the following views of the building, using them.
   (i) Front Elevation
   (ii) Side Elevation
   (iii) Cross sectional Elevation of *XY* and *AB*

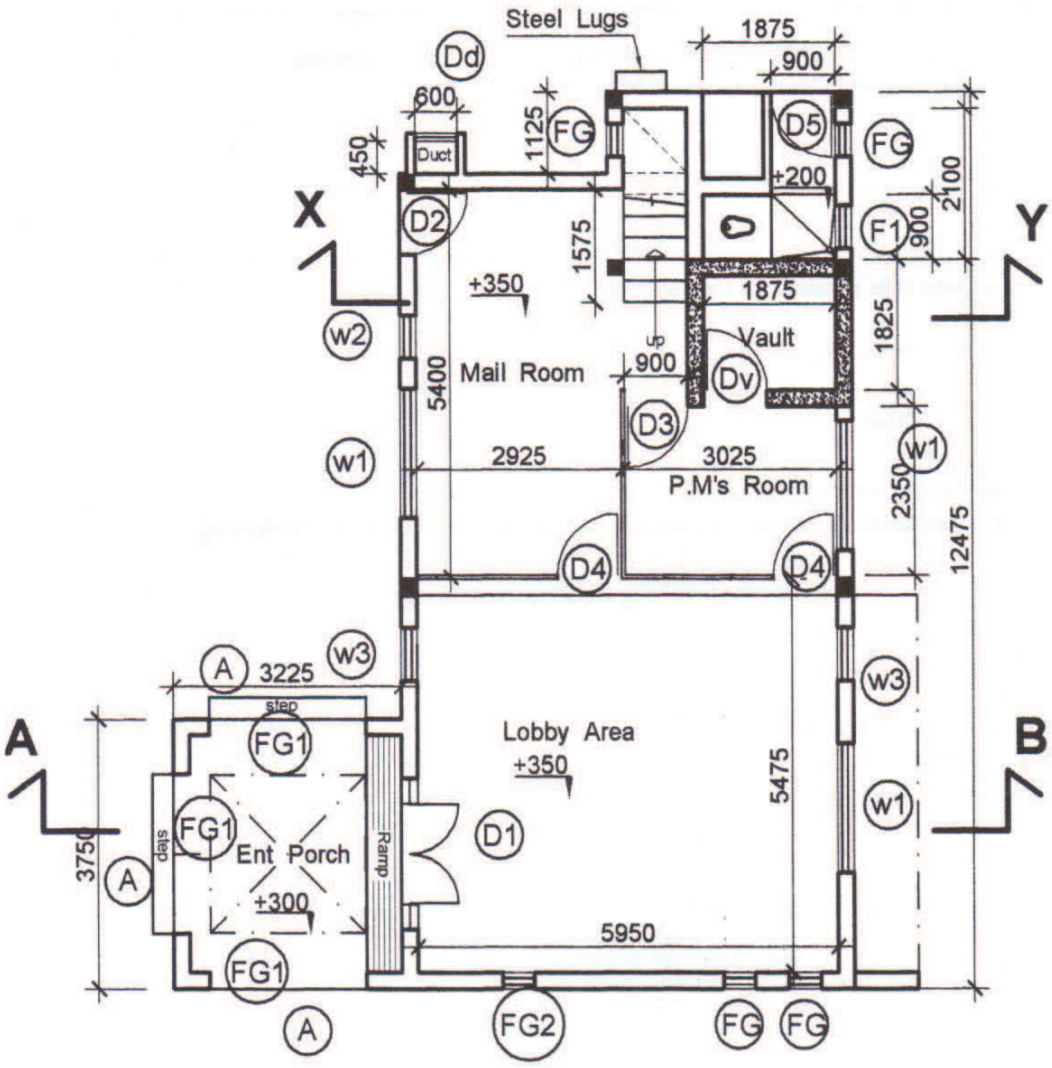
2. (i) What are the service requirements that should be indicated in a set of architectural drawings of a building?
   (ii) What are the drawings to be prepared for each of them?

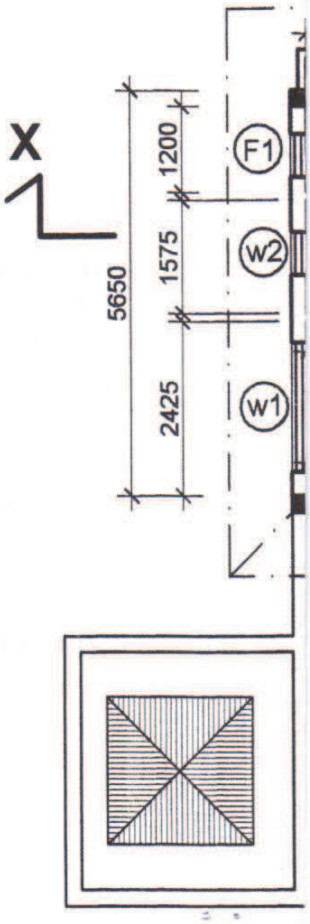
3. Draw detailed sketches of the following.
   (i) Eave gutter and down pipe joint
   (ii) Concrete Column foundation

4. (i) What is the importance of a contour plan in a set of architectural drawings?
   (ii) What are the necessary details to be indicated in a site plan included in an architectural drawing?

5. (i) What are the scales you use to produce the following architectural drawings.
      (a) Layout plan
      (b) Detailed drawings
      (c) Site plan
   (ii) Write short notes on any **one** of the following.
      (a) Architectural Drawings
      (b) Building Service Drawings

* * *





GROUND FLOOR PLAN.

