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இலங்கை பரீட்சைத் திணைக்களம் / Department of Examinations, Sri Lanka

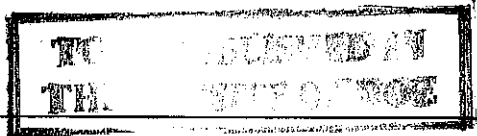
Senior Technical Examination (Theory) – 2014 (2019)
Irrigation Department

(01) Departmental Regulations and Accounts

Three hours

Answer five questions only including question No. 1.

1. It was decided to demarcate all the reservation boundaries in an Irrigation scheme under an ongoing Irrigation rehabilitation project.
 - (i) What is the currently valid Departmental circular for the above purpose? (02 marks)
 - (ii) How to decide the Reservation limit of a Reservoir bed located in a flat terrain? (02 marks)
 - (iii) Write the Reservation limits on road side and other side separately for the following canals and bunds.
 - (a) Main Canal (b<8m)
 - (b) Distributing Canal
 - (c) Field Canal
 - (d) Operational and Maintenance Road / O and M road (without canal)
 - (e) Farm road with the top width 4m
 - (f) Main drainage Canal (10 marks)
 - (iv) What are the available Acts and Ordinances used at present to decide above reservation limits? (06 marks)
2. The government has entrusted more responsibilities to the Irrigation Department and formed new Sub Departments and branches in Head office to address current demand of Irrigation and Water Resource sector.
 - (i) Describe the main sub departments at present and their functions in the Irrigation Department. (10 marks)
 - (ii) Indicate the order of delegation of powers from Head of the Department to field level in Irrigation Department. (05 marks)
 - (iii) Explain the list of duties allocated to Divisional Assistant. (minimum 10 duties) (05 marks)
3. Several foreign funded and local funded projects are commenced under the Department. Engineering Assistants in the permanent cadre of the Department are required to be released for projects on various basis.
 - (i) Briefly indicate the procedure for releasing an Engineering Assistant for foreign funded project with circular references, special conditions, salaries and allowances etc. in general. (10 marks)
 - (ii) What will be the applicable monthly leave in the 1st year of contract for an Engineering Assistant who is appointed under contract basis from outside? (05 marks)
 - (iii) Check roll system of the Department is not allowed to be used at present. But need to employ labourers for force account work in projects. Explain how to employ labourers for the purpose. (05 marks)



4. The occasions for paying overtime (OT) and conditions for payment overtime for officers in a Government Department are mentioned in section VIII of the Establishment code.
- (i) Name minimum **three** types of service categories which are **not** entitled for Over Time Payment? (05 marks)
 - (ii) Explain how to calculate the rate of OT Payment (for 1 hour) from monthly salary.
 - (iii) What is meant by standby duties? What is the rate of OT Payment (for 1 hour) for the same? (05 marks)
 - (iv) Briefly describe the accident leave including entitled occasions, periods applicable and procedure. (05 marks)
5. (i) Define the Accounting Officer and the Chief Accounting Officer. (03 marks)
- (ii) Briefly explain the several duties of an Accounting Officer regarding safety and custody of government money. (07 marks)
- (iii) What are the factors to be considered when delegating the financial authority of an Accounting Officer to another party? (05 marks)
- (iv) What is meant by Authorization under F.R. 136? (05 marks)
6. (i) Write **five** responsibilities of an officer who is empowered to certify the payments. (05 marks)
- (ii) What are the responsibilities of an officer who is empowered to make payments on certified vouchers? (05 marks)
- (iii) What factors are to be considered in the case of cheque payments? (05 marks)
- (iv) What is meant by imprest and sub imprest? Explain in brief with examples. (05 marks)
7. (i) Explain the purposes of conducting annual survey of stores and duties of the board of survey. (06 marks)
- (ii) Explain the responsibilities of the Head of Department for conducting board of surveys. (05 marks)
- (iii) What are the duties and responsibilities of a store keeper in a Government institution? (05 marks)
- (iv) What are the tasks of the following forms? (04 marks)
- (a) Tr & Aud 66
 - (b) General 47

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Standard Method of Measurement (SMM)

Department of Examinations Sri Lanka

Department of Examinations
Sri Lanka

TO BE PUBLISHED IN
THE GAZETTE OF DOE

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SECTION A

GENERAL RULES

This selection of the standard covers the general rules applicable to measurement of building works

1.0 SCOPE

- 1.1 This selection of the standard covers the general rules applicable to measurement of building work.
- 1.2 This Standard Method of Measurement Provides a uniform basis for measuring buildings work and embodies the essentials of good practice.

2.0 USE OF THE TABULATED RULES

- 2.1 The rules in the document are set out in tables. Each section of the rules comprises information (to be) provided, classification tables and supplementary rules. The tabulated rules are written in the present tense.
- 2.2 Horizontal lines divided the classification table and supplementary rules into zones to which different rules apply.

Classification tables

- 2.3 With in the classification table where a broken line is shown, the rules given above the broken line may be used as alternatives.
- 2.4 In referring to columns in classification tables the measurement unit column has been disregarded.
- 2.5 The left hand column of the classification table lists descriptive features commonly encountered in building works. The next column lists further sub-groups into which each main group of items shall be divided and similarly the third column provided for further division. The lists in these columns are not intended to be exhaustive.

- 2.6 Each item description shall identify the work with respect to one descriptive feature drawn from each of the first three columns in the classification table and as many of the descriptive features in the fourth column as are applicable to the item. The general principle does not apply to preliminaries in that it will be necessary to select as many descriptive features as appropriate from each column.
- 2.7 Where the abbreviation (nr) is given in the classification table the quantity shall be stated in the item description.

Supplementary rules

- 2.8 Within the supplementary rules everything above the horizontal line, which is immediately below the classification table heading, is applicable throughout that table.
- 2.9 Measurements rules set out when work shall be measured and the method by which quantities shall be computed.
- 2.10 Definition rules define the extent and limits of the work represented by a word or expression used in the rules and in a bill of quantities prepared in accordance with the rules.

2.11 Coverage rules draw attention to particulars incidental work which shall be deemed to be included in the appropriate items in the bill of quantities to the extent that such work is included in the tender documents. Where the coverage rules include materials they shall be mentioned in the item description.

2.12 The column headed supplementary information contain rules governing the information which shall be given in addition to the information given as a result of the application of rule 2.6.

2.13 A separate item shall be given for any work which differs from other work with respect to any matter listed as supplementary information.

3.0 BILLS OF QUANTITIES

3.1 Bills of quantities shall fully describe and accurately represent the quantity and quality of the works to be carried out.

3.2 More detailed information than is required by these rules shall be given where necessary in order to define the precise nature and extent of the required work.



