MADE EASY

Leading Institute for ESE, GATE & PSUs

ESE 2025 : Mains Test Series

UPSC ENGINEERING SERVICES EXAMINATION

Civil Engineering

Test-5

Section A : Building Material + Construction Practice [All Topics]

Section B : Planning and Management + Tunnelling [All Topics]

Name : .....

Roll No :

Test Centres			Student's Signature
Delhi ☑	Bhopal ☐	Jaipur ☐	
Pune ☐	Kolkata ☐	Hyderabad ☐	

Instructions for Candidates

1. Do furnish the appropriate details in the answer sheet (viz. Name & Roll No).
2. There are Eight questions divided in TWO sections.
3. Candidate has to attempt FIVE questions in all in English only.
4. Question no. 1 and 5 are compulsory and out of the remaining THREE are to be attempted choosing at least ONE question from each section.
5. Use only black/blue pen.
6. The space limit for every part of the question is specified in this Question Cum Answer Booklet. Candidate should write the answer in the space provided.
7. Any page or portion of the page left blank in the Question Cum Answer Booklet must be clearly struck off.
8. There are few rough work sheets at the end of this booklet. Strike off these pages after completion of the examination.

FOR OFFICE USE	
Question No.	Marks Obtained
Section-A	
Q.1	40
Q.2	
Q.3	
Q.4	41
Section-B	
Q.5	53
Q.6	
Q.7	49
Q.8	32
Total Marks Obtained	215

Signature of Evaluator: Adarsh ..... Cross Checked by: .....

p it up!

IMPORTANT INSTRUCTIONS

CANDIDATES SHOULD READ THE UNDERMENTIONED INSTRUCTIONS CAREFULLY. VIOLATION OF ANY OF THE INSTRUCTIONS MAY LEAD TO PENALTY.

DONT'S

1. Do not write your name or registration number anywhere inside this Question-cum-Answer Booklet (QCAB).
2. Do not write anything other than the actual answers to the questions anywhere inside your QCAB.
3. Do not tear off any leaves from your QCAB, if you find any page missing do not fail to notify the supervisor/invigilator.
4. Do not leave behind your QCAB on your table unattended, it should be handed over to the invigilator after conclusion of the exam.