UPPER

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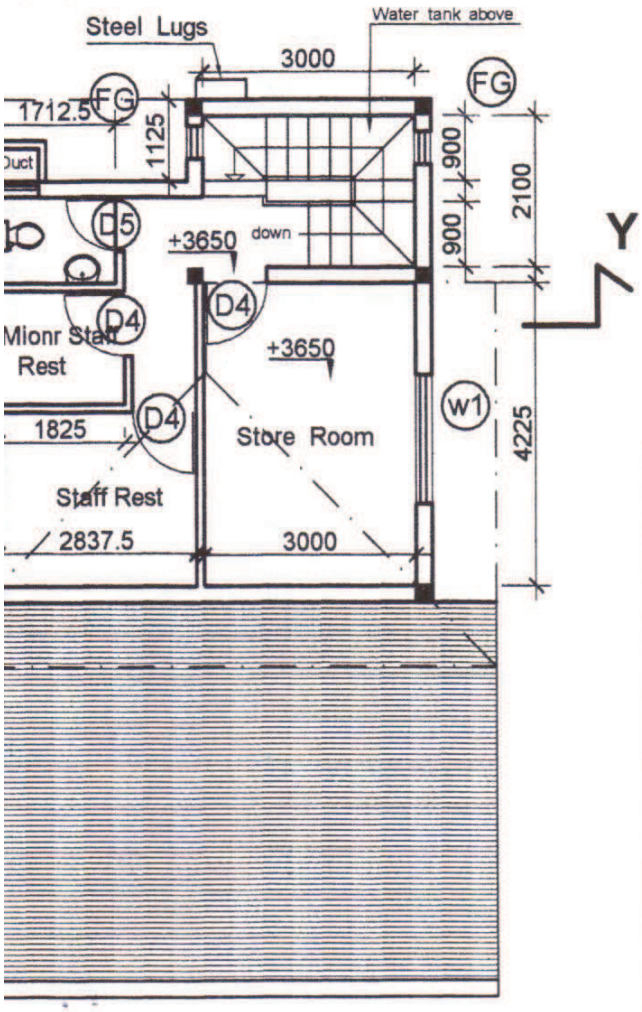
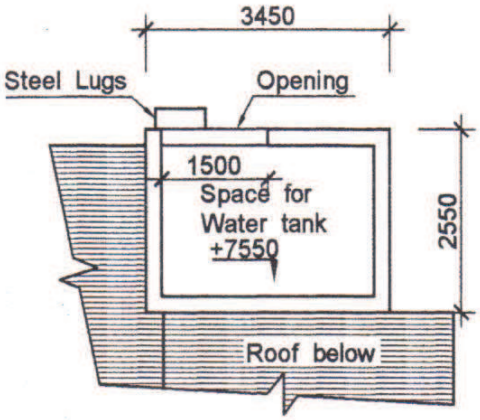
ல வரைதல்
ral Drawing



FLOOR PLAN.



PLAN - water Tank.

SCHEDULE OF OPENINGS

Type	Size	Description	Cill ht
D1	1500x2700 300x2700	Powder coated Aluminium framed glazed door with Louvres above and Fixed Glass At both sides	—
D2	1000x2700	Powde coated Aluminium framed glazed door with louvres above	—
D3	900x2100	Powder coated Aluminium framed glazed door	—
D4	900x2100	Powder coated Aluminium framed glazed & PVC covered ply-wood panel door	—
D5	750x2100	P V C door & frame	—
Dv	900x2100	Steel door & Frame	—
Dd	600x1800	Steel duct door	—
w1	1800x1800	Powder coated Aluminium framed glazed window	900
w2	600x1800	Powder coated Aluminium framed glazed window	900
w3	600x1200	Powder coated Aluminium framed fixed glass window	900
F1	600x1200	Powder coated Aluminium framed glazed fanlight	1500
FG	450 x450	Powder coated Aluminium framed fixed glass	
FG1	2225x600	Powder coated Aluminium framed fixed glass	2900
FG2	600x3375	Powder coated Aluminium framed fixed glass	1000
A	2225x3500	Flat arch	—
G1	1450x900	Stainless steel gate	—

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(48) Surveying and Levelling *Three hours*

Answer **five** questions only. Scientific Calculators are allowed to be used.

---

1. (i) Explain the principle of chain surveying. In what conditions, is the chain surveying more suitable? *(05 marks)*

(ii) Define the followings.
- (a) Systemic errors
- (b) Check lines
- (c) Main Survey Station
- (d) Tie Line
- (e) Random Errors *(05 marks)*

(iii) Explain the main factors to be considered when selecting survey stations and survey lines in chain surveying. *(05 marks)*

(iv) Explain with help of diagrams the way of taking offsets for the following objects.
- (a) Gate and Gate post
- (b) Curved Road
- (c) Straight boundary
- (d) Sea shore
- (e) Square building *(05 marks)*

2. (i) Explain the method to erect a perpendicular at a point in chain surveying. *(07 marks)*

(ii) Explain the method of overcoming difficulties if there are obstacles both in chaining and ranging in chain surveying. *(08 marks)*

(iii) Determine the maximum length of the offset if the error in direction is 4°. The maximum displacement on plan should not exceed 0.020 cm. Scale of plan is 1:2500. *(05 marks)*

3. The following readings are successively taken with a level:

0.355, 0.485, 0.625, 1.755, 1.895, 2.350, 1.780, 0.345, 0.685, 1.230 and 2.150 (m)

The instrument was shifted after the fourth and seventh readings. Prepare a level book page (rise and fall method) and calculate the Reduced level of different points. The reduced level of the first point is 225.500 (m). Apply the arithmetic checks and indicate the highest and lowest points. *(20 marks)*

4. (i) What is meant by Face Left and Face Right observation of a Theodolite? *(05 marks)*

(ii) On a given *AB* line, a straight line *AC* of length 2000 m is required to be set out at right angle to the given line *AB*. This is done by traversing from *A* towards *C* through *D*,*E* and *F*. The observations are as follows.