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4.0 MEASUREMENT

- 4.1 Unless otherwise specifically required by the rules given or otherwise specifically stated in the Bill of Quantities, work shall be measured net as fixed in position overlaps.
- 4.2 Dimensions used in calculating quantities shall be taken to the nearest 10mm (ie. 5mm and less than 5mm shall be disregarded).
- 4.3 Quantities measured in tonnes shall be given to two decimal places.
- 4.4 Other quantities shall be given in the nearest whole except that any quantity less than ten shall be given as to the nearest 1st decimal.
- 4.5 where minimum deductions for voids or openings are dealt with herein, they shall refer to the following:-
 - i. Voids or openings which are wholly within the boundaries of measured areas.
 - ii. Door, window and black openings.
 - iii. Voids or openings at the boundaries of measured piers, columns and similar members.

5.0 DESCRIPTIONS

- 5.1 Dimensions shall be stated in description generally in the sequence of length, width, height or thickness. Where ambiguity could arise, the dimensions shall be specifically identified.
- 5.2 All sizes, dimensions, girths, thicknesses, gauges, weights and other relevant information necessary for the proper assessment of items shall be included in the descriptions.
- 5.3 Where patented or standard components are specified these shall be fully described and the name of the manufacturer, catalogue reference etc. given. Alternatively a precise and unique cross reference to a catalogue or to standard specification may be given in an item description.
- 5.4 Descriptions of items or headings to groups of items shall contain reference to their general location in the works irrespective of the level.
- 5.5 Unless otherwise specifically stated in bill of quantities or herein, the following shall be deemed to be included with all items :-
 - i. Labour and all costs in connection therewith.

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- ii. Materials, goods and all costs in connection therewith.
 - iii. Tools, plant other than hoisting plant and all costs in connection therewith.
 - iv. Waste of materials.
 - v. Square cutting.
 - vi. Establishment charges, overhead charges and profit.
- 5.6 The forming of ends, angles, mitres and junctions between straight and raking or curved work shall unless stated otherwise herein, be held to be included with the work in which they occur.
- 5.7 Notwithstanding the provisions of this document for labours to be given in matters such labours may be included in the description of any linear item of work on which they occur.
- 5.8 Notwithstanding the provisions of this document for labours to be enumerated, such labours may be included in the description of any enumerated item of work on which they occur.

6.0 DRAWN INFORMATION

6.1 Location Drawings

6.1.1 Block Plan : Shall identify the site and locate the outlines of the building works in relation to a town plan (or other context).

6.1.2 Site Plan : Shall locate the position of the building works in relation to setting out points, means of access and general layout of the site.

6.1.3 Plans, Sections and Elevations shall show the position occupied by the various spaces in a building and the general construction and location of the principal elements.

6.2 Component Drawings : Shall show the information necessary for manufacture and assembly of a component.

6.3 Dimensioned diagrams : Shall show the shape and dimensions of the work covered by an item and may be used in a bill of quantities in places of a dimensioned description, but not in place of an item otherwise required to be measured.

7.0 PROVISIONAL OR PRIME COST SUMS

7.1 Where this document requires provisional or prime cost sums to be given in accordance with this clause, the choice of terms shall be made in conformity with the following definitions unless otherwise provided in the conditions of contract.

7.1.1 The term "Prime Cost Sum" is defined a sum provided for work or services to be executed by a nominated sub contractor, authority or a public undertaking or for materials or goods to be obtained from a nominated supplier. Such sum shall be deemed to be exclusive of any profit required by the general contractor and provision shall be made for the addition thereof.

7.1.2 The term "Provisional Sum" is defined as a sum provided for unforeseen works or for the value of works, where the quantity of work required cannot be accurately determined at the time of bill preparation.

7.2 Works which are to be carried out by nominated sub contractors shall be given as p.c sums in accordance with provisions of 7.1.1. unless otherwise stated in the conditions of contract.

7.3 General attendance on provision of general facilities for nominated sub contractors shall be defined and given as item following each p.c. sum.

7.4 Special attendance on special facilities for nominated sub contractors shall be given as an item giving particulars.

7.5 Materials and goods which are required to be obtained from nominated suppliers shall be given as p.c. sums in accordance with provisions of 7.1.1

7.6 Fixing materials and goods obtained from nominated suppliers shall be given in accordance with the provisions of the appropriate section herein. Where the cost of transporting such materials and goods to the site are required to be borne by the contractor, particular shall be given.

7.7 Where the condition of contract require that a sum to be provided for work or services to be executed by a nominated sub contractor, authority or a public undertaking or for materials or goods to be obtained from a nominated supplier, be defined as "provisional sum" then, provision will be made following each such provisional sum item, for addition of profit, general attendance and / or special attendance.



8.0 WORKS OF SPECIAL TYPES

Work of each of the following special types shall be separately identified:

- 8.1 Work on or in existing buildings - see general rule 9.
- 8.2 Work to be carried out and subsequently removed (other than temporary works).
- 8.3 Work carried out in or under water shall be so described stating whether canal, river or sea water and (where applicable the mean spring levels of high and low water.
- 8.5 Work carried out in compressed air shall be so described stating the pressure and the method of entry and exit.

9.0 WORK TO EXISTING BUILDINGS

- 9.1 work to existing buildings shall be so described. Such work is defined as work on, or in, or immediately under the work existing before the current project.
- 9.2 The additional rules for work to existing buildings are to be read in conjunction with the preceding rules in the appropriate work sections.

- 9.3 A description of the additional preliminaries which are pertinent to the work to the existing building shall be given, drawing attention to nature of the work.

10.0 CIRCULAR WORK

- 10.1 Where the rules require work to be described as curved with the radii stated details shall be given of the curved work including if concave or convex, if conical or spherical, if to more than one radius and shall state the radius or radii.
- 10.2 The radius stated shall be the mean radius measured to the centre line of the material unless otherwise stated.

11.0 SYMBOLS AND ABBREVIATIONS

- 11.1 The following symbols and abbreviations are used in this method of measurement.



m	=	metre
m ²	=	square metre
m ³	=	cubic metre
mm	=	milli metre
nr	=	number
kg	=	kilogram
t	=	tonne
h	=	hour
pc sum	=	prime cost sum
pro. sum	=	provisional sum
>	=	exceeding
≥	=	equal to or exceeding
≠	=	not exceeding
<	=	less than
%	=	percentage

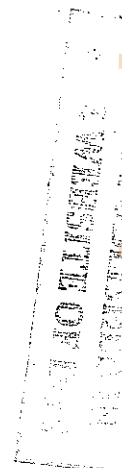
11.2 Cross references within the classification tables are given in the form:

Work Selection Number	Number from first Column	Number from second Column	Number from third Column
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Example :

D.1.1.1

Excavation and Earthwork
 Site preparation
 Clearing site vegetation:
 of bushes, scrub,
 undergrowth etc.....



Department of Examinations SLS 573 : 1999

SECTION F

CONCRETE WORKS

This Section of the standard covers the Method of Measurement of insitu concrete work, formwork, reinforcement in insitu concrete, ordinary pre-cast & pre-tensioned concrete, pre-cast and post tensioned concrete and insitu pre-stressed concrete of building works.

