UNIT: I

DEFINITION OF ESTIMATING AND COSTING

Estimating is the technique of calculating or computing the various quantities and the expected expenditure to be incurred on a particular work or project.

In case the funds available are less than the estimated cost the work is done in part or by reducing it or specifications are altered, the following requirement are necessary for preparing an estimate.

a) Drawings like plan, elevation and sections of important points.

b) Detailed specifications about workmanship & properties of materials etc.

c) Standard schedule of rates of the current year.

NEED FOR ESTIMATION AND COSTING

1.Estimate give an idea of the cost of the work and hence its feasibility can be determined i..e whether the project could be taken up with in the funds available or not.

2. Estimate gives an idea of time required for the completion of the work.

3. Estimate is required to invite the tenders and Quotations and to arrange contract.

4. Estimate is also required to control the expenditure during the execution of work.

5. Estimate decides whether the proposed plan matches the funds available or not.

PROCEDURE OF ESTIMATING OR METHOD OF ESTIMATING.

Estimating involves the following operations

1. Preparing detailed Estimate.
2. Calculating the rate of each unit of work
3. Preparing abstract of estimate

DATA REQUIRED TO PREPARE AN ESTIMATE

1. Drawings i.e. plans, elevations, sections etc.
2. Specifications.
3. Rates.

Introduction to the Subject

1.4.1 DRAWINGS

If the drawings are not clear and without complete dimensions the preparation of estimation become very difficult. So, It is very essential before preparing an estimate.

SPECIFICATIONS

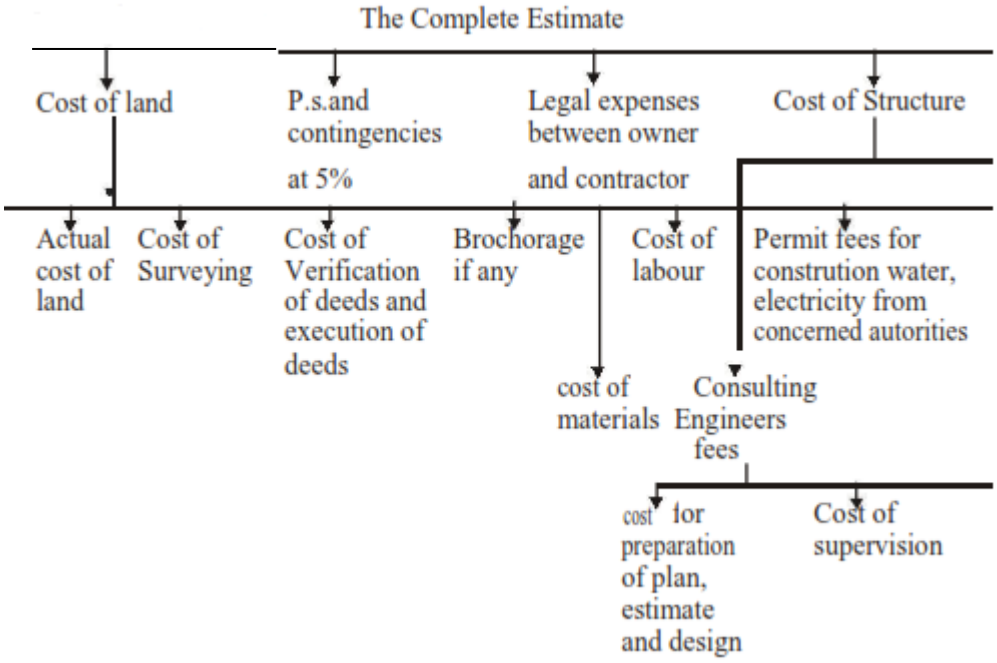
a) General Specifications: This gives the nature, quality, class and work and materials in general terms to be used in various parts of wok. It helps no form a general idea of building.

b) Detailed Specifications: These gives the detailed description of the various items of work laying down the Quantities and qualities of materials, their proportions, the method of preparation workmanship and execution of work.