Line	Length (m)	Bearing
AB	-	00° 00'
AD	731	113° 48'
DE	467	81° 18'
EF	583	105° 57'

Compute the necessary length and bearing for *FC*. *(15 marks)*

[*See page two*

5. (i) What is contour line interval? What are the factors to be considered in selecting the contour line interval? *(05 marks)*

(ii) Define the followings in levelling.

(a) Levelling station
(b) Height of instrument
(c) Datum surface
(d) Altitude
(e) Turning point *(05 marks)*

(iii) The fore bearings of the four lines *AB*, *CD*, *EF* and *GH* are respectively as follows.

(a) 15° 30'
(b) 115° 45'
(c) 250° 30'
(d) 340° 0'

Determine the back bearings with diagrams. *(10 marks)*

6. (i) Explain **two** methods of chaining on a sloping ground. *(05 marks)*

(ii) A survey line *AB* is run along different slopes as described below.
A to *C*, elevation 7° 11', measured distance is 300 m
C to *D*, rise = 30 m, measured distance is 200 m
D to *B*, downward slope of 1 in 10, measured distance is 247 m.
Find the horizontal distance between *A* and *B*. (*C* and *D* lie between *AB*) *(10 marks)*

(iii) What are the different methods of representing the scale of a map? *(05 marks)*

* * *

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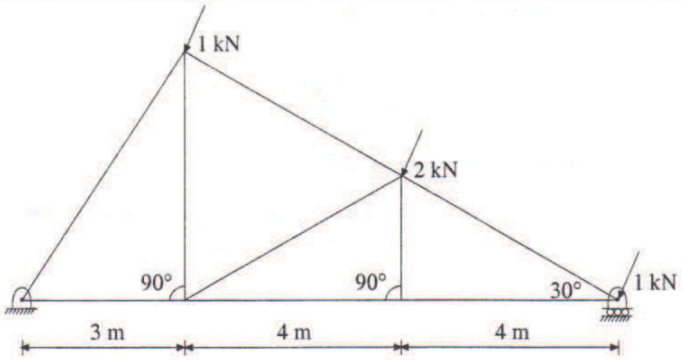
(49) Mechanical Engineering I

Three hours

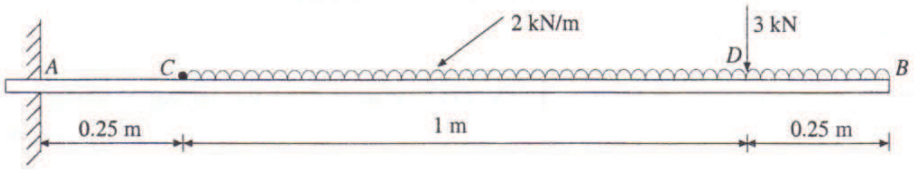
Answer only **five** questions.

1.



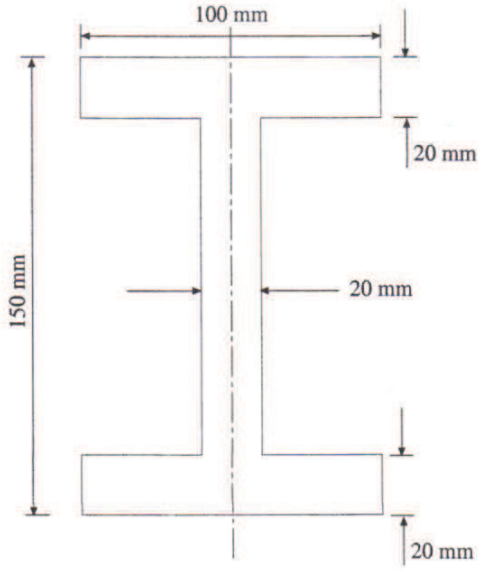
The above figure shows a truss 11 m long Pin - joined at one end and freely supported at the other end. It carries loads as shown in the figure.
Determine the forces in all the members of the truss and state their nature. *(20 marks)*

2.



The cantilever (1.5 m long) shown in the above figure is loaded with a uniformly distributed load of 2 kN/m run over a length of 1.25 m from the free end. (up to *C*) It also carries a point load of 3 kN at *D* at a distance of 0.25 m from the free end, Draw the shear force and Bending moment diagrams of the cantilever. *(20 marks)*

3.



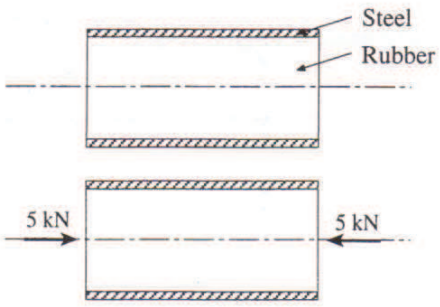
The cross section of an I - beam is shown in the above figure and its dimensions are also shown in the figure. Calculate the second moment of area of the section about the neutral axis. If the bending stress in the beam material does not to exceed 180 MN/m², determine the maximum bending moment in the beam. *(20 marks)*

[See page two

4. Briefly explain the following mechanical properties of metals.
   (i) Ductility
   (ii) Malleability
   (iii) Brittleness
   (iv) Plasticity
   (v) Hardness

(20 marks)

5.



As shown in the above figure, a steel tube with outside diameter 26 mm and inside diameter 20 mm is filled with rubber and subjected to 5 kN compressive force on their two ends.

Calculate the developed stresses on Rubber and Steel.

For Steel, $E = 200\ GN/m^2$

For Rubber, $E = 2.5\ GN/m^2$

(20 marks)

6. (i) State the Torque Formula for a Circular solid shaft and write the units for their symbols.
   (ii) When subjected to an applied torque, a circular shaft of length 600 mm twists through an angle of 2°. If the shear modulus for the shaft material is 80 GN/m^2, determine the shear stress,
      (a) at the centre of the shaft.
      (b) at a radius of 20 mm.
   (iii) If the maximum shear stress in the shaft is 120 MN/m2, what will be the outside diameter?

