



# UNIVERSITY OF RUHUNA

## Faculty of Engineering

End-Semester 4 Examination in Engineering: January 2022

Module Number: CE4301

Module Name: Building Planning and Cost Estimating

[Three Hours]

[Answer all questions]

[You may refer separately provided City of Colombo Development Plan when answering for Q1 and Q2]

- Q1. Assume that you are assigned to plan a two-storey house for a wealthy businessman. His wife is a doctor. She is planning to provide consultancy services to patients in a separate section of the house. The Businessman has two daughters who are 15 years and 13 years old and a son who is 10 years old. Businessman's wife spends her leisure time on gardening with the help of her two daughters. The Businessman has a vehicle for family use. There is a woman servant for housekeeping.
- a) List out the activity spaces for the proposed house. [2.0 Marks]
- b) Draw bubble diagrams for the above activity spaces. [2.0 Marks]
- c) Draw a neat sketch of the proposed ground floor plan. (It is not required to draw the figure according to a scale). [4.0 Marks]
- b) Your proposed plan should be based on client's requirements, resources availability and regulations. Explain how each of these factors affects your proposed building plan. [2.0 Marks]
- Q2.
- a) Define the term "Qualified Person" within the context of planning and building regulations. [4.0 Marks]
- b) Explain the duties of a qualified person during the construction stage of a building project as per planning and building regulations. [2.0 Marks]
- c) Assume that you are working as a planning engineer in a construction company. You are responsible for one of the on-going four-story building construction project. The project has completed all the sub-structure works and first slab concreting is scheduled to start in two weeks' time. Now you decided to resign from company.
- i Explain the procedure that you should follow with your termination.
- ii Explain how the construction company can resume the construction work after your resignation? [4.0 Marks]

Q3.

- a) Explain one advantage of using each of the following standard documents for BOQ preparation.
- i Standard Method of Measurements
  - ii Building Schedule of Rates
- [2.0 Marks]
- b) Explain the procedure of calculating the approximate cost of a construction project
- [3.0 Marks]
- c) Calculate following requirements based on the information provided in Figures Q3(a) and Q3(b).
- i Centerline dimensions
  - ii Take-off quantities of site clearing
  - iii Take-off quantities of excavation for foundations
  - iv Take-off quantities of DPC
- [10.0 Marks]

Q4.

- a) Categorize the following cost items into job overheads and general overheads.
- i Transportation of head office staff
  - ii Setting out and measurement of work
  - iii Temporary fencing and protection at site
  - iv Supervision of work
  - v Head office rent, lights and telephone
  - vi Cost for providing test samples
- [3.0 Marks]
- b) Calculate the unit rates for the following work norms. You may use the price data given in the Table Q4.
- i Filling under floors including levelling, watering & compacting in 3" layers with imported selected earth. Per cube  
1.0 cube earth delivered at site  
2 days unskilled labour
  - ii Mixing of concrete 1:3:6 ( 1/2 "). Per cube  
Materials  
13 cwt cement (50 kg bags)  
0.53 cubes sand  
0.92 cubes 3/4 metal  
1/3 day hire of mixer  
Water (120 gals)  
  
Labour  
1 day skilled labour  
6 days unskilled labour
  - iii 6" thick cement concrete floor (mass concrete). Per Square  
Materials  
0.5 cubes of concrete  
Add 5% for wastage

Water (200 gals)

Labour

½ day skilled labour

1 ¼ day unskilled labour

- iv Terrazzo floor tiles on ½" thick cement and sand 1:2 in ground floor.

Per square

Materials

100 12"x12" terrazzo tiles

Add 5% for wastage

1 ¼ cwt cement (50 kg bags)

0.07 cubes sand

Labour

4 days skilled mason

3 days unskilled labour

½ day unskilled labour (polishing)

[7.0 Marks]

- c) The principal of your school needs to upgrade the existing cement rendering floor of the school main hall to a terrazzo tile floor. As a civil engineering student, you have been required to estimate the probable cost for this work. Removing of existing floor and hard earth will be financially supported by the Old Pupils' Association. The proposed floor area is 12m x 26m. Corresponding foundation is shown in Figure Q4. For this work, the following cost activities are identified.