RATES:

For preparing the estimate the unit rates of each item of work are required

1. For arriving at the unit rates of each item.
2. The rates of various materials to be used in the construction.
3. The cost of transport materials.
4. The wages of labour, skilled or unskilled of masons, carpenters, Mazdoor, etc.



Purpose of Estimating:

1.To ascertain the necessary amount received by the owner to complete the proposed work and arranging fund for the same. For public work construction estimates are required to obtain administrative approval, allotment of fund and technical sanction.

2. To ascertain the quantity of materials required for programming timely procurement.

3. To know the number of different categories of works that is to be employed to complete the work within the schedule time of completion.

3. Helps to assess the requirements of Tools, Plants and equipments required to complete the work according to the programme.

4. To fix up the completion period from the volume of work involved in the estimate.

5. To justify the investment from benefit cost ratio.

6. Estimate is required to invite tender and preparation of bills for payment.

UNITS OF MEASUREMENTS:

The units of measurements are mainly categorised for their nature, shape and size and for making payments to the contractor and also. The principle of units of measurements normally consists the following:

a) Single units work like doors, windows, trusses etc., are expressed in numbers.

b) Works consists linear measurements involve length like cornice, fencing, hand rail, bands of specified width etc., are expressed in running metres (RM)

c) Works consists areal surface measurements involve area like plastering, white washing, partitions of specified thickness etc., are expressed in square meters (m^2)

d) Works consists cubical contents which involve volume like earth work, cement concrete, Masonry etc are expressed in Cubic metres.

[BASED ON IS 1200 REVISED]

Sl. No.	Particulas of item	Units of Measurement	Units of payment
I	**Earth work:**		
	1. Earth work in Excavation	cum	Per%cum
	2. Earthwork in filling in foundation trenches	cum	Per%cum
	3. Earth work in filling in plinth	cum	Per%cum
II	**Concrete:**		
	1. Lime concretre in foundation	cum	percum
	2. Cement concrete in Lintels	cum	percum
	3. R.C.C.in slab	cum	percum
	4. C.C. or R.C.C. Chujja, Sun-shade	cum	percum
	5. L.C. in roof terracing (thickness specified)	sqm	persqm

	6. Cement concrete bed	cum	per cum
	7. R.C. Sunshade (Specified Width & Height	cum	1rm
III	**Damp Proof Cource (D.P.C)** (Thickness should be mentioned)	sqm	persqm
IV	**Brick work:**		
	1. Brickwork in foundation	cum	Percum
	2. Brick work in plinth	cum	percum
	3. Brick work in super structure	cum	percum
	4. Thin partition walls	sqm	percum
	5. Brick work in arches	cum	percum
	6. Reinforced brick work (R.B.Work)	cum	percum
V	**Stone Work:**		
	Stone masonry	cum	percum
VI	**Wood work:**		
	1. Door sand windows frames or chowkhats, rafters beams	cum	percum
	2. Shutters of doors and windows (thickness specified)	sqm	persqm
	3. Doors and windows fittings (like hinges, tower bolts, sliding bolts, handles)	Number	per number
VII	**Steel work**		
	1. Steel reinforcement bars etc in R.C.C. and R.B.work. quintal	Quintal	per quintal
	2. Bending, binding of steel Reinforcement	Quintal	per quintal
	3. Rivets, bolts, & nuts, Anchor bolts, Lewis bolts, Holding down bolts.	Quintal	per quintal
	4. Iron hold fasts	Quintal	per quintal
	5. Iron railing (height and types specified)	Quintal	per quintal
	6. Iron grills	sqm	per sqm