DO'S

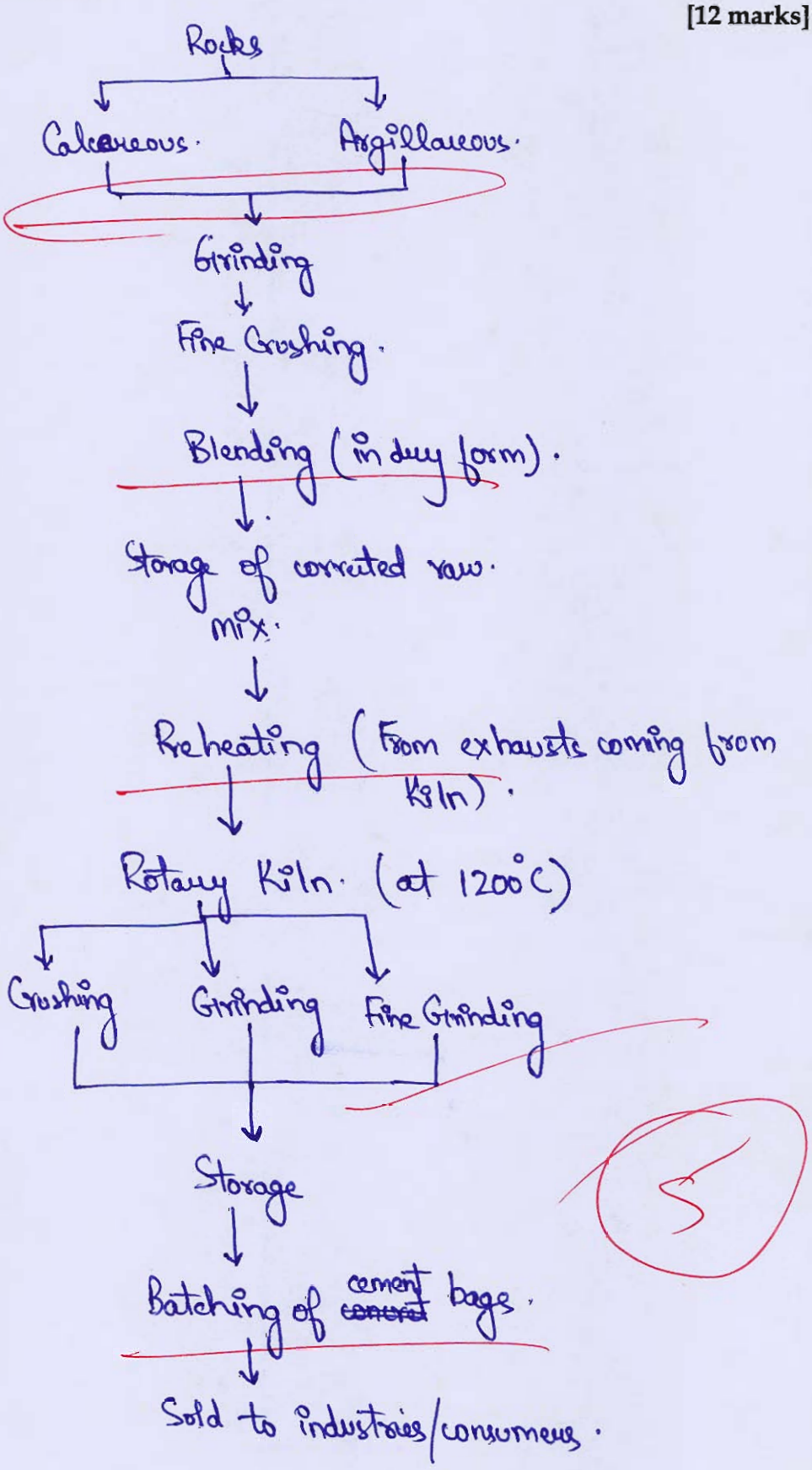
1. Read the Instructions on the cover page and strictly follow them.
2. Write your registration number and other particulars, in the space provided on the cover of QCAB.
3. Write legibly and neatly.
4. For rough notes or calculation, the last two blank pages of this booklet should be used. The rough notes should be crossed through afterwards.
5. If you wish to cancel any work, draw your pen through it or write "Cancelled" across it, otherwise it may be evaluated.
6. Handover your QCAB personally to the invigilator before leaving the examination hall.

Section A : Building Material + Construction Practice

a) Explain the process of manufacturing ordinary portland cement (OPC) by dry process with a neat flow diagram

[12 marks]

Sol^n:



5

b) Describe the initial and final setting time tests of cement. What are the standard values for OPC as per IS codes?

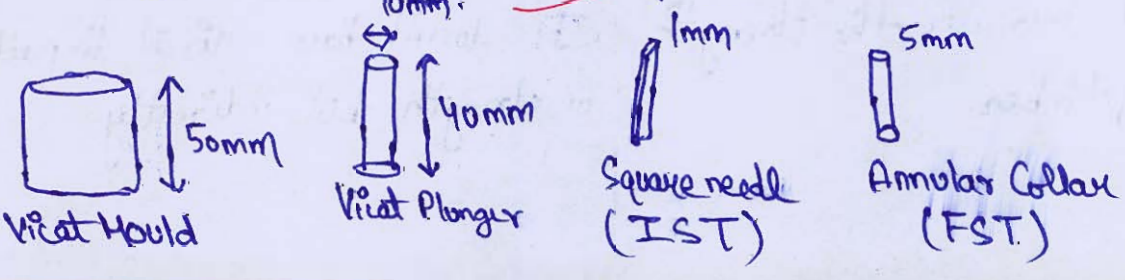
[12 marks]

Initial setting time test:

- The test is performed with the help of a vicat apparatus at $0.85p$ where p is the consistency.
- The point of addn of water to mix till the time it is moulded is time of gauging & shouldn't be more than 3-5 min.
- The attachement of square needle of 1mm is used and till it makes a penetration of 35-33mm into the vicat mould.
- The water content at which square needle reaches 5-7mm from bottom or where the mix looses its plasticity. is the p consistency & time taken is the initial setting time.