(20 marks)

* * *

[*See page three*

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Written Examinations for Technical Officers (Civil/ Mechanical) in Public Service and Provincial Public Service - From 2005 to 2009 (3rd Exam) - 2010

(50) Mechanical Engineering II

Three hours

Answer **five** questions selecting at least **two** questions from each part, **A** and **B**.
Steam table can be used for reference.

Part A

1. In a slider crank mechanism, length of the crank shaft AB is 100 mm and it makes 45° from outer dead centre (ODC). The length of the connecting rod BC is 500 mm. The crank shaft rotates about A, in anti clock wise (ACW) direction with angular velocity of 75 $rads^{-1}$ and angular acceleration of 900 $rads^{-2}$.

   Find the acceleration of the piston at point C.

2. A six cylinder engine running under full load conditions develops maximum torque at 1500 rpm when the power is 22 kW. Calculate,

   (i) the torque transmitted by the clutch.

   (ii) the force exerted by each of the eight springs if the clutch is a single - plate type.

   The friction surfaces are 1.8 m outside diameter and 0.25 m inside diameter and the coefficient of friction is 0.32.

3. A steem plant, works on ideal Rankine cycle having the boiler pressure 14 bar and condenser pressure 0.015 bar. Find the thermal efficincy of the plant. Now a superheater is fixed so that it delivers super heated steam to the turbine at a pressure of 14 bar and a temperature of 500°C. Find the new thermal efficiency. Also compare the specific steam consumption. (SSC)

4. A single-acting two-stage Reciprocating compressor with complete intercooling delivers 6 kg/min of air pressure at 16 bar. Assuming an intake state of 1 bar and 15°C, that the reversible compression and expansion processes are $PV^{1.3} = C$ and polytropic with n=1.3. Calculate the power required, the isothermal efficiency and free air delivery.

   Given that,

$$\dot{\omega} = 2\dot{m}\frac{n}{n-1}RT_1\left\{r_p^{\frac{n-1}{n}} - 1\right\}$$

Part B

5. A Porter governor has 300 mm arms and the rotating balls each have a mass of 1.8 kg, At the mean speed of 120 rpm, the arms make 30° to the vertical. Determine the central dead load and the sensitivity of the governor if the sleeve moment is ±25 mm.

6. A sigle phase motor operating of a 400 v, 50 Hz supply is developing 7.5 kw with an efficiency of 84% and a lagging power factor 0.7.
   Calculate,
   (i) The input kVA.
   (ii) Active and Reactive component of current
   (iii) kVAR

[See page two

7. A centrifugal pump is required to lift water to a total head of 40 m at the rate of 50 litres/sec. If the overall efficiency is 62%. Find the power required for the pump.

8. A leather belt, 125 mm wide and 6 mm thick, transmits power from a pulley 750 mm diameter which runs at 500 rpm. The angle of lap is 150° and $\mu = 0.3$. If the mass of 1 m^3 of leather is 1000 kg and the maximum stress in the belt is not to exceed 2.75 MN/m^2. Find the maximum efficiency which can be transmitted by the belt.
   Given that,