Measurement of Materials and Works

VIII	**Roofing**		
	1. R.C.C. and R.B.Slab roof (excluding steel)	cum	per cum
	2. L.C. roof over and inclusive of tiles or brick or stone slab etc (thickness specified)	sqm	per sqm
	3. Centering and shuttering form work	sqm	per sqm
	4. A.C.Sheet roofing	sqm	per sqm
IX	**Plastering, points&finishing**		
	1. Plastering-Cement or Lime Mortar (thickness and pro-portion specified)	sqm	per sqm
	2. Pointing	sqm	per sqm
	3. White washing, colour washing, cement wash (number of coats specified)	sqm	per sqm
	4. Distempering (number of coats specified)	sqm	per sqm
	5. Painting, varnishing (number of coats specified)	sqm	per sqm
X	**Flooring**		
	1. 25mm cement concrete over 75mm lime concrete floor (including L.C.)	sqm	per sqm
	2. 25mm or 40mm C.C. floor	sqm	per sqm
	3. Doors and window sills (C.C. or cement mortar plain)	sqm	per sqm
XI	**Rain water pipe /Plain pipe**	1RM	per RM
XII	**Steel wooden trusses**	1No	per 1No
XIII	**Glass pannels(supply)**	sqm	per sqm
XIV	**Fixing of glass panels or cleaning**	No	per no.

RULES FOR MEASUREMENT:

The rules for measurement of each item are invariably described in IS-1200. However some of the general rules are listed below.

1. Measurement shall be made for finished item of work and description of each item shall include materials, transport, labour, fabrication tools and plant and all types of overheads for finishing the work in required shape, size and specification.

2. In booking, the order shall be in sequence of length, breadth and height or thickness.

3. All works shall be measured subject to the following tolerances.

i) Linear measurement shall be measured to the nearest 0.01m.

ii) Areas shall be measured to the nearest 0.01 sq.m

iii) Cubic contents shall be worked-out to the nearest 0.01 cum

4. Same type of work under different conditions and nature shall be measured separately under separate items.

5. The bill of quantities shall fully describe the materials, proportions, workmanships and accurately represent the work to be executed.

6. In case of masonry (stone or brick) or structural concrete, the categories shall be measured separately and the heights shall be described:

a) from foundation to plinth level

b) from plinth level to First floor level

c) from Fist floor to Second floor level and so on.

1. Administrative Approvals: For any work or project initiated by or related to the requirements of a department with respect to cost and work, it is necessary to obtain formal "acceptance" known as **"Administrative Approval"** from the competent authority of concern department to execute the work.

An approximate estimate and such preliminary plans as are necessary to explain the proposal are submitted by an engineering department to the administration to obtain administrative approval to execute work within the sanctioned amount.

After receiving administrative approval detailed drawing, design and estimated cost are prepared by engineering department and submitted to the administrative department for sanction.

2. Technical Sanction: After obtaining administrative approval to a work, it is necessary to prepare detailed drawing and estimate of the proposed work, which is to be submitted to the appropriate authority of public works department of the state government for sanction. Such sanction is known as Technical Sanction.

If the estimated amount of work exceeds 10% of the amount administrative approval, technical sanction can only be granted after obtaining administrative approval for the work.

Preliminary Estimates.

It is rough estimate prepared to know the approximate cost of work in short time. In this type of estimate, estimate is prepared on the basis of actual cost of similar existing structure. The various factors of comparison may be cubic content, per capita, per Km, service unit, etc. These are useful to know the cost at initial stage to decide the feasibility of work. To prepare approximate estimate less skill and time is required.

Preliminary or approximate estimate is required for studies of various aspects of work of project and for its administrative approval. It can decide, in case of commercial projects, whether the net income earned justifies the amount invested or not. The approximate estimate is prepared from the practical knowledge and cost of similar works. The estimate is accompanied by a report duly explaining necessity and utility of the project and with a site or layout plan. A percentage 5 to 10% is allowed for contingencies.

Purpose of approximate estimate.

1. To know the feasibility of project.
2. To know project duration
3. To obtain administrative approval
4. For insurance and tax schedule.
5. For planning the project.
6. To know benefit cost ration.
7. Investment

Types of or approximate estimate

1. Plinth area method.
2. Cubic content method
3. Service unit method.
4. Approximate quantities method.
5. Typical bay method.