SECTION F1

INSITU CONCRETE

INFORMATION PROVIDED	MEASUREMENT RULES	DEFINITION RULES	COVERAGE RULES	SUPPLEMENTARY INFORMATION
<p>The following information is shown on location drawings described under Section B Preliminaries or on further drawings which accompany the bills of quantities :</p> <p>a. The relative position of concrete member</p>	<p>M1 Concrete volume is measured net except that deductions are not made for the following :</p> <p>a.Reinforcement</p> <p>b.Structural steel except voids in bored steel</p> <p>c.Cast in accessories</p> <p>d.Voids $\leq 0.05 \text{ m}^3$ in volume (except voids in troughed & coffered slabs)</p> <p>e.Intersection of beams</p>	<p>D1 Concrete work shall be given separately as follows :</p> <p>a.Foundation up to the top of structural floor level of lowest basement floor</p> <p>b.From top of structural floor level of lowest basement or top of structural floor level of ground floor</p> <p>c.In the absence of basement floor foundation shall be measured up to the top of structural floor level of ground floor</p>	<p>C1 Concrete is deemed to include finishing as struck from basic finish formwork or with a non-mech. tamped finish unless other wise required under worked finishes/cutting</p> <p>C2 Concrete work is deemed to include for mixing, depositing, handling hoisting & placing</p>	<p>S1 Kind & quality of materials</p> <p>S2 Tests of material & finish work</p> <p>S3 Measures to achieve water-tightness</p> <p>S4 Limitations on method, sequence speed or size of pouring</p> <p>S5 Methods of compaction & curing</p>

CLASSIFICATION TABLE				MEASUREMENT RULES	DEFINITION RULES	COVERAGE RULES	SUPPLEMENTARY INFORMATION
					d. Work above top of structural floor level of ground floor shall be grouped together irrespective of no. of storeys.		
CLASSIFICATION TABLE							
1 Testing (nr)	1 Type of tests specified	1 Mass concrete	nr				
2 Foundation	1 Screed, thickness stated	2 Reinforced concrete	m ²	1 Curved radii stated			S6 Poured into ground or into formwork.
	2 Column base 3 Column & pier on plan ≤ 0.5 m ² 4 Column & pier on plan > 0.5 m ² 5 Strip 6 Beams 7 Basement walls 8 Kerb 9 Raft		m ³	2 Other shape stated			
3 Beds & slabs on ground	1 Thickness ≤ 150 mm				M2 Measured overall beams		S7 In coffered & trough slabs give particulars including Overall thickness of slab, size of ribs
4 Slabs	2 Thickness > 150 mm → 300 mm				M3 Thickness and other bearings are measured with the respective members		
5 Slabs to slope ≤ 15°	3 Thickness > 300 mm						
6 Slabs to slope > 15°							
7 Coffered troughed slab							
8 Walls					M4 Measured between columns		

9 Filling	1 Hollow steel members 2 Concrete block work		
10 Columns	1 Sectional area $\leq 0.10 \text{ m}^2$	1 Isolated 2 Attached	
11 Piers	2 Sectional area $> 0.10 \text{ m}^2$		
12 Beams			
13 Casing to steel work	1 Column 2 Beams 3 Lintels		
14 Lintels (nr)			
15 Stairs and isolated steps	1 Steps, waist and the like 2 Beams 3 Landings 4 Balustrade wall		
16 Coping	1 Flat 2 Raking 3 String courses 4 Cornices 5 Similar projection	1 Dimensioned description	m
17 Ducts 18 Channels			
19 Channels formed in concrete beds			

		N5 Measured from floor level to floor level.
		N6 Measured up to the underside of roof/floor slab or up to top of roof/floor slab for upstand beams
		N7 Length of beams measured between faces of columns
		N8 Measured beyond the face of the walls, slabs or beams
		N9 Measured the area of sides & bottom
	D2 Channels formed in concrete bed include	

S8 Details given

S9 Description of extra concrete excavation and filling stated

DEPARTMENT OF
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CLASSIFICATION TABLE				MEASUREMENT RULES	DEFINITION RULES	COVERAGE RULES	SUPPLEMENTARY INFORMATION
20 Machine bases & raised platform (nr)		1 Thickness \leq 300 mm	m^3		a. Formwork b. Extra concrete c. Excavation & filling		
		2 Thickness $>$ 300 mm					
21 Expansion joint	1 Dimensioned description		m	1 Plan 2 Formed 3 Cut	M10 The width or depth of joints is measured overall.	D3 Plain joints are those which do not require formwork	S10 Details of filters, water stops, dowels backing strips and reinforcement crossing joints
22 Weakened plane						C4 Angles and inter-sections in water stops are deemed to be included	
23 Construction joint							
24 Separation joint							
25 Sealants							C5 Work is deemed to include preparation, cleaners, primers and sealers
26 Work finishes /cutting into concrete	1 Width \leq 300 mm	1 Thickness stated	m^2	1. Plastic concrete 2. Hardened concrete		D4 Work finish in plastic concrete include : 1 Tamped finish 2 Floated 3 Trowelled finish Work finish in hardened concrete include : 1 Abrasive blasted finish 2 Scored finish 3 Tooled 4 Power ground	
	2 Width $>$ 300 mm						

27 Gutters	1 Eaves 2 Sixed 3 Facia 4 Parapet	1 Dimensioned description	m			floor		
28 Woods 29 Sun- shades (nr)	1 Thickness stated 2 Where thickness vary maximum & minimum thickness stated		m ²					

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 DEPARTMENT OF EXAMINATIONS

SECTION F2

FORMWORK

INFORMATION PROVIDED				MEASUREMENT RULES	DEFINITION RULES	COVERAGE RULES	SUPPLEMENTARY INFORMATION
<p>The following information is shown on location drawings described under Section B Preliminaries or on further drawings which accompany the bills of quantities :</p> <p>a. The relative position of concrete members</p> <p>b. The size of members</p>				<p>M1 Formwork shall be measured to the contact surface of concrete and formwork</p> <p>M2 Curved surfaces are so described with the radius stated</p>	<p>D1 Formwork shall mean everything necessary to uphold concrete</p> <p>D2 Formwork shall given in the same order as concrete. Refer D1 of in situ concrete</p>	<p>C1 Measurement for formwork is deemed to include for all necessary boardings, supports, erecting, framing, cutting angles, cleaning, wetting and treatment before placing concrete and removal</p>	<p>S1 Kind and quality of materials</p> <p>S2 Basic finish where not at the discretion of the contractor</p> <p>S3 Any special finish to be stated</p> <p>S4 Materials and workmanship, stating time to be left in position</p> <p>S5 Design responsibility</p>
CLASSIFICATION TABLE							
<p>1 Sides of foundation</p>	<p>1 Screeds</p> <p>2 Column & pier bases</p> <p>3 Strip footings</p> <p>4 Ground beams</p> <p>5 Kerbs</p> <p>6 Rafts</p> <p>7 Basement walls</p>	<p>1 Height \leq 300 mm</p> <p>2 Height $>$ 300 mm</p>	<p>m</p> <p>m²</p>	<p>1 Left in</p> <p>2 Permanent</p>	<p>M3 Where foundations or foundation beams are partially above ground, formwork shall be measured full height to sides and so described</p> <p>M4 Where foundation or foundation beams are wholly in the ground and the excavation is expected to act as formwork, then formwork shall not be measured unless stated</p>	<p>D3 Formwork left in is that which is not designed to remain in position but is impossible to remove.</p> <p>D4 Permanent formwork is that which is designed to remain in position</p>	
<p>2 Soffit of slabs</p>	<p>1 Slab thickness \leq 150 mm</p>	<p>1 Horizontal</p> <p>2 Sloping \leq 15°</p>		<p>1 Height \leq 3.5 m</p> <p>2 and thereafter</p>	<p>M5 No deduction shall be made for</p>		<p>S6 Overall thickness to be stated</p>