Final setting time test

- When an annular collar is unable to mark impression. while the needle does is final setting time
- Determined at $0.85p$ by same apparatus.
- It is the time when the cement has gain some sort of strength to resist certain pressure.



IST → 30 min.
FST → 16 hours

12

3.1 (c) Differentiate between seasoning of timber and preservation of timber. Explain any two methods of each of them.

[12 marks]

Seasoning	Preservation
• It is a method of removing sap from tree after felling.	• It is a method of preserving timber from various agents.
• Sap from cell cavities are removed using various methods	• Chemicals are applied on the surface or beneath the surface.
• Increases the durability of timber sections.	• It also increases the life of timber section.
• It increases the strength of timber	• It doesn't have direct impact on strength but indirectly.

- Various methods are:
  - → Natural Seasoning
  - → Artificial Seasoning
    - → Chemical / Salt seasoning
    - → Electric Seasoning
    - → Kiln Seasoning
    - → Water Seasoning
    - → Boiling

- Kiln Seasoning: Dry air is passed through the section to attrait moisture
  - → Then moisture air passes through the section which dries internal part.

- Chemical Seasoning: Salt is present in water which absorbs the moisture by attracting it Upto surface

- Various Preservatives used are of the following types:
  - → Creosote Oil Type
  - → Organic solvent Type.
  - → Water Soluble Type:
    - → Leachable
    - → Fixed Type.

- Water Soluble (Leachable Type).

Methods are:

- Charring: Outer layer of timber is burnt which is generally Organic.

- Pressurizing chemicals:

Water Soluble Preservatives are generally not applied on outer surface but inside as are prone to form leachate so pressurizing is done.

12

Q.1 (d) (i) Discuss in detail the various impurities commonly found in lime.

(ii) As per IS 712, classify lime into different classes. Mention the characteristics, composition, and typical uses of each class.

[4 + 8 = 12 marks]

(i) Various Impurities of lime are:

- Clay: In the range of 30%, impart hydraulicity.
- $MgCO_3$: About 5%, retard setting & promote slaking
- MgO: It also helps in hydraulic setting.
- Silicates of Mg, Ca: It helps the lime to set therefore retard slaking.

Conclusion: Thus, certain impurities are added in lime to make it a hydraulic lime which can set as well as gain strength in presence of water.

Example: Kankar, Dolomitic/Mg Lime.

(ii) As to IS 712: lime is classified into 6 types.

Class A → Eminently Hydraulic lime.
Class B → Moderatly Hydraulic lime
Class C → Fat lime.
Class D → Dolomitic/Mg Lime.
Class E → Kankar Lime.
Class F → Poor Lime.

Classes of Lime

Class A
- Mostly consist of impurities of MgO, $MgCO_3$, Clay
- Used in works related to strength

Class B
- Contains somewhat less impurities so slakes also.
- Uses are in works that require considerable less strength like Brick masonry with Lime.

Class C
- Type of a lime with negligible impurities.
- It's volume is 2-2.5 times of CaO
- Plastering Whitewashing

Class D
- Impure lime.
- Uses are in sub-structure, Garden walls.

Class E
- Again a Hydraulic lime.
- Found near sea-shores.
- Uses are in Pointing mortar, underwater works, Canals.

Class F
- Impurities >30% Clay >5% MgO
- Uses are very less when no strength desired like gardens, Paths, Road Sub-grade

09

Q.1 (e) (i) Mention the precautions to be taken during the application of cement paint.

(ii) Mention the advantages and disadvantages of cement paint in comparison to other surface finishes.

[4 + 8 = 12 marks]

(1) Various Precautions to be taken

→ Cleaning of the surface to be painted.

→ Proper gloves and mask should be used by Person applying it.

→ Box where it is stored should be clean.

→ Cement Paints can form flakes if not properly painted over surface

→ Putty should be preferable before applying paints.

2

2 (a) (i) Define ferrocement and fiber reinforced concrete. Discuss the advantages and typical applications of each.