   $\frac{T_1}{T_2} = e^{\mu\theta}$ and

   $P_{MAX} = \sqrt{\frac{T_m}{3m}} \cdot \frac{2T_m}{3}(1 - e^{-\mu\theta})$

* * *

Superheated Steam†

p[bar] (t_s[°C])		t [°C]	50	100	150	200	250	300	400	500
		v								
0	$u = h - RT$	u	2446	2517	2589	2662	2737	2812	2969	3132
	at $p = 0$	h	2595	2689	2784	2880	2978	3077	3280	3489
		s								
	v_g 206.1	v	243.9	281.7	319.5	357.3	395.0	432.8	508.3	583.8
0.006112	u_g 2375	u	2446	2517	2589	2662	2737	2812	2969	3132
(0.01)	h_g 2501	h	2595	2689	2784	2880	2978	3077	3280	3489
	s_g 9.155	s	9.468	9.739	9.978	10.193	10.390	10.571	10.897	11.187
	v_g 129.2	v	149.1	172.2	195.3	218.4	241.4	264.5	310.7	356.8
0.01	u_g 2385	u	2446	2517	2589	2662	2737	2812	2969	3132
(7.0)	h_g 2514	h	2595	2689	2784	2880	2978	3077	3280	3489
	s_g 8.974	s	9.241	9.512	9.751	9.966	10.163	10.344	10.670	10.960
	v_g 28.20	v	29.78	34.42	39.04	43.66	48.28	52.90	62.13	71.36
0.05	u_g 2420	u	2445	2516	2589	2662	2737	2812	2969	3132
(32.9)	h_g 2561	h	2594	2688	2784	2880	2978	3077	3280	3489
	s_g 8.394	s	8.496	8.768	9.008	9.223	9.420	9.601	9.927	10.217
	v_g 14.67	v	14.87	17.20	19.51	21.83	24.14	26.45	31.06	35.68
0.1	u_g 2437	u	2443	2516	2588	2662	2736	2812	2969	3132
(45.8)	h_g 2584	h	2592	2688	2783	2880	2977	3077	3280	3489
	s_g 8.149	s	8.173	8.447	8.688	8.903	9.100	9.281	9.607	9.897
	v_g 3.239	v		3.420	3.890	4.356	4.821	5.284	6.209	7.134
0.5	u_g 2483	u		2512	2585	2660	2735	2812	2969	3132
(81.3)	h_g 2645	h		2683	2780	2878	2976	3076	3279	3489
	s_g 7.593	s		7.694	7.940	8.158	8.355	8.537	8.864	9.154
	v_g 2.217	v		2.271	2.588	2.901	3.211	3.521	4.138	4.755
0.75	u_g 2496	u		2510	2585	2659	2734	2811	2969	3132
(91.8)	h_g 2662	h		2680	2779	2877	2975	3075	3279	3489
	s_g 7.456	s		7.500	7.750	7.969	8.167	8.349	8.676	8.967
	v_g 1.694	v		1.696	1.937	2.173	2.406	2.639	3.103	3.565
1	u_g 2506	u		2506	2583	2659	2734	2811	2968	3131
(99.6)	h_g 2675	h		2676	2777	2876	2975	3075	3278	3488
	s_g 7.359	s		7.360	7.614	7.834	8.033	8.215	8.543	8.834
	v_g 1.673	v			1.912	2.145	2.375	2.604	3.062	3.519
1.01325	u_g 2506	u			2583	2659	2734	2811	2968	3131
(100.0)	h_g 2676	h			2777	2876	2975	3075	3278	3488
	s_g 7.355	s			7.608	7.828	8.027	8.209	8.537	8.828
	v_g 1.159	v			1.286	1.445	1.601	1.757	2.067	2.376
1.5	u_g 2519	u			2580	2656	2733	2809	2967	3131
(111.4)	h_g 2693	h			2773	2873	2973	3073	3277	3488
	s_g 7.223	s			7.420	7.643	7.843	8.027	8.355	8.646
	v_g 0.8856	v			0.9602	1.081	1.199	1.316	1.549	1.781
2	u_g 2530	u			2578	2655	2731	2809	2967	3131
(120.2)	h_g 2707	h			2770	2871	2971	3072	3277	3487
	s_g 7.127	s			7.280	7.507	7.708	7.892	8.221	8.513
	v_g 0.6057	v			0.6342	0.7166	0.7965	0.8754	1.031	1.187
3	u_g 2544	u			2572	2651	2729	2807	2966	3130
(133.5)	h_g 2725	h			2762	2866	2968	3070	3275	3486
	s_g 6.993	s			7.078	7.312	7.517	7.702	8.032	8.324
	v_g 0.4623	v [m³/kg]			0.4710	0.5345	0.5953	0.6549	0.7725	0.8893
4	u_g 2554	u [kJ/kg]			2565	2648	2727	2805	2965	3129
(143.6)	h_g 2739	h [kJ/kg]			2753	2862	2965	3067	3274	3485
	s_g 6.897	s [kJ/kg K]			6.929	7.172	7.379	7.566	7.898	8.191

† The entries in all tables are regarded as pure numbers and therefore the symbols for the physical quantities should be divided by the appropriate units as shown for the entries at p[bar] = 4. Because of lack of space, this has not been done consistently in the superheat and supercritical tables on pp. 6–9 and in the tables of pp. 11 and 15.

Superheated Steam*

p[bar] (t_s[°C])		t [°C]	200	250	300	350	400	450	500	600
	v_g 0.3748	v	0.4252	0.4745	0.5226	0.5701	0.6172	0.6641	0.7108	0.8040
5	u_g 2562	u	2644	2725	2804	2883	2963	3045	3129	3300
(151.8)	h_g 2749	h	2857	2962	3065	3168	3272	3377	3484	3702
	s_g 6.822	s	7.060	7.271	7.460	7.633	7.793	7.944	8.087	8.351
	v_g 0.3156	v	0.3522	0.3940	0.4344	0.4743	0.5136	0.5528	0.5919	0.6697
6	u_g 2568	u	2640	2722	2801	2881	2962	3044	3128	3299
(158.8)	h_g 2757	h	2851	2958	3062	3166	3270	3376	3483	3701
	s_g 6.761	s	6.968	7.182	7.373	7.546	7.707	7.858	8.001	8.267
	v_g 0.2728	v	0.3001	0.3364	0.3714	0.4058	0.4397	0.4734	0.5069	0.5737
7	u_g 2573	u	2636	2720	2800	2880	2961	3043	3127	3298
(165.0)	h_g 2764	h	2846	2955	3060	3164	3269	3374	3482	3700
	s_g 6.709	s	6.888	7.106	7.298	7.473	7.634	7.786	7.929	8.195
	v_g 0.2403	v	0.2610	0.2933	0.3242	0.3544	0.3842	0.4138	0.4432	0.5018
8	u_g 2577	u	2631	2716	2798	2878	2960	3042	3126	3298
(170.4)	h_g 2769	h	2840	2951	3057	3162	3267	3373	3481	3699
	s_g 6.663	s	6.817	7.040	7.233	7.409	7.571	7.723	7.866	8.132
	v_g 0.2149	v	0.2305	0.2597	0.2874	0.3144	0.3410	0.3674	0.3937	0.4458
9	u_g 2581	u	2628	2714	2796	2877	2959	3041	3126	3298
(175.4)	h_g 2774	h	2835	2948	3055	3160	3266	3372	3480	3699
	s_g 6.623	s	6.753	6.980	7.176	7.352	7.515	7.667	7.811	8.077
	v_g 0.1944	v	0.2061	0.2328	0.2580	0.2825	0.3065	0.3303	0.3540	0.4010
10	u_g 2584	u	2623	2711	2794	2875	2957	3040	3124	3297
(179.9)	h_g 2778	h	2839	2944	3052	3158	3264	3370	3478	3698
	s_g 6.586	s	6.695	6.926	7.124	7.301	7.464	7.617	7.761	8.028
	v_g 0.1317	v	0.1324	0.1520	0.1697	0.1865	0.2029	0.2191	0.2351	0.2667
15	u_g 2595	u	2597	2697	2784	2868	2952	3035	3120	3294
(198.3)	h_g 2792	h	2796	2925	3039	3148	3256	3364	3473	3694
	s_g 6.445	s	6.452	6.711	6.919	7.102	7.268	7.423	7.569	7.838
	v_g 0.0996	v		0.1115	0.1255	0.1386	0.1511	0.1634	0.1756	0.1995
20	u_g 2600	u		2681	2774	2861	2946	3030	3116	3291
(212.4)	h_g 2799	h		2904	3025	3138	3248	3357	3467	3690
	s_g 6.340	s		6.547	6.768	6.957	7.126	7.283	7.431	7.701
	v_g 0.0666	v		0.0706	0.0812	0.0905	0.0993	0.1078	0.1161	0.1324
30	u_g 2603	u		2646	2751	2845	2933	3020	3108	3285
(233.8)	h_g 2803	h		2858	2995	3117	3231	3343	3456	3682
	s_g 6.186	s		6.289	6.541	6.744	6.921	7.082	7.233	7.507
	v_g 0.0498	v			0.0588	0.0664	0.0733	0.0800	0.0864	0.0988
40	u_g 2602	u			2728	2828	2921	3010	3099	3279
(250.3)	h_g 2801	h			2963	3094	3214	3330	3445	3674
	s_g 6.070	s			6.364	6.584	6.769	6.935	7.089	7.368
	v_g 0.0394	v			0.0453	0.0519	0.0578	0.0632	0.0685	0.0786
50	u_g 2597	u			2700	2810	2907	3000	3090	3273
(263.9)	h_g 2794	h			2927	3070	3196	3316	3433	3666
	s_g 5.973	s			6.212	6.454	6.646	6.818	6.975	7.258
	v_g 0.0324	v			0.0362	0.0422	0.0473	0.0521	0.0566	0.0652
60	u_g 2590	u			2670	2792	2893	2988	3081	3266
(275.6)	h_g 2784	h			2887	3045	3177	3301	3421	3657
	s_g 5.890	s			6.071	6.336	6.541	6.719	6.879	7.166
	v_g 0.0274	v [m³/kg]			0.0295	0.0352	0.0399	0.0441	0.0481	0.0556
70	u_g 2581	u [kJ/kg]			2634	2772	2879	2978	3073	3260
(285.8)	h_g 2772	h [kJ/kg]			2841	3018	3158	3287	3410	3649
	s_g 5.814	s [kJ/kg K]			5.934	6.231	6.448	6.635	6.796	7.088