3 Soffit of coffered or troughed slabs	2 Slab thickness 150 - 300 mm 3 Slab thickness > 300 mm	3 Sloping > 15°		1.5 m stages 3 Left in 4 Permanent	openings of 0.5m ² or less M6 Soffits of coffered or troughed slabs are measured as if projected surface on plan		for coffered or troughed slabs
4 Soffit of landings							
5 Soffit of stair flights							
6 Edges of ground slabs							
7 Edges of floor and roof slabs	1 Height ≤ 300 mm 2 Height > 300 mm		m m ²				
8 Edges of landings							
9 Sides of stair flights					M7 Height of risers are measured between top and bottom nosings		
10 Sides of risers					M8 Widths are measured overall		
11 Sides of walls	1 Vertical 2 Battened 3 Curved, radii stated	1 Height ≤ 3.5 m above floor level 2 Height > 3.00 m above floor level		1 Left in 2 Permanent to both sides 3 Permanent to one side only, wall thickness and background to other side stated	M9 No deductions shall be made for openings of 0.5m ² or less M10 The area measured for walls whose height is > 3.0 m includes the area below 3.00 m high	M5 Floor level means the level of the floor frame which the formwork is supported	

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CLASSIFICATION TABLE			MEASUREMENT RULES	DEFINITION RULES	COVERAGE RULES	SUPPLEMENTARY INFORMATION
12 Sides of columns	1 Isolated 2 Attached	1 Square or rectangular 2 Circular 3 Hexagonal 4 L-shape 5 U-shape				C2 Formwork to beam column and casings is deemed to include ends
13 Sides & soffit of beams	1 Isolated 2 Attached 3 Uprand					
14 Sides & soffit of lintels						
15 Formwork to sides of plant machine base & raised platform	1 Height \leq 300 mm		m			
	2 Height $>$ 300 mm		m ²			
16 Cornices & mouldings			m	1 Dimension, description & shape stated		
17 Copings						
18 Gutters						
19 Hoods & sunshades	1 Vertical 2 Edges 3 Horizontal	1 Girth \leq 300 mm 2 Girth $>$ 300 mm	m ²			
20 Extra over a basic formwork finish for formed finishes	1 Slab 2 Walls 3 Beams 4 Columns 5 Other stated				D6 Formed finishes are those where a finish other than a basic finish is defined	S7 Details of formed finish

SECTION F3

REINFORCEMENT IN INSITU CONCRETE

INFORMATION PROVIDED		MEASUREMENT RULES	DEFINITION RULES	COVERAGE RULES	SUPPLEMENTARY INFORMATION
The following information is shown on location drawings described under section B Preliminaries or on further drawings which accompany the bills of quantities : a. The relative position of concrete members		M1 Reinforcement shall be given separately as per D1 of INSTU CONCRETE		C1 Reinforcement is deemed to include for cleaning, cutting, bending, fabricating, binding wires, ties, spaces, chairs, placing and provision of all necessary temporary fixing & supports unless other wise stated separately	S1 Kind and quality of materials S2 Details of tests S3 Bending requirements S4 Any special requirements as to welding hot or cold S5 Laps & splices and measurement allowances
CLASSIFICATION TABLE					
1 Mild steel round bar	Size of Bar	1 In column bases and rafts	t		
2 High yield Ter steel bar	1 Diameter ≤ 10 mm 2 Diameter 10-16 mm 3 Diameter > 16 mm	2 In strip footings and ground beams 3 In beds and slabs on ground 4 In suspended slabs, hoods & sun-shades 5 In walls 6 In columns & piers 7 In beams & lintels 8 In stairs & landings 9 In casing to steel work		M2 Bar reinforcement shall be measured to the length shown or specified and the length of bars in kerbs, hooks, cranks, splices and the like shall be measured. M3 No allowance shall be made for rolling margin. M4 Where bar reinforcement is specified or to be lapped or spliced,	D1 Foundation means work below the lowest structural floor level

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CLASSIFICATION TABLE				MEASUREMENT RULES	DEFINITION RULES	COVERAGE RULES	SUPPLEMENTARY INFORMATION
					the length of bar in such laps or splices as specified or detailed shall be measured M5 Where the position of such laps or splices is not indicated, allowance for same shall be measured at centres of 6m		
4 Special spacers & chair supports	1 Dimensioned description				M6 Spacers, chairs, special joint special labour and treatment are measured only where they are not at the discretion of the contractor		
5 Special joint	2 Nominal size and type stated		nr				
6 Special labour/treatment	1 Welding 2 Galvanising 3 Bitumen dipping 4 and the like		Item				
7 Fabric	1 Type stated	1 Width \leq 1.00 m 2 Width $>$ 1.00 m	m ²		M7 The area measured for fabric is laps over		C2 Fabric reinforcement is deemed to include laps, tying wire all cuttings & bending and spacers and chairs which are at the discretion of the contractor
	2 Cutting	1 Raking 2 Circular	m		M8 Voids \leq 1.0 m ² in area are not measured		

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 முழுப் பதிப்புரிமையுடையது]
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Senior Technical Examination (Theory) – 2014 (2019)
 Irrigation Department

(04) Theory of Structures and Strength of Materials

Three hours

Answer five questions only.

1. (i) With the help of phase diagram describe the followings.

- Void ratio
- Dry density
- Dry unit weight
- Specific gravity

(ii) A soil sample has porosity of 40%. The specific gravity of the soil is 2.70.