A. **Plinth area method:** This estimate is prepared
    1. P.A. is approximate estimate
    2. Plinth area should be calculated for covered area by taking external dimensions of the building at the floor level.
    3. Courtyard and other open area should not be included.
    4. For multi storeyed building Plinth Area for each storey is determined separately.
    5. Approximate total plinth area may be calculated by adding 30 to 40% of the already calculated area for walls, circulation and waste etc.
    6. Plinth area rate is known from cost of similar building in the locality.

B. Cubic content method

1. Cube rate estimate is again approximate estimate.
2. Cubical content of the building is determined by multiplying length, breadth and height of the building.
3. External length and breadth at the floor level are calculated for the purpose.
4. Height should be taken from the floor level to the top of roof.
5. For multi storeyed building height is taken from floor level of one storey to top of next higher floor.
6. Cube rate estimate is more accurate as compared to the plinth area estimate.

C. Service unit method.

In this method all costs of a unit quantity such as per Km for a highway , per meter of sapn for a bridge, per classroom for school building, per bed for hospital, per litre for water tanks, per seat for cinema hall, etc. Are considered first and approximate cost is prepared by multipliying the cost per service unit by the number of unit in the structure.

Sr. No	Types of Structure	Service Unit
1.	School building	Per Class Room
2.	Hospital	Per Bed
3.	Stadium/Theatre	Per seat
4.	Water Tank	Per unit litre
5.	Office	Room
6.	Bridge	Per meter of span

D. Approximate quantities method.

1. Structure divided into two parts – (i) Foundation including plinth (ii) Superstructure.
2. Total length of walls is found out.
3. To find running meter rate of foundation, appx. quantities of various items are calculated per running meter.
4. Similarly for superstructure appx. Quantities of brickwork, roof, flooring etc is calculated per running meter.

E. Typical bay method.

Bay is centre to centre distance between the supports. When the area of a structure consists of similar parts such as a go down, a railway platform, factory shades etc. Which are constructed with intermediate columns or with roof truss on walls place d at equal distance forming bays.

Approximate cost= No of bays X Cost of one bay.

Problems on Plinth Area Method

Example 3.1: Prepare an approximate estimate of building project with total plinth area of all building is 800 sqm. and from following data.

i)Plinth area rate Rs. 4500 per sqm
ii)Cost of water supply @7½%of cost of building.
iii)Cost of Sanitary andElectrical installations each @ 7½% of cost of building.
iv)Cost of architectural features @1% of building cost.
v)Cost of roads and lawns @5% of building cost.
vi)Cost of P.S. and contingencies @4% of building cost. Determine the total cost of building project.

Data given:

Plinth area = $800m^2$.

Plinth area rate = Rs. 4500 per Sqm.

∴ Cost of building = 800 x 4500 = Rs. 36,00,000=00

Add the cost of the water supply charges @7½%

$$= \frac{36,00,000 \times 7.5}{100} = 2,70,000 = 00$$

Add the Cost of Sanitary and electrical installation @ 15%

$$= \frac{36,00,000 \times 15}{100} = 5,40,000 = 00$$

Add the cost of archetectural features @1%

$$= \frac{36,00,000 \times 1}{100} = 36,000 = 00$$

Add the cost of Roads Lawns @ 5%= $\frac{36,00,000 \times 5}{100}$ =1,80,000 =00

Add the Cost of P.S. and contingencies @ 4%

$$= \frac{36,00,000 \times 4}{100} = 1,44,000 = 00$$

Total Rs. 47,70,000=00

Assume Add supervision charges 8% on overall cost

$$= 47,70,000 \times \frac{8}{100} = 3,81,600 = 00$$

Grand Total Rs. 51,51,600=00

Types of Estimates

Example 3.2 : The plinth area of an appartment is 500 sqm. Detemine the total cost of building from the following data:

a) Rate of construction = Rs.1230/--per m^3.

b) The height of appartment = 16.25 m

c) Water Supply, Sanitary and Electrical installations each at 6% of building cost.

d) Architectural appearance @ 1% of building cost.

e) Unforeseen item @2% of Building cost.

f) P.S. and contingencies @4% of building.