* See footnote on p. 6.

Saturated Water and Steam

t [°C]	p_s [bar]	v_g [m³/kg]	h_f [kJ/kg]	h_{fg} [kJ/kg]	h_g [kJ/kg]	s_f [kJ/kg K]	s_{fg} [kJ/kg K]	s_g [kJ/kg K]
0.01	0.006112	206.1	0*	2500.8	2500.8	0†	9.155	9.155
1	0.006566	192.6	4.2	2498.3	2502.5	0.015	9.113	9.128
2	0.007054	179.9	8.4	2495.9	2504.3	0.031	9.071	9.102
3	0.007575	168.2	12.6	2493.6	2506.2	0.046	9.030	9.076
4	0.008129	157.3	16.8	2491.3	2508.1	0.061	8.989	9.050
5	0.008719	147.1	21.0	2488.9	2509.9	0.076	8.948	9.024
6	0.009346	137.8	25.2	2486.6	2511.8	0.091	8.908	8.999
7	0.01001	129.1	29.4	2484.3	2513.7	0.106	8.868	8.974
8	0.01072	121.0	33.6	2481.9	2515.5	0.121	8.828	8.949
9	0.01147	113.4	37.8	2479.6	2517.4	0.136	8.788	8.924
10	0.01227	106.4	42.0	2477.2	2519.2	0.151	8.749	8.900
11	0.01312	99.90	46.2	2474.9	2521.1	0.166	8.710	8.876
12	0.01401	93.83	50.4	2472.5	2522.9	0.180	8.671	8.851
13	0.01497	88.17	54.6	2470.2	2524.8	0.195	8.633	8.828
14	0.01597	82.89	58.8	2467.8	2526.6	0.210	8.594	8.804
15	0.01704	77.97	62.9	2465.5	2528.4	0.224	8.556	8.780
16	0.01817	73.38	67.1	2463.1	2530.2	0.239	8.518	8.757
17	0.01936	69.09	71.3	2460.8	2532.1	0.253	8.481	8.734
18	0.02063	65.08	75.5	2458.4	2533.9	0.268	8.444	8.712
19	0.02196	61.34	79.7	2456.0	2535.7	0.282	8.407	8.689
20	0.02337	57.84	83.9	2453.7	2537.6	0.296	8.370	8.666
21	0.02486	54.56	88.0	2451.4	2539.4	0.310	8.334	8.644
22	0.02642	51.49	92.2	2449.0	2541.2	0.325	8.297	8.622
23	0.02808	48.62	96.4	2446.6	2543.0	0.339	8.261	8.600
24	0.02982	45.92	100.6	2444.2	2544.8	0.353	8.226	8.579
25	0.03166	43.40	104.8	2441.8	2546.6	0.367	8.190	8.557
26	0.03360	41.03	108.9	2439.5	2548.4	0.381	8.155	8.536
27	0.03564	38.81	113.1	2437.2	2550.3	0.395	8.120	8.515
28	0.03778	36.73	117.3	2434.8	2552.1	0.409	8.085	8.494
29	0.04004	34.77	121.5	2432.4	2553.9	0.423	8.050	8.473
30	0.04242	32.93	125.7	2430.0	2555.7	0.436	8.016	8.452
32	0.04754	29.57	134.0	2425.3	2559.3	0.464	7.948	8.412
34	0.05318	26.60	142.4	2420.5	2562.9	0.491	7.881	8.372
36	0.05940	23.97	150.7	2415.8	2566.5	0.518	7.814	8.332
38	0.06624	21.63	159.1	2411.0	2570.1	0.545	7.749	8.294
40	0.07375	19.55	167.5	2406.2	2573.7	0.572	7.684	8.256
42	0.08198	17.69	175.8	2401.4	2577.2	0.599	7.620	8.219
44	0.09100	16.03	184.2	2396.6	2580.8	0.625	7.557	8.182
46	0.1009	14.56	192.5	2391.8	2584.3	0.651	7.494	8.145
48	0.1116	13.23	200.9	2387.0	2587.9	0.678	7.433	8.111
50	0.1233	12.04	209.3	2382.1	2591.4	0.704	7.371	8.075
55	0.1574	9.578	230.2	2370.1	2600.3	0.768	7.223	7.991
60	0.1992	7.678	251.1	2357.9	2609.0	0.831	7.078	7.909
65	0.2501	6.201	272.0	2345.7	2617.7	0.893	6.937	7.830
70	0.3116	5.045	293.0	2333.3	2626.3	0.955	6.800	7.755
75	0.3855	4.133	313.9	2320.8	2634.7	1.015	6.666	7.681
80	0.4736	3.408	334.9	2308.3	2643.2	1.075	6.536	7.611
85	0.5780	2.828	355.9	2295.6	2651.5	1.134	6.410	7.544
90	0.7011	2.361	376.9	2282.8	2659.7	1.192	6.286	7.478
95	0.8453	1.982	398.0	2269.8	2667.8	1.250	6.166	7.416
100	1.01325	1.673	419.1	2256.7	2675.8	1.307	6.048	7.355