- Hard core filling of 225mm thick layer
- 1:3:6 (20) Concrete base above the hard core
- 12"x12" Terrazzo tile floor

- i Calculate the quantities of;

- Hard core filling in m<sup>3</sup>
- Concrete work in m<sup>3</sup>
- Tile work in m<sup>2</sup>

- ii Calculate the total cost of the job. You may use the data and the answers taken from the part (b).

[5.0 Marks]

Q5.

- a) Data Sheet 1 given in the pages 6 to 8 shows a part of a BOQ. Identify (write down the Item number) all the non-adjustable elements giving reasons to mark them as non-adjustable elements. Wrong answers leads to negative marks maximum up to 4 marks

[4.0 Marks]

- b) The data given in the Table Q5 (a) includes the General Contract data and the details of interim claims No 1, and 2 for a housing project. Calculate the price adjustment for the claim No. 2. Necessary indices are included in Table Q5 (b).

[6.0 Marks]

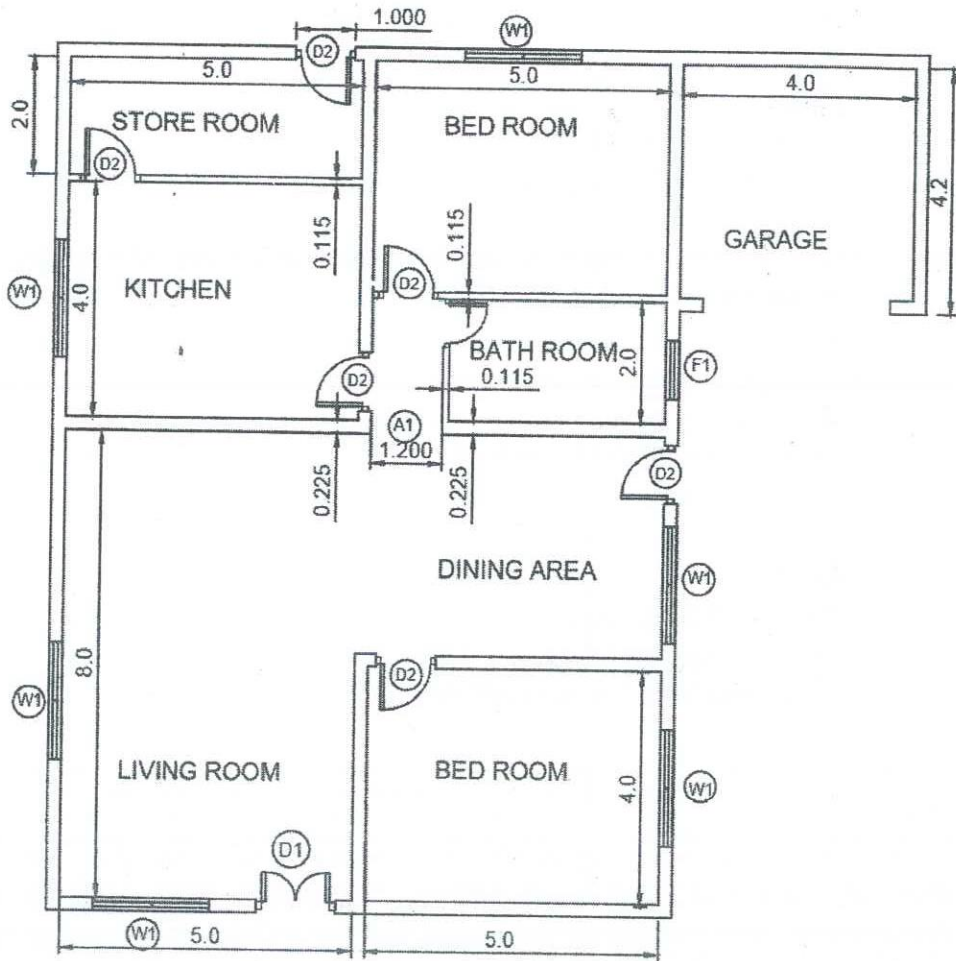
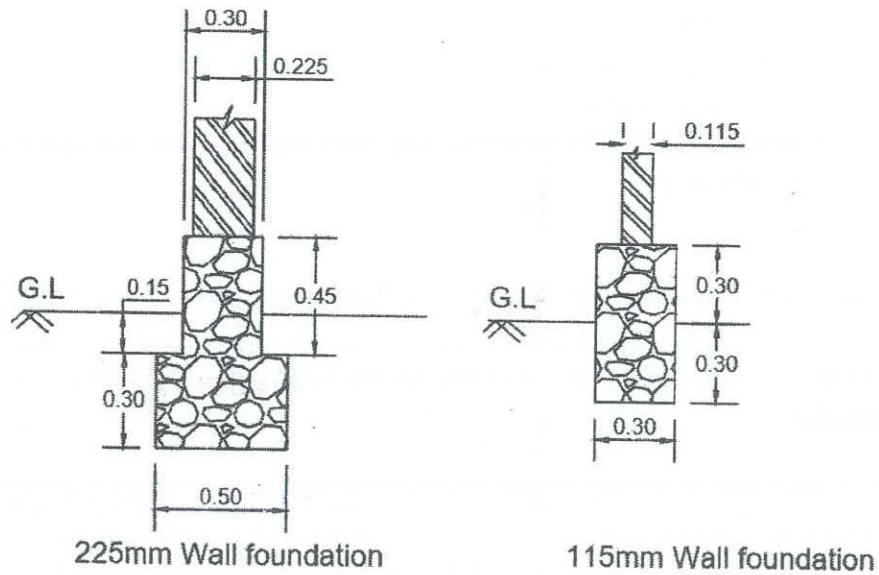