Solution :

a) The Cost of building = cubic content x cubic rate

= 500 ×16.25 ×1230 = Rs. 99,93,750/

b) Provision for water supply, sanitary and Electrical installations water supply and sanitation each @ 6%

$$= \frac{99,93,750 \times 18}{100} = \text{Rs.}17,98,875/-$$

i.e total percent = 3×6 = 18% building cost

c) Architectural appearance @1%= $\frac{99,93,750 \times 1}{100}$ = Rs. 99,937/-

d) Unforeseen items @2% = Rs. 1,99,875/-

e) P.S. and contingenies @4% = Rs. 3,99,750/-

Total = Rs.1,24,92,187/-

Sundries 7,813/-

Total cost of the building project = Grand Total = Rs.1,25,00,000/-

Example 3.3: The plinth area and plinth area rate of a residential building are 100 sqm and Rs. 5000/- respectively. Determine the total cost of building as-suming suitable provisions.

Solution :

Cost of building = 100 x 5000 = Rs.5,00,000

Cost of water supply and

sanitary fittings @15% = $\frac{5,00,000\times15}{100}$ = Rs. 75,000

Cost of Electrification @7½% = $\frac{5,00,000\times7.5}{100}$ = Rs. 37,500

Cost of Roads & Lawns @5% = $\frac{5,00,000\times5}{100}$ = Rs. 25,000

Cost of P.S.& contingencies@4% = $\frac{5,00,000\times4}{100}$ = Rs. 20,000

Total Cost Rs. 6,57,500/-

Example 3.4 : Prepare an approximate Extimate of a proposed building from the follwoing?

Plinth area of the building = 226 sqm.

Cost of the structure = 2500 per sqm.

Water supply and sanitary arangements =

12½% Electrification =7%

Fluctuation of rates = 5% petty

supervision charges = 3%

sol: Cost of Building = 226x 2500 = Rs.5,65,000 Water supply & Sanitory arrangements @ 12½ %

= $\frac{5,65,000\times12.5}{100}$ = Rs. 70,000

Electrification @7% = $\frac{5,65,000\times7}{100}$ = Rs. 39,550

Fluctuation of rates 5% = $\frac{5,65,000 \times 5}{100}$ = Rs. 28,250

Pettysupervision charges 3%= $\frac{5,65,000 \times 3}{100}$ = Rs.16,950

Total Cost Rs. = 7,19,750.00

Problem on Cubical content Method:

Example 3.5 : Prepare the rough estimate for a proposed commertial comples for a municipal corporation for the following data.

Plinth Area = 500m^2/floor
Ht of each storey = 3.5m
No.of storeys = G+2
Cubical content rate = Rs. 1000/m^3

Provided for a following as a pecentage of structured cost

a) water supply & Sanitary arrangement -8%
b) Electrification -6%
c) Fluctuation of rates - 5%
d) Contractors profit - 10%
e) Petty supervision & contingencies - 3%

Sol : Cubical content = No.of storeys (Plinth Area x height of each storey) = 3(500x3.5) = 5250m^3

Structural cost = Cubical content x cubical content rate
= 5250 x 1000 = 52.5 Lakhs

other provisons:-

a) Water supply and sanitation = 52.5x8/100 = Rs.4.2 Lakhs
b) Electrification = 52.5 x 6/100 = Rs.3.15 lakhs
c) fluctuation of rates = 52.5 x 5/100 = Rs.2.625

Total = Rs. 9.975 Lakhs
Structural cost = Rs. 52.500 Lakhs
Total = Rs.62.475 Lakhs

d) P.S./& contingencies = 62.475 x 3/100 = Rs.1.874 Lakhs
e) Contractors Profit = 62.475 x 10/100 = Rs.6.247 Lakhs

Total Cost = Rs.70.596 Lakhs

Problems on Unit Base Method:

Example 3.6: Prepare an approximate estimate or rough cost estimate of a hospital building for 50 beds. The cost of construction altogether for each bed is Rs. 60,000/-. Determine the total cost of hospital building.