Calculate,

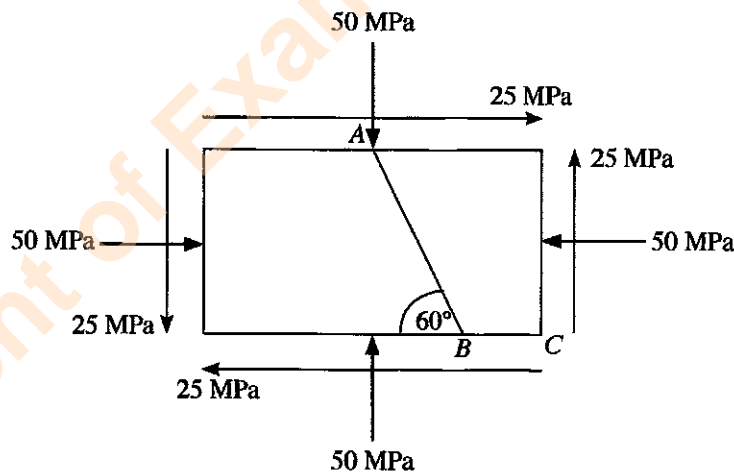
- Void ratio
- Dry density
- Unit weight of the soil if soil is 50% saturated
- Unit weight of the soil if soil is fully saturated

(20 marks)

2. (i) Define following terms.

- Tensile stress
- Compressive stress
- Shear stress
- Bending stress
- Strain

(ii) A machine component is subjected to the stresses as shown in figure.



- Find normal and shear stress on the section AB.
- Find the resultant stress on the section AB.

(20 marks)

[See page two

3. A $457 \times 191 \times 67$ UC in steel grade S355 is to be used under three different conditions, as described below. Classify the section for each case and evaluate the local cross-sectional resistance. (See annexure 01)

Conditions:

- (i) under pure bending
- (ii) under bending plus 700 kN axial compression
- (iii) under pure axial compression of 700 kN

The following section properties are given. All symbols have their usual meaning.

$$\begin{aligned} B &= 189.9 \text{ mm} & T &= 12.7 \text{ mm} \\ d &= 407.6 \text{ mm} & t &= 8.5 \text{ mm} \\ A_g &= 85.5 \text{ cm}^2 & Z &= 1300 \text{ cm}^3 & S &= 1470 \text{ cm}^3 \end{aligned}$$

Slenderness ratios:

$$b/T = 7.48 \text{ and } d/t = 48.0$$

Influence of material strength:

Maximum material thickness = 12.7 mm, and given $p_y = 355 \text{ N/mm}^2$

Hence,

$$\epsilon = (275/355)^{0.5} = 0.88$$

(20 marks)

4. Design a steel section in grade S275 steel, for simply supported beam carrying a concrete floor slab over a span of 5.0 m for ultimate load combination 1. The unfactored dead load, which includes an allowance for self-weight is 14 kN/m (G_k), and the unfactored imposed load is 19 kN/m (Q_k).

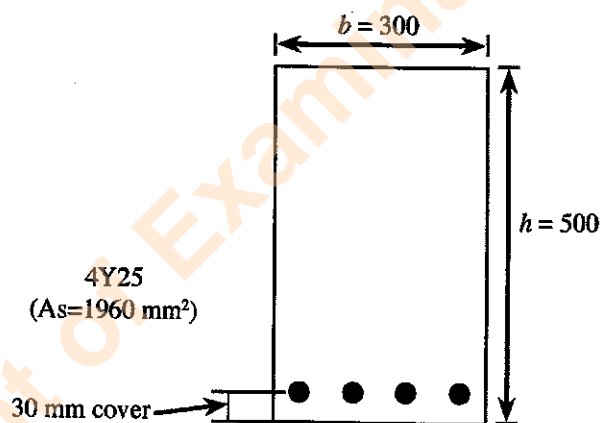
Assume that the maximum thickness is 16 mm and beam is fully restrained.

$$P_y = 275 \text{ N/mm}^2$$

$$\text{Ultimate load combination 1} = 1.4 G_k + 1.6 Q_k$$

(20 marks)

5. Grade 30, ($f_{cu} = 30 \text{ N/mm}^2$) singly reinforced concrete beam contains 1960 mm^2 ($f_y = 500 \text{ N/mm}^2$) of tension reinforcement as in figure given below.



If the effective span is 7 m and the density of reinforced concrete is 24 kN/m^3 .

Calculate the maximum imposed load that the beam can carry assuming that the load is

- (i) uniformly distributed
- and

- (ii) applied as a point load at mid-span

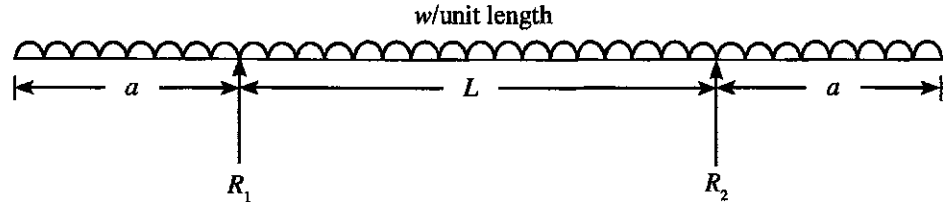
(20 marks)

[See page three

6. (i) Briefly describe the followings.

- (a) Simply supported beam
- (b) Cantilever beam
- (c) Overhung beam
- (d) Fixed support beam

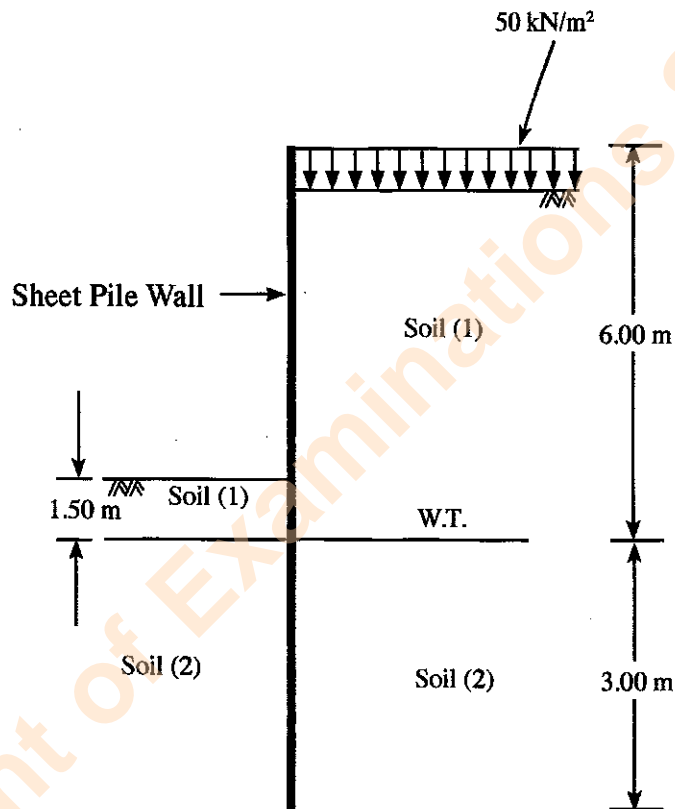
(ii) For the overhanging beam shown in figure draw bending moment and shear force diagrams. The beam carries a uniformly distributed load of w per unit length. Take $L > 2a$.