Figure Q3 (a): Ground Floor Plan



225mm Wall foundation

115mm Wall foundation

Figure Q3 (b): Foundation Details

All Dimentions are in meters

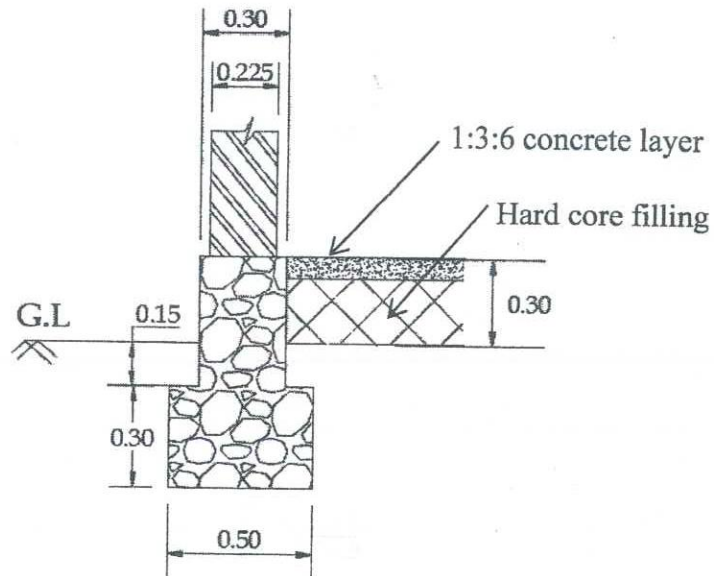


Figure Q4: Foundation Details of School Main Hall  
All Dimintions are in meters

Table Q4: Price Data for Unit Rate Analysis (transport included)

| Resource                    | Price (Rs.)    |
|-----------------------------|----------------|
| 20mm metal 1 cube           | 7500.00        |
| Cement bag (50 kg)          | 1400.00        |
| Sand 1 cube                 | 15000.00       |
| Rubble 1 cube               | 6000.00        |
| Imported soil 1 cube        | 3500.00        |
| Tiles (12"x12")             | 350.00         |
| Water                       | Free of charge |
| Mixer per day               | 4500.00        |
| Skilled labour 8 hour day   | 2500.00        |
| skilled mason 8 hour da     | 3000.00        |
| Unskilled labour 8 hour day | 2000.00        |