Solution:

No. of beds = 50

Cost of construction = Rs. 60,000/-

Total Cost of Hospital building = 50x 60,000= **Rs. 30,00,000/-**

Example 3.7: To prepare the rough cost estimate of a hostel building which accommodate 150 students. The cost of construction including all provisions is Rs. 15,000/- per student. Determine total cost of building.

Solution :

No.of students= 150

Cost of construction including all L.S. provisions = Rs. 15,000/-Total Cost of hostel building =150 x 15000 = Rs. 22,50,000/-(Rupees twenty two lakhs, fifty thousands only)

Different methods to workout Earthwork Quantity for Roads and Canals

1. Mean Area method
2. Mid Sectional method
3. Trapezoidal method
4. Prismoidal Method

1. Mean Area method: In this method area mean is considered

Mean Area

$$A = \frac{A1 + A2}{2}$$

$A1 = Bd1 + Sd1^2$ $\qquad$ $A2 = Bd2 + Sd2^2$

$$Q = \frac{A1 + A2}{2} X\ L$$

L = Length of section

2. Mid Sectional method: In this method area mean is considered

$$dm = \frac{d1 + d2}{2}$$

$$A = Bdm + Sdm^2$$

$$Q = AX\ L$$

3. Trapezoidal method:

$$Q = \frac{\mathrm{L}}{3}[First\ Area + Last\ Area + 4\sum.Even\ Area + 2\sum.Odd\ Area]$$

4. Prismoidal Method:

$$Q = \frac{\mathrm{L}}{2}[First\ Area + Last\ Area + 2\sum.RemainingArea]$$

Calculation of quantities in cutting & filling:

1. Calculation formation levels

   $$F.L\ at\ next\ chainage\ = F.L\ of\ previous\ chainage \pm \frac{1}{Gradient} XChainage\ \ Difference$$

2. Calculation depth of section

   $$d = F.L - G.L$$

   $Negative\ Value\ \rightarrow Section\ In\ Cutting$

   $Positive\ Value\ \rightarrow Section\ In\ Filling$ (Embankment)

Problem No: 1

Calculate quantity of earthwork of road from the following data:

Formation width=10m
Side Slope = 2:1
Formation Level at starting chainage = 51.20m
Falling Gradient = 1 in 40

Distance	**160**	**200**	**240**	**280**	**320**	**360**	**400**
G.L	50.6	50.7	51.2	51.4	51.3	51	50.6

Mid Sectional Method

Chainage	**G.L**	**F.L**	**Depth**	**Mean depth**	**Bd**	**Sd^2**	**Area**	**Length**	**Q=Area X Length**	
160	50.6	51.2	0.6	-----	---	-----	----	----	**Qf**	**Qc**
200	50.7	50.2	-0.5	0.05	0.6	0.005	0.605	40	24.2	------
240	51.2	49.2	-2	-1.25	-15	3.125	-11.875	40	-475	---
280	51.4	48.2	-3.2	-2.6	-31.2	13.52	-17.68	40	-707.2	------
320	51.3	47.2	-4.1	-3.65	-43.8	25.215	69.015	40	-----	2760.6
360	51	46.2	-4.8	-4.45	-53.4	34.56	87.96	40	-----	3518.4
400	50.6	45.2	-5.4	-5.1	-61.2	43.74	104.94	40	--------	4197.6
									-1158	10476.6

Problem No: 2

Calculate quantity of earthwork of road from the following data:

Formation width=12m
Slope in banking= 2:1
Slope in Cutting=1.5:1
Formation Level at starting chainage = 51.40m
Falling Gradient = 1 in 200

Chainage	**0**	**30**	**60**	**90**	**120**	**150**
G.L	50.8	50.6	50.7	51.2	51.4	51.3