† u and s are chosen to be zero for saturated liquid at the triple point.

Note: values of v_f can be found on p. 10.

p [bar]	t_s [°C]	v_g [m³/kg]	u_f [kJ/kg]	u_g [kJ/kg]	h_f [kJ/kg]	h_{fg} [kJ/kg]	h_g [kJ/kg]	s_f [kJ/kg K]	s_{fg} [kJ/kg K]	s_g [kJ/kg K]
0.006112	0.01	206.1	0†	2375	0*	2501	2501	0†	9.155	9.155
0.010	7.0	129.2	29	2385	29	2485	2514	0.106	8.868	8.974
0.015	13.0	87.98	55	2393	55	2470	2525	0.196	8.631	8.827
0.020	17.5	67.01	73	2399	73	2460	2533	0.261	8.462	8.723
0.025	21.1	54.26	88	2403	88	2451	2539	0.312	8.330	8.642
0.030	24.1	45.67	101	2408	101	2444	2545	0.354	8.222	8.576
0.035	26.7	39.48	112	2412	112	2438	2550	0.391	8.130	8.521
0.040	29.0	34.80	121	2415	121	2433	2554	0.422	8.051	8.473
0.045	31.0	31.14	130	2418	130	2428	2558	0.451	7.980	8.431
0.050	32.9	28.20	138	2420	138	2423	2561	0.476	7.918	8.394
0.055	34.6	25.77	145	2422	145	2419	2564	0.500	7.860	8.360
0.060	36.2	23.74	152	2425	152	2415	2567	0.521	7.808	8.329
0.065	37.7	22.02	158	2427	158	2412	2570	0.541	7.760	8.301
0.070	39.0	20.53	163	2428	163	2409	2572	0.559	7.715	8.274
0.075	40.3	19.24	169	2430	169	2405	2574	0.576	7.674	8.250
0.080	41.5	18.10	174	2432	174	2402	2576	0.593	7.634	8.227
0.085	42.7	17.10	179	2434	179	2400	2579	0.608	7.598	8.206
0.090	43.8	16.20	183	2435	183	2397	2580	0.622	7.564	8.186
0.095	44.8	15.40	188	2436	188	2394	2582	0.636	7.531	8.167
0.100	45.8	14.67	192	2437	192	2392	2584	0.649	7.500	8.149
0.12	49.4	12.36	207	2442	207	2383	2590	0.696	7.389	8.085
0.14	52.6	10.69	220	2446	220	2376	2596	0.737	7.294	8.031
0.16	55.3	9.432	232	2450	232	2369	2601	0.772	7.213	7.985
0.18	57.8	8.444	242	2453	242	2363	2605	0.804	7.140	7.944
0.20	60.1	7.648	251	2456	251	2358	2609	0.832	7.075	7.907
0.22	62.2	6.994	260	2459	260	2353	2613	0.858	7.016	7.874
0.24	64.1	6.445	268	2461	268	2348	2616	0.882	6.962	7.844
0.26	65.9	5.979	276	2464	276	2343	2619	0.904	6.913	7.817
0.28	67.5	5.578	283	2466	283	2339	2622	0.925	6.866	7.791
0.30	69.1	5.228	289	2468	289	2336	2625	0.944	6.823	7.767
0.32	70.6	4.921	295	2470	295	2332	2627	0.962	6.783	7.745
0.34	72.0	4.649	302	2472	302	2328	2630	0.980	6.745	7.725
0.36	73.4	4.407	307	2473	307	2325	2632	0.996	6.709	7.705
0.38	74.7	4.189	312	2475	312	2322	2634	1.011	6.675	7.686
0.40	75.9	3.992	318	2476	318	2318	2636	1.026	6.643	7.669
0.42	77.1	3.814	323	2478	323	2315	2638	1.040	6.612	7.652
0.44	78.2	3.651	327	2479	327	2313	2640	1.054	6.582	7.636
0.46	79.3	3.502	332	2481	332	2310	2642	1.067	6.554	7.621
0.48	80.3	3.365	336	2482	336	2308	2644	1.079	6.528	7.607
0.50	81.3	3.239	340	2483	340	2305	2645	1.091	6.502	7.593
0.55	83.7	2.964	351	2486	351	2298	2649	1.119	6.442	7.561
0.60	86.0	2.731	360	2489	360	2293	2653	1.145	6.386	7.531
0.65	88.0	2.535	369	2492	369	2288	2657	1.169	6.335	7.504
0.70	90.0	2.364	377	2494	377	2283	2660	1.192	6.286	7.478
0.75	91.8	2.217	384	2495	384	2278	2662	1.213	6.243	7.456
0.80	93.5	2.087	392	2498	392	2273	2665	1.233	6.201	7.434
0.85	95.2	1.972	399	2500	399	2269	2668	1.252	6.162	7.414
0.90	96.7	1.869	405	2502	405	2266	2671	1.270	6.124	7.394
0.95	98.2	1.777	411	2504	411	2262	2673	1.287	6.089	7.376
1.00	99.6	1.694	417	2506	417	2258	2675	1.303	6.056	7.359