**Data Sheet 1**

| <b>Construction of office building complex for ABC (Pvt) Company</b> |   |            |                |             |                      |
|--|---|------------|----------------|-------------|----------------------|
| <b>BILL OF QUANTITIES</b>  |   |            |                |             |                      |
| <b>Item</b>  | <b>Description</b>  | <b>Qty</b> | <b>Unit</b>    | <b>Rate</b> | <b>Amount</b>        |
| <b><u>A-Preliminaries</u></b>  |   |            |                |             |                      |
| A1   | Providing an advance payment  |            | Item           | Pro. Sum    | 50,000.00            |
| A2   | Construction and maintenance of site office for contractor  |            | Item           | Pro. Sum    | 25,000.00            |
| A3   | Construction and maintenance of site office for Engineer  |            | Item           | Pro. Sum    | 25,000.00            |
| A4   | Provide construction management services  | 9          | months         | 40,000.00   | 360,000.00           |
| A5   | Allow sanitary facilitate for workers and staff   |            | Item           | Pro. Sum    | 15,000.00            |
|  | Total carried to summary (page ....)  |            |                |             | <b>500,000.00</b>    |
| <b><u>B-Demolition</u></b>   |   |            |                |             |                      |
| B1   | Demolition of existing building and removal it from the site as directed.   |            | Item           | Pro. Sum    | 456,893.00           |
|  | Total carried to summary (Page....)   |            |                |             | <b>456,893.00</b>    |
| <b><u>C-Excavation and Earth Work</u></b>                            |   |            |                |             |                      |
| C1   | Site clearing and preparation of the site including removal of top soil up to a depth of 150mm for the entire site area |            | Item           | Pro. Sum    | 199,000.00           |
| C2   | Excavate trenches to receive foundations commencing at foundation level, maximum depth not exceed 1.5m.                 | 601        | m <sup>3</sup> | 1,500.00    | 901,500.00           |
| C3   | Filling to excavations with materials arising from the excavations deposited and compacted in 150mm thick layers.       | 908        | m <sup>3</sup> | 827.00      | 750,916.00           |
| C4   | Removal of surplus excavated materials as directed by the Engineer  |            | Item           | Pro. Sum    | 131,500.00           |
| C5   | Approved hard earth filling under floors.   | 172        | m <sup>3</sup> | 827.00      | 142,244.00           |
|  | Total carried to summary (page ....)  |            |                |             | <b>1,125,160.00</b>  |
| <b><u>D-Concrete Work</u></b>  |   |            |                |             |                      |
| D1   | Reinforced concrete 1:2:4 (38mm) in raft foundations.   | 574        | m <sup>3</sup> | 15,606.00   | 8,957,844.00         |
| D2   | Reinforced concrete 1:2:4 (38mm) in slabs   | 2199       | m <sup>3</sup> | 15,606.00   | 34,317,594.00        |
| D3   | Reinforced concrete in columns  | 32         | m <sup>3</sup> | 16,670.00   | 533,440.00           |
| D4   | Reinforced concrete in beams  | 149        | m <sup>3</sup> | 17,765.00   | 2,646,985.00         |
| D5   | Reinforcement   | 124800     | kg             | 200.00      | 24,960,000.00        |
|  | Total carried to summary (page ....)  |            |                |             | <b>71,415,863.00</b> |