Mid Sectional Method

Chainage	**G.L**	**F.L**	**Depth**	**Mean depth**	**Bd**	**Sd^2**	**Area**	**Length**	**Q=Area X Length**	
0	50.8	51.4	0.6	----	----	----	----	------	**Qf**	**Qc**
30	50.6	51.25	0.65	0.625	7.5	0.78125	8.28	30	248.44	-----
60	50.7	51.1	0.4	0.525	6.3	0.55125	6.85	30	205.54	------
78.46	---	----	---	0.2	2.4	0.08	2.48	18.46	45.78	-------
90	51.2	50.95	-0.25	-0.125	-1.5	0.09375	1.59	11.54	-------	18.39
120	51.4	50.8	-0.6	-0.425	-5.1	0.54	5.64	30	-------	169.20
150	51.3	50.65	-0.65	-0.625	-7.5	0.63375	8.13	30	---------	244.01
180	51	50.5	-0.5	-0.575	-6.9	0.375	7.27	30	---------	218.25
									499.7558	649.85

Problem No: 3

Calculate quantity of earthwork of road from the following data:

Formation width=10m
Slope in banking= 2:1
Slope in Cutting=1.5:1

Chainage	**0**	**30**	**60**	**90**	**120**
G.L	500	498.5	497.5	495	494
F.L	497	496.5	496	495.5	495

Mean Area Method

Chainage	**G.L**	**F.L**	**Depth**	**Bd**	**Sd^2**	**Area**	**Mean Area**	**Length**	**Q=Area X Length**	
0	500	497	-3	30	13.5	43.5			Qf	Qc
30	498.5	496.5	-2	20	6	26	34.75	30		1042.5
60	497	496	-1	10	1.5	11.5	18.75	30		562.5
80							5.75	20		115
90	495	495.5	0.5	-5	0.375	5.375	2.6875	10	26.875	
120	494	495	1	-10	1.5	11.5	8.4375	30	253.125	
							Total Qty of Earthwork in Excavation =		280	1720

Problem No: 4

Calculate quantity of earthwork of road from the following data:

Formation width=12m
Slope in banking= 2:1
Slope in Cutting=1.5:1
Formation Level at starting chainage = 51.40m
Falling Gradient = 1 in 200

Chainage	**0**	**60**	**120**	**180**	**240**	**300**	**360**	**420**	**480**	**540**
G.L	73.12	72.44	71.86	72.08	71.3	70.8	70.54	70.82	70.96	71.5
F.L	72.42	**Downward gradient 0.8%**				**Upward gradient 0.5%**				

Mid Sectional Method

Chainage	**G.L**	**F.L**	**Depth**	**Mean depth**	**Bd**	**Sd^2**	**Area**	**Length**	**Q=Area X Length**	
0	73.12	72.42	-0.7						**Qf**	**Qc**
60	72.44	71.94	-0.5	-0.6	-7.2	0.72	7.92	60		475.2
120	71.86	71.46	-0.4	-0.45	-5.4	0.405	5.805	60		348.3
180	72.08	70.98	-1.1	-0.75	-9	1.125	10.125	60		607.5
240	71.3	70.5	-0.8	-0.95	-11.4	1.805	13.205	60		792.3
300	70.8	70.8	0	-0.4	-4.8	0.32	5.12	60		307.2
360	70.54	71.1	0.56	0.28	3.36	0.1568	3.5168	60	211.008	
420	70.82	71.4	0.58	0.57	6.84	0.6498	7.4898	60	449.388	
480	70.96	71.7	0.74	0.66	7.92	0.8712	8.7912	60	660.396	
540	71.5	72	0.5	0.62	7.44	0.7688	8.2088	60	1320.792	
									2641.584	2530.5

Problem No: 5

Calculate quantity of earthwork of road from the following data:

Formation width=10m
Slope in banking= 2:1
Slope in Cutting=1.5:1

Chainage	0	50	100	150
G.L	498	497.9	497.1	496.4
F.L	496.5	496	495.5	495

Mean Area Method

Chainage	G.L	F.L	Depth	Bd	Sd^2	Area	Mean Area	Length	Q=Area X Length	
0	498	496.5	-1.5	15	3.375	18.375	-----	---	Qf	Qc
50	497.9	496	-1.9	19	5.415	24.415	21.395	50	--	1069.75
100	497.1	495.5	-1.6	16	3.84	19.84	22.128	50	--	1106.375
150	496.4	495	-1.4	14	2.94	16.94	18.39	50	--	919.5
				Total Qty of Earthwark in Cutting =						**3095.625**