(20 marks)

7. (i) Write the definitions of the 'Active pressure coefficient (K_A)' and 'Passive pressure coefficient (K_p)'.

(ii) The soil conditions adjacent to a sheet pile wall are given in the figure, a surcharge pressure of 50 kN/m^2 being carried on the surface behind the wall. For soil (1), a sand above the water table, $C=0$, $\phi=38^\circ$, $\gamma=18 \text{ kN/m}^3$. For soil (2), a saturated clay $C=10$, $\phi=28^\circ$, $\gamma=20 \text{ kN/m}^3$. Plot the distributions of active pressure behind the wall and passive pressure in the front of the wall.



(20 marks)

* * *

Table 2.1 Limiting width-to-thickness ratios for sections other than CHS and RHS

Compression elements		Ratio ^{a)}	Limiting value ^{b)}			
			Class 1 plastic	Class 2 compact	Class 3 semi-compact	
Outstand element of compression flange	Rolled section	b/T	9ϵ	10ϵ	15ϵ	
	Welded section	b/T	8ϵ	9ϵ	13ϵ	
Internal element of compression flange	Compression due to bending	b/T	28ϵ	32ϵ	40ϵ	
	Axial compression	b/T	Not applicable			
Web of an I-, H- or box section ^{c)}	Neutral axis at mid-depth		d/t	80ϵ	100ϵ	120ϵ
	Generally ^{d)}	If r_1 is negative:	d/t	$\frac{80\epsilon}{1+r_1}$	$\frac{100\epsilon}{1+r_1}$	$\frac{120\epsilon}{1+2r_2}$ but $\geq 40\epsilon$
		If r_1 is positive:	d/t	but $\geq 40\epsilon$	$\frac{100\epsilon}{1+1.5r_1}$ but $\geq 40\epsilon$	
	Axial compression ^{d)}		d/t	Not applicable		
Web of a channel		d/t	40ϵ	40ϵ	40ϵ	
Angle, compression due to bending (Both criteria should be satisfied)		b/t	9ϵ	10ϵ	15ϵ	
		d/t	9ϵ	10ϵ	15ϵ	
Single angle, or double angles with the components separated, axial compression (All three criteria should be satisfied)		b/t	Not applicable			
		d/t				
		$(b+d)/t$				15ϵ
Outstand leg of an angle in contact back-to-back in a double angle member		b/t	9ϵ	10ϵ	15ϵ	
Outstand leg of an angle with its back in continuous contact with another component						
Stem of a T-section, rolled or cut from a rolled I- or H-section		D/t	8ϵ	9ϵ	18ϵ	

a) Dimensions b , D , d , T and t are in Figure 2.2. For a box section b and T are flange dimensions and d and t are web dimensions, where the distinction between webs and flanges depends upon whether the box section is bent about its major axis or its minor axis.

b) The parameter $\epsilon = (275/p_y)^{0.5}$

c) For the web of a hybrid section ϵ should be based on the design strength p_y of the flanges.

d) The stress ratios r_1 and r_2 are defined in Section 2.2.2.

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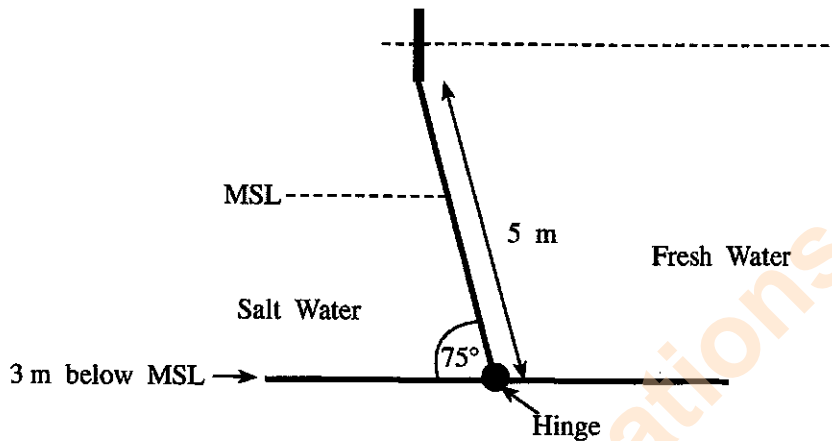
Senior Technical Examination (Theory) – 2014 (2019)
Irrigation Department

(05) Hydraulics

Three hours

Answer five questions only. Assume any data required.

1. A structure for a salinity barrier across a river was designed with low hydraulic gates of 20 numbers of 6 m wide and 5 m height. The gates were hinged at the sill of the structure and installed at an inclination of 75° to the sill on the salt water side. The weight of the gate is 150 kg. The sill level of the structure is 3.00 m below M.S.L. The tide is ± 1.0 m. If there is a flood, at what level of flood in the river, the gate will be collapsed during a high tide. Assume the density of the salt water is 1250 kgm^{-3} and the density of the fresh water is 1000 kgm^{-3} . The acceleration of gravity is 9.81 ms^{-2} . The sketch of the structure is shown below. Assume no frictional losses in the hinge.



(20 marks)

2. A concrete dam retains water to its total depth of 20 m. The face of the dam in contact with water is vertical to a depth of 3 m from the crest of the dam and the balance portion is inclined 15° to the vertical face in order to increase the thickness of the base of the dam. Determine the magnitude and the direction of the resultant force due to the water pressure per meter length of the dam and the depth to its point of action on the face of the dam. Assume the density of water as 1000 kgm^{-3} .

(20 marks)

3. A hydraulic jump occurs on the horizontal apron of a spillway. The initial depth before the jump is 1.0 m and the sequent depth after the jump is 1.5 m.

- (i) Determine the discharge of the spillway per unit width. (10 marks)
- (ii) To stabilize the position of the jump a concrete sill is constructed. For a flow of $10 \text{ m}^3\text{s}^{-1}$ per meter length of the spillway the initial depth of flow is 1.5 m. Calculate the minimum height of the sill. (10 marks)