| <b>E-Masonry Work</b>                |  |      |                |          |                     |
|--------------------------------------|--|------|----------------|----------|---------------------|
| E1                                   | Random rubble masonry in foundation in cement and sand mortar 1:8 mix up to D.P.C.level.                               | 6    | m <sup>3</sup> | 3,980.00 | 23,880.00           |
| E2                                   | 230mm brick walls in 1:5 cement sand mortar, flush pointed on both side.   | 451  | m <sup>2</sup> | 2,100.00 | 947,100.00          |
| E3                                   | 115mm brick walls in 1:5 cement sand mortar, flush pointed on both side.   | 178  | m <sup>2</sup> | 1,100.00 | 195,800.00          |
| E4                                   | 100mm block work in 1:5 cement sand mortar flush pointed on both sides   | 13   | m <sup>2</sup> | 1,398.00 | 18,174.00           |
| E5                                   | Cement and sand 1:3 mix in 15mm thick Damp Proof Course laid over foundation   | 2.4  | m <sup>2</sup> | 2,300.00 | 5,520.00            |
| Total carried to summary (page ....) |  |      |                |          | <b>1,190,474.00</b> |
| <b>F-Roof work</b>                   |  |      |                |          |                     |
| F1                                   | Zink Aluminium Sheet   | 349  | m <sup>2</sup> | 2,145.00 | 748,605.00          |
| F2                                   | Roof Truss   | 1966 | m              | 1,424.00 | 2,799,584.00        |
| F3                                   | Zink Aluminium valance board   | 8.8  | m <sup>2</sup> | 1,400.00 | 12,320.00           |
| Total carried to summary (page ....) |  |      |                |          | <b>3,560,509.00</b> |
| <b>G-Plumbing</b>                    |  |      |                |          |                     |
| G1                                   | Allow for a system of water supply including all the water and sanitary appliances.                                    |      | Item           | Pro. Sum | 1,500,000.00        |
| Total carried to summary (page ....) |  |      |                |          | <b>1,500,000.00</b> |
| <b>H-Drainage Work</b>               |  |      |                |          |                     |
| H1                                   | Allow for construction of trenches, manholes, soakage pits etc. including the pipe work for removal of sewage.         |      | Item           | Pro. Sum | 1,500,000.00        |
| Total carried to summary (page ....) |  |      |                |          | <b>1,500,000.00</b> |
| <b>J- Wall Finishes</b>              |  |      |                |          |                     |
| J1                                   | 15mm thick 1:1:5 cement lime sand plaster in two coats finished smooth to external walls                               | 484  | m <sup>2</sup> | 500.00   | 242,000.00          |
| J2                                   | 15mm thick 2:5 lime sand plaster in two coats finished smooth with lime putty to internal walls                        | 414  | m <sup>2</sup> | 500.00   | 207,000.00          |
| J3                                   | 15mm thick cement sand 1:3 plaster approved water proofing compound, on two coats finished with neat cement in Toilets | 225  | m <sup>2</sup> | 1,500.00 | 337,500.00          |
| J4                                   | Soffit plaster   | 1808 | m <sup>2</sup> | 867.00   | 1,567,536.00        |
| J5                                   | Water proofing in toilets walls up to 2.0m height with flexible cementations water proofing membrane.                  | 132  | m <sup>2</sup> | 1,800.00 | 237,600.00          |
| Total carried to summary (page ....) |  |      |                |          | <b>2,591,636.00</b> |