$$\frac{h_f}{[\text{kJ/kg}]} = \frac{pv_f}{[\text{kJ/kg}]} = \frac{p}{[\text{bar}]} \times \frac{10^5[\text{N/m}^2]}{[\text{m}^2]} \times \frac{v_f}{[\text{m}^3/\text{kg}]} \times \left[\frac{\text{m}^3}{\text{kg}}\right] \times \frac{[\text{kJ}]}{10^3[\text{N m}]} \times \frac{1}{[\text{kJ/kg}]}$$

$$= \frac{p}{[\text{bar}]} \times \frac{v_f}{[\text{m}^3/\text{kg}]} \times 10^2 = 0.006112 \times 0.0010002 \times 10^2 = 0.0006112$$

ශ්‍රී ලංකා විභාග දෙපාර්තමේන්තුව / இலங்கைப் பரீட்சைத் திணைக்களம் / Department of Examinations, Sri Lanka

Written Examination for Technical Officers (Civil / Mechanical)
in Public Service and Provincial Public Service - From 2005 to 2009 (3rd Exam) - 2010

(51) Mechanical Engineering III *Three hours*

Answer **four** questions. All questions carry **equal** marks.

1. (i) Discuss the main functions involved in production management. What are the procedures / techniques that helpful for the success of the above process?
   (ii) What are the advantages and disadvantages of specialization of labour?
   (iii) Describe the concept of Work Study with reference to method study and time study techniques.

2. (i) Discuss the importance of production scheduling for a manufacturing work site.
   (ii) Describe **two** techniques (methods) used for production scheduling.

3. (i) (a) Briefly describe the main functions of store keeping.
   (b) What are the important information that should be included in a "Stores Requisition"?
   (ii) Write short notes on the following topics.
   (a) Usefulness of Inventory Control
   (b) Ordering cost

4. (i) Discuss the importance of occupational health and safety.
   (ii) Explain the basic steps in an industrial accident prevention (safety) programme.

5. (i) What is meant by standardization? Discuss to its usefulness in production processes.
   (ii) Discuss the purposes of implementing industrial research and development programmes.
   (iii) Write short notes on any **two** of the following topics.
   (a) Factors contributing to reduction of production cost
   (b) Important objectives in purchasing
   (c) Demand and supply effect on prices
   (d) Capital and Income

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Written Examination for Technical Officers (Civil / Mechanical)
in Public Service and Provincial Public Service - From 2005 to 2009 (3rd Exam) - 2010

(52) Economics of Engineering

Three hours

Answer **four** questions.

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1. (i) What are the factors needed to be considered by the employers when salaries of employees are determined?
   (ii) What are the steps that employees can take when they are not satisfied with their salaries?

2. (i) Explain how a Manager uses "supply and demand theory" when taking decisions related to production of goods.
   (ii) Explain with examples how Managers use "incentive plans" to increase production levels.

3. Discuss the provisions in Industrial Disputes Act for prevention and settlement of industrial disputes in an organization.

4. Write short notes on,
   (i) Selling of goods
   (ii) Marketing of goods
   (iii) Objectives and limitations of standardizartion

5. Discuss about the advantages and disadvantages of having Trade Unions in an organization.

* * *

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Written Examination for Technical Officers (Civil / Mechanical)
in Public Service and Provincial Public Service - From 2005 to 2009 (3rd Exam) - 2010

(53) Mechanical Engineering (Drawing) *Three hours*

Answer question No. **one** and **two** others.

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1. The figure given in the annexure shows the detail parts of an "Adjusting Unit." According to the numbers, those parts are
   (1) Body
   (2) Handle
   (3) Pivot
   (4) Screw
   (5) Collar
   (6) Pin
   (i) Assemble the parts in their correct positions and draw the following views to a scale of full size in First Angle Projection.
      (a) A sectional front elevation (view) on the cutting plane **A - A**.
      (b) An end elevation (view) looking in the direction of arrow **B** including all hidden details.
      Note: Assume any dimensions not given.
   (ii) Add the following items to your answer.
      (a) Main title and sub titles
      (b) Scale
      (c) Symbol to show the projection angle

2. Draw neat sketches to show the specific details / features of following types of keys.
   (i) Flat Saddle key
   (ii) Round key
   (iii) Feather key
   (iv) Rectangular key
   (v) Square key

3. (i) Draw neat sketches indicating all the important parts/parameters of screw threads (internal and external). Name the important parameters.
   (ii) With neat sketches illustrate the details of;
      (a) Square threads
      (b) Acme threads
      (c) Knuckle threads

4. (i) Sketch the conventional representation of a bearing.
   (ii) With neat sketches illustrate the details of the following types of bearings.
      (a) Single and double - row deep - groove ball bearings
      (b) Needle roller bearings
      (c) Tapered roller bearings

* * *

ANNEXURE

Written Examination for Technical officers (Civil/ Mechanical) in Public Service and Provincial Public Service

(53) Mechanical Engineering (Drawing)

ADUSTING UNIT