[See page two

4. A rectangular channel with the horizontal bottom of 3 m width and the depth of water is 2 m. In the channel there is a smooth contraction to 2.4 m and the sill of bottom is 0.3 m higher than the channel bottom so that there is no loss of energy. The water surface is 0.15 m lower than the upstream section. Assume the density of water is 1000 kgm^{-3} and acceleration of gravity is 9.81 ms^{-2} .
- Determine:
- (i) The discharge through the channel. (10 marks)
 - (ii) The difference in bottom level in case of the water surface elevation in both sections are same. (10 marks)
5. (i) Derive the geometric and hydraulic relationship of a most economical section under fluid flow of the following channels.
- (a) Rectangular Channel (03 marks)
 - (b) Triangular Channel (03 marks)
 - (c) Trapezoidal Channel (04 marks)
- (ii) An earthen channel with a bed width of 2 m and side slopes of 1 vertical to 1.5 horizontal carries water at a rate of $5 \text{ m}^3\text{s}^{-1}$. The gradient of the channel is 0.0004 and the Manning's coefficient is 0.025. Calculate the depth of the flow in the channel. (10 marks)
6. (i) Tank A with a cross sectional area of 30 m^2 located at a higher level is connected to a Tank B with a cross sectional area of 10 m^2 at a lower level by a 250 m long pipe with 150 mm diameter. Calculate the time taken to reduce the water level difference from 7 m to 2 m. Assume the Darcy's friction coefficient of the pipe as 0.08. (10 marks)
- (ii) Now the pipe is disconnected from the Tank B (one side of the pipe is open). Calculate the time taken to reduce the water level in the Tank A from 7 m to 2 m. (10 marks)
7. (i) Derive the discharge equation through an orifice from the basic principles. (10 marks)
- (ii) A gauge was installed in an irrigation channel at the beginning of the channel. The discharge through the channel is calculated by the equation of $Q = 8h^{2.226} \text{ ms}^{-1}$. The size of the sluice gate is $1.5 \text{ m} \times 1.5 \text{ m}$. When the water level of the reservoir is 12.5 m above the sill of sluice and the sluice was opened by 0.75 m, the gauge reading is 1.21 m. Find the Coefficient of Discharge of the sluice at this condition. (10 marks)

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Senior Technical Examination (Theory) - 2014 (2019)
Irrigation Department

(02) Irrigation

Three hours

Answer five questions only.

1. A farm has been tested and found the following soil to the depth against them.

Depth from the surface (mm)	Type of soil	Volumetric Moisture Content		
		Saturation	Field Capacity	Wilting Point
0 to 75	Loamy Fine Sand	0.439	0.179	0.060
75 to 100	Loose Loam	0.455	0.340	0.110
100 to 200	Silt Loam	0.509	0.461	0.092
200 to 350	Silty Clay Loam	0.475	0.372	0.185

In this farm, paddy was planted (root depth of 250 mm) and its depletion rate is 40%. Find the followings.

- (i) Available Moisture in mm (05 marks)
- (ii) Readily available moisture in mm (05 marks)
- (iii) If the farm size is 1 ha and the discharge through the farm turnout is 15 l/s find the time taken to soak the land. Assume the deep percolation rate is 4 mm/day, evaporation for the period is 5.2 mm/day and no other losses in the farm and the land is wetted uniformly. (05 marks)
- (iv) Under the above condition find out the time taken to issue water for land preparation. Assume no losses during the issue. (05 marks)
2. 150 days chilli is to be cultivated in a farm of 1 ha land with Silty Clay Loam Soil uniformly distributed to the root zone depth. The cultivation was commenced on 15th March. The crop data and the climatological data are as follows:

Crop Data

	Initial Stage	Development Stage	Mid Season Stage	Late Stage
Days	25	25	75	25
Crop Coefficient	0.65		1.00	0.90
Root zone Depth(m)	0.10		0.30	

Volumetric moisture content of the soil at saturation, Field capacity and Wilting point are 0.475, 0.372 and 0.185 respectively. The initial volumetric moisture content on 15th March was 0.20. The depletion rate could be assumed as uniform and it is 35% throughout the growing period.

Climatological Data at the location are as follows

Month	March	April	May	June	July	Aug	Sep
Evaporation (mm/day)	4.14	3.66	3.25	4.29	4.35	5.03	4.35
Reference crop evapotranspiration (mm/day)	5.2	5.07	4.81	4.84	4.89	5.18	4.77

[See page two.

- (i) Find the crop water requirement for the week of 12th April to 18th April. (10 marks)
- (ii) If the Application efficiency is 75% and the Distribution efficiency is 80% find the Field Irrigation Requirement during the period of 12th April to 18th April. Assume no rainfall during that period. (10 marks)
3. An irrigation channel was designed to carry $3 \text{ m}^3\text{s}^{-1}$. The bed width is 1.25 m, side slope is 1 vertical to 2 horizontal, gradient is 0.00035 and Manning's coefficient is 0.025.
- (i) Find the depth of flow in the canal. (03 marks)
- (ii) However after construction it was found that only $2.5 \text{ m}^3\text{s}^{-1}$ is flowing to the designed depth of flow. Explain the reason for the reduction of flow and find the varied factor. (03 marks)
- (iii) Now this channel was rehabilitated by introducing a concrete retaining wall on one side at the edge of the bed. Find the flow through the channel if the average Manning's Coefficient is 0.020 to the same depth of flow as in 3(i). (05 marks)
- (iv) The channel was rehabilitated as a concrete rectangular channel with the same bed width and the Manning's Coefficient is 0.018. Find the flow through the channel for the same depth of flow as in 3(i). (04 marks)
- (v) Find the bed width of a concrete rectangular channel to convey the flow of $3 \text{ m}^3\text{s}^{-1}$ with the same depth of flow as in 3(i), if the Manning's Coefficient is 0.018. (05 marks)
4. (i) Explain the different methods in current metering to determine the flow in a channel. (05 marks)
- (ii) Following observations were found after current metering in a channel to estimate the discharge. The top width of water surface has been divided in to 10 equal sectors of 600 mm each and the readings of current meter were taken by two point method. The time readings were taken for 50 pulses and are as follows.

Distance from LB side (mm)	0	600	1200	1800	2400	3000	3600	4200	4800	5400	6000
Depth (mm)	0	400	750	1170	1250	1400	1400	1320	1100	500	0
Time in sec for 50 pulses at $0.2 \times$ depth	0	3.2	3.5	4.5	4.8	5.2	3.5	3.1	3.1	2.5	0
Time in sec for 50 pulses at $0.8 \times$ depth	0	3.5	4.2	5.4	6.2	6.8	5.2	4.8	3.8	3.4	0

The velocity is given as follows:

The revolution per second is lesser or equal to 1.85 the velocity V is given by

$$V = 0.1312 \times \text{Number of revolution per second} + 0.025 \text{ ms}^{-1}$$

If the revolution per second is more than 1.85 and lesser or equal to 18.54 the velocity

V is given by

$$V = 0.1339 \times \text{Number of revolution per second} + 0.02 \text{ ms}^{-1}$$

(15 marks)