| <b>K-Floor Finishes</b>              |   |      |                |          |                     |
|--------------------------------------|---|------|----------------|----------|---------------------|
| K1                                   | 20mm thick 1:3 cement sand rendering  | 560  | m <sup>2</sup> | 2,300.00 | 1,288,000.00        |
| K2                                   | Supplying and fixing 2' x 2' mat ceramic floor tiles  | 1248 | m <sup>2</sup> | 3,500.00 | 4,368,000.00        |
| K3                                   | Water Proofing in toilets floors  | 82   | m <sup>2</sup> | 1,800.00 | 147,600.00          |
| K4                                   | Supplying and fixing 1' x 1' mat ceramic floor tiles  | 82   | m <sup>2</sup> | 3,500.00 | 287,000.00          |
| Total carried to summary (page ....) |   |      |                |          | <b>6,090,600.00</b> |
| <b>L- Electrical Work</b>            |   |      |                |          |                     |
| L1                                   | Allow for a system of electricity including main switch, lams, switches, plug points etc.   |      | Item           | Pro. Sum | 200,000.00          |
| Total carried to summary (p...)      |   |      |                |          | <b>200,000.00</b>   |
| <b>M-Painting</b>                    |   |      |                |          |                     |
| M1                                   | Prepare and apply one coat of primer and two coats of crack bridging primer and two coats of weather shield paint of approved colour and quality to external faces of walls & columns.    | 113  | m <sup>2</sup> | 500.00   | 56,500.00           |
| M2                                   | Prepare and apply one coat of primer and two coats of emulsion paint of approved colour and quality to internal faces of walls. Rate is included for preparing the surface with skim coat | 339  | m <sup>2</sup> | 400.00   | 135,600.00          |
| Total carried to summary (p...)      |   |      |                |          | <b>192,100.00</b>   |
| <b>N Landscaping</b>                 |   |      |                |          |                     |
| N1                                   | Landscaping the open spaces with pavings, turfing, planting trees, flowering and other bushes and adding other amenities.   |      | Item           | Pro. Sum | 250,000.00          |
| Total carried to summary (p...)      |   |      |                |          | <b>250,000.00</b>   |
| <b>P Air Conditioning</b>            |   |      |                |          |                     |
| P1                                   | Provision of Air Conditioning machine with all necessary duct, wiring etc as directed by the Engineer. (Provided as an Item)  |      | Item           | Pro. Sum | 300,000.00          |
| Total carried to summary (p...)      |   |      |                |          | <b>300,000.00</b>   |



**Table Q5 (a): Data for Price Adjustment**

| Contract Data                                |                  |
|--|------------------|
| Total Contract Sum                           | Rs. 8,327,653.33 |
| Date of Closing Bids                         | 01- Feb- 2020    |
| Date of commencement of work                 | 20-April-2020    |
| Claim No. 1                                  |                  |
| Date of submission                           | 15-June-2020     |
| Value of certified work done (cumulative)    | Rs. 1,767,915.73 |
| 80% of cost of material at site              | Rs. 85,000.00    |
| Value of non-adjustable Element (cumulative) | Rs. 45,000.00    |
| Claim No. 2                                  |                  |
| Date of submission                           | 05-August-2020   |
| Value of certified work done (cumulative)    | Rs. 2,765,163.29 |
| 80% of cost of material at site              | Rs. 75,000.00    |
| Value of non-adjustable Element (cumulative) | Rs. 65,000.00    |

**Table Q5 (b): Monthly Cost Indices for Various Types of Construction Works in 2020**

| Month    | Modern Housing | Non-Residential Housing | Water Supply & Drainage |
|----------|----------------|-------------------------|-------------------------|
| January  | 789.4          | 729.6                   | 676.6                   |
| February | 809.5          | 745.4                   | 692.8                   |
| March    | 813.4          | 749.3                   | 690.3                   |
| April    | 813.7          | 749.6                   | 690.4                   |
| May      | 814.7          | 750.0                   | 690.4                   |
| June     | 815.9          | 750.8                   | 690.4                   |
| July     | 816.5          | 751.4                   | 690.4                   |
| August   | 816.6          | 751.6                   | 690.4                   |

ICTAD Price Fluctuation Formulas

$$F = \frac{0.966(V - V_{na})}{100} * \sum \frac{P_x(I_{xc} - I_{xb})}{I_{xb}} \quad \text{for contracts exceeding Rs. 10 million}$$

$$F = 0.869(V - V_{na}) * \frac{I_{tc} - I_{tb}}{I_{tb}} \quad \text{for contracts not exceeding Rs. 10 million}$$

All the parameters are with their usual notations.