Problem No: 6

Calculate quantity of earthwork of canal from the following data:

Bed Width =3m
Free Board = 44cm
Slope in digging 1:1
Side Slope of banking 1.5:1
Full supply depth = 1m
Top width of both the bank = 1.5m
Ht of bank above G.L = Full supply depth + Free Board= 1m+44cm=1.44m

Road	G.L	Proposed Level
0	225.24	224
30	224.8	223.94
60	224.43	223.88
90	224.12	223.82
120	224.5	223.76
150	224.98	223.7

Digging									
Road	**G.L**	**Proposed Level**	**Depth of digging "d"**	**Bd**	**Sd^2**	**Area=Bd+Sd2**	**Mean Sectional Area**	**Dist D**	**Q1= AXD**
0	225.24	224	1.24	3.72	1.5376	5.2576			
30	224.8	223.94	0.86	2.58	0.7396	3.3196	4.2886	30	128.658
60	224.43	223.88	0.55	1.65	0.3025	1.9525	2.63605	30	79.0815
90	224.12	223.82	0.3	0.9	0.09	0.99	1.47125	30	44.1375
120	224.5	223.76	0.74	2.22	0.5476	2.7676	1.8788	30	56.364
150	224.98	223.7	1.28	3.84	1.6384	5.4784	4.123	30	123.69
									431.931

Embankment b1=b2=1.5m; S1=1.5						
Ht of bank above bed H	**Ht of bank above G.L h=H-d**	**(b1+b2)h**	**$2S1h^2$**	**Total Area**	**Mean Area**	**Q2= mean area X D**
1.44	0.2	0.6	0.12	0.72		
1.44	0.58	1.74	1.0092	2.7492	1.735	52.038
1.44	0.89	2.67	2.3763	5.0463	3.898	116.9325
1.44	1.14	3.42	3.8988	7.3188	6.183	185.4765
1.44	0.7	2.1	1.47	3.57	5.444	163.332
1.44	0.16	0.48	0.0768	0.5568	2.063	61.902
						579.681

Problem No: 7

Calculate quantity of earthwork of canal from the following data:

Slope in digging 1:1
Full supply depth = 1m
R.L = 98.50 at station 0

Free Board = 44cm
Side Slope of banking 1.5:1
Top width of left bank = 3m

Road	G.L
0	100
50	100.31
100	100.52
150	100.57
200	99.68
250	99.21

Side Slope in cutting = 1:1
Side Slope in both the banks = 1.5:1
Height of banks from the bed = 2.25
Longitudinal slope of the bed = 1 in 5000

Digging B=5m, S=1									
Road	**G.L**	**Proposed Level**	**Depth of digging "d"**	**Mean Depth dm**	**Bdm**	**Sd2**	**Area=Bd+Sd^2**	**Dist D**	**Q1= AXD**
0	100	98.5	1.5						
50	100.31	98.49	1.82	1.66	8.3	2.7556	11.0556	50	552.78
100	100.52	98.48	2.04	1.93	9.65	3.7249	13.3749	50	668.745
150	100.57	98.47	2.1	2.07	10.35	4.2849	14.6349	50	731.745
200	99.68	98.46	1.22	1.66	8.3	2.7556	11.0556	50	552.78
250	99.21	98.45	0.76	0.99	4.95	0.9801	5.9301	50	296.505
									2802.555

Embankment b1=3m, b2=1.5m; S1=1.5					
Ht of bank above bed H	**Ht of bank above G.L h=H-dm**	**(b1+b2)h**	**2S1h^2**	**Total Area**	**Q2= mean areaXD**
2.55	0.89	4.005	2.3763	6.3813	319.06
2.55	0.62	2.79	1.1532	3.9432	197.16
2.55	0.48	2.16	0.6912	2.8512	142.56
2.55	0.89	4.005	2.3763	6.3813	319.06
2.55	1.56	7.02	7.3008	14.321	716.04
					1693.9