5. (i) Explain the following programmes in detail and giving the number of schemes under each programme.
- (i) INMAS Programme
 - (ii) Waphaula Programme (08 marks)
- (ii) Write the Number of Major Reservoirs and Medium Reservoirs under the purview of Irrigation Department. (04 marks)
- (iii) What is the total cultivable extent under the purview of Irrigation Department? (03 marks)
- (iv) Explain the meaning of the 'Salt Water Extrusion Scheme'. How many Salt Water Extrusion schemes are available in Sri Lanka under the purview of Irrigation Department? (05 marks)
6. Write short notes on the followings.
- (i) Project Management Committee
 - (ii) District Agricultural Committee
 - (iii) Pre-cultivation meeting
 - (iv) Gated Regulator
 - (v) Channel Spill
 - (vi) 75% Probability Rainfall
 - (vii) Cropping Intensity
 - (viii) Duty of an Irrigation system
 - (ix) Conveyance efficiency
 - (x) Field Irrigation Requirement
- (20 marks)
7. (i) What is the frequency of inspection of Dam during normal period and monsoon period by an Engineering Assistant and a Divisional Irrigation Engineer according to the departmental circular number 4 of 2013 on inspection of dams? (03 marks)
- (ii) Explain in detail what has to be observed and recorded during the inspection of a dam with the methods of inspection. (07 marks)
- (iii) During inspection of a dam it has been observed that the seepage at one location of the dam has been increased. Explain what actions to be taken in this regard. (05 marks)
- (iv) While taking Piezometer reading of a dam it has been observed that the Piezometer installed at the downstream of the dam that didn't indicate any reading. What is your action as an Engineering Assistant under this condition? (05 marks)

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Senior Technical Examination (Theory) – 2014 (2019)
Irrigation Department

(03) Design, Drawing and Specifications

Four hours

Answer two questions including question No. 1. State all the assumptions made in your calculations.

1. (i) Write technical specifications for following items.

- Jungle Clearing
- Placement of Rock for Rip-Rap
- Compressive Strength of Concrete
- Field Tests on Soil
- Rubble Masonry Construction

(02 × 5 = 10 marks)

(ii) Briefly explain the followings.

- Construction Joints Vs. Expansion Joints
- Curing of Concrete
- Types of Reinforcement used in construction
- Bearing Capacity of Soil
- Compaction of earthen embankment

(01 × 5 = 05 marks)

(iii) Briefly explain the followings.

- Components required to include in 'General Arrangement Drawing' of a structure (01 mark)
- Bar Schedule format (01 mark)
- Standard size of drawing sheets in international "A" series (01 mark)

(iv) Specify scales that you would follow in following drawings

- Plans of streams, rivers etc., Layout of downstream development for detail planning and general arrangement (01 mark)
- Component drawings, assembly drawings, and details of structure with reinforcement (01 marks)

(v) You are required to carry out a construction using 1 : 2 : 4 (20 mm) concrete. Calculate cement, sand 20 mm aggregate and water by weight used in making 1 m³ of concrete. Assume a suitable value for water cement ratio.

Material	Bulk Density (Kg/m ³)
Concrete	2400
Cement	1440
Sand	1575
20 mm aggregate	1700

(05 marks)

(vi) (a) How many days should you wait to remove shuttering,

- on vertical face of a concrete column? (01 mark)
- under the soffit of a concrete slab? (01 mark)

(b) How many concrete cube samples you should get from a concrete batch in order to test compressive strength of grade 20 concrete? Clearly explain the results (% of nominal strength) you would expect after specified days of casting according to British Standards. (03 marks)

[See page two

- (vii) What are the main components that is required to include in feasibility report in developing an irrigation system and planning settlements? (05 marks)
- (viii) Give standard notations for the followings. (05 marks)
- (a) Earth slope
 - (b) Concrete slope
 - (c) Bridge
 - (d) Regulator
 - (e) Earth in section

2. (i) Briefly explain the following terms. Use sketches whenever required.

- (a) Inflow Flood Hydrograph Vs Outflow Flood Hydrograph
- (b) Time of concentration in a given catchment
- (c) Return period of a storm
- (d) Intensity–Duration–Frequency curves
- (e) Elements of Flood Hydrograph

(02 × 5 = 10 marks)

(ii) State water balance equation for a reservoir derived from the principle of conservation of mass and briefly explain each term. (05 marks)

(iii) What is the recommended return period to be considered in designing a spillways of an earth bund of;

- (a) height < 30 feet
- (b) height > 30 feet

Explain the reason for above selections. (05 marks)

(iv) (a) State the types of flow for which Manning's formula is valid. (03 marks)

(b) The depth of flow in a trapezoidal canal of 5 m bed width, 1.2 H : 1 V side slope, 0.0003 bed slope and with Manning's coefficient $n = 0.025$ is 2.5 m.

Compute the discharge in the canal using Manning's formula. (12 marks)

(c) Discuss about the effect of roughness of the bed to the discharge of the flow. (05 marks)

(v) Followings are the information of a 50 year storm.

Duration (min)	15	30	45	60	180
Rainfall (mm)	40	60	75	100	120

A culvert has to drain 2 km² of land with a maximum length of travel of 1.25 km. The general slope of the catchment is 0.001 and the run off coefficient is 0.2. Estimate the peak flow for designing the culvert for a flood of 50 years return period.

You may use following table and the equation (with usual notation) for your calculation.

Average Gradient of the stream in %	Average Velocity in ft/s
0 to < 1	1.5
1 to < 2	2.0

$$T_c = \frac{L}{(v \times 60)} + 15 \dots \text{ in minutes.}$$

(20 marks)

3. (i) Briefly describe the followings.

- (a) Crop Water Requirement
- (b) Irrigation Requirement (Duty)
- (c) Effective Rainfall
- (d) Run off Coefficient
- (e) Unit Hydrograph
- (f) Return Period of a storm
- (g) Free Board of a canal
- (h) Dead Storage of a Reservoir
- (i) Gross Catchment Boundary Vs Net Catchment Boundary
- (j) Rainfall Intensity

(02 × 10 = 20 marks)

- (ii) (a) What is the usage of weirs in irrigation practices? (05 marks)
- (b) Discuss various types of weirs. (05 marks)
- (c) Discharge over a V notch weir is given by following equation.

$$Q = \frac{8}{15} C_d \left[\tan\left(\frac{\theta}{2}\right) \right] (\sqrt{2g}) h^{3/2}$$

A right-angled V-notch was used to measure the discharge of a canal. If the depth of water at V-notch is 200 mm, calculate the discharge over the notch in m³/s. Assume coefficient of discharge as 0.62.

(05 marks)

- (iii) (a) What is the function of a spillway in a reservoir? (04 marks)
- (b) State 3 types of spillways with the aid of sketches. Give examples for the tanks where these spillways are present in Sri Lanka. (06 marks)
- (iv) Following a bed contour survey of a proposed village tank, areas corresponding to contour lines were found as in the table below.

Contour Elevation (m)	Area (m ²)
76	8900
78	25900
80	44500
82	102500
84	158000
86	258000
88	450000
90	685000

- (a) Draw the elevation-capacity curve of the given reservoir on the graph sheet provided. (09 marks)
- (b) Determine the full supply level of the reservoir considering the capacity of the reservoir as 1000 Acft (1 MCM = 800 Acft) and indicate the same on your depth-capacity curve. (03 marks)
- (c) If the sluice sill level is 77 m MSL, what is the active storage of the reservoir? (03 marks)

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