(ii) What is bacterial concrete? Explain the principle behind its self-healing mechanism. Discuss its advantages and limitations in concrete.

[12 + 8 = 20 marks]

Do n
write
this

Q.2 (b) (i) A concrete mix is to be proportioned with a water content of 165 kg/m³ and a target water-cement ratio of 0.52. However, due to aggressive environmental exposure, the maximum permissible water-cement ratio is limited to 0.45.

Assuming that mortar occupies 58% of the total concrete volume (by volume), determine the required quantities of cement, fine aggregate, and coarse aggregate per m³ of concrete (in kg/m³). Neglect air voids in the mix.

Take the specific gravities as follows:

- Cement: 3.10
- Fine aggregate: 2.68
- Coarse aggregate: 2.74

(ii) Discuss how the following parameters influence the workability of fresh concrete. Provide a brief description for each of the following factors:

1. Size of aggregate
2. Cement content
3. Water-cement ratio
4. Entrained air

[10 + 10 = 20 marks]

2 (c) (i) Explain the mechanism of hydration of Portland cement with reference to the chemical reactions involved. Discuss the role of individual Bogue's compounds in strength development, setting behaviour, and heat of hydration.

Define the terms tobermorite and portlandite, and mention their relevance in the microstructure of hydrated cement paste.

Illustrate your answer with relevant graphs showing:

- Rate of hydration of various cement compounds
- Strength gain pattern of these products with time

(ii) Differentiate between bound water and gel water, and explain their roles in hydration of cement.

[15 + 5 = 20 marks]

(a) (i) List and explain the major steps involved in concrete construction. Also, mention an important precaution to be taken during each step.

(ii) Enumerate and explain the green attributes of lime that contribute to sustainable construction.

[10 + 10 = 20 marks]

Q.3 (b) (i) What are the characteristics of a good building stone?

(ii) Discuss about the following types of brick masonary bonds with neat sketches:

(I) English bond

(II) Flemish bond

(III) Double Flemish bond

(IV) Dutch bond

[10 + 10 = 20 marks]

3 (c) (i) Write a short on plastering while highlighting the following:

(I) Purpose of plastering

(II) Types of plasters

(III) Defects in plastering

(IV) Characteristics of an ideal plaster

(ii) A sample of concrete is made with 450 g of cement with water-cement ratio as 0.48. Calculate the gel-space ratio and theoretical strength of the sample assuming:

(I) full hydration

(II) 75% hydration

(Assume 1 ml of cement on hydration produces 2.06 ml of gel.)

[10 + 10 = 20 marks]

Q.4 (a) (i) Enumerate and discuss briefly about the classification of timber based on the following criteria:

(I) Service life
(II) Availability
(III) Strength
(IV) Seasoning properties

(ii) What are the advantages of aluminium as a building material?

[10 + 10 = 20 marks]

(ii) Advantages of Aluminium are

→ light weight
→ Good Aspect Ratio.
→ Suffiient modulus of elasticity.
→ Thermally resist good temperatures.
→ Cheap
→ A protective oxide layer Al_2O_3 forms over its surface which prevent it from corrosion.
→ $\alpha = 17 \times 10^{-6}$ °C so can't counter thermal expansion also.

6

.4 (b) (i) What are admixtures? Describe the effects of retarders, accelerators and water proofing admixture on cement concrete with examples.

(ii) Explain the phenomenon of bulking of sand and its significance. How is it determined?

[10 + 10 = 20 marks]

(1) Admixtures are not essential but necessary components nowadays to prepare concrete of desired properties.

- These are added in Concrete so as to make concrete suitable to use & modify certain properties in it.

- There are different types of Admixtures:

→ Retarders
→ Accelerators
→ Plasticizers
→ Super-Plasticizers
→ Air entrainers.

Accelerators:

- Examples are $CaCl_2$, Ethanol amine,
- These are used to increase the rate of setting.
- Especially used in areas where temp. is low so as to decrease the viscosity

Retarders

- Examples are $CaSO_4$, sugar, starch, Tartaric Acid
- They are used in areas where setting is to be delayed
- Like in areas where transportation is difficult so concrete is not allowed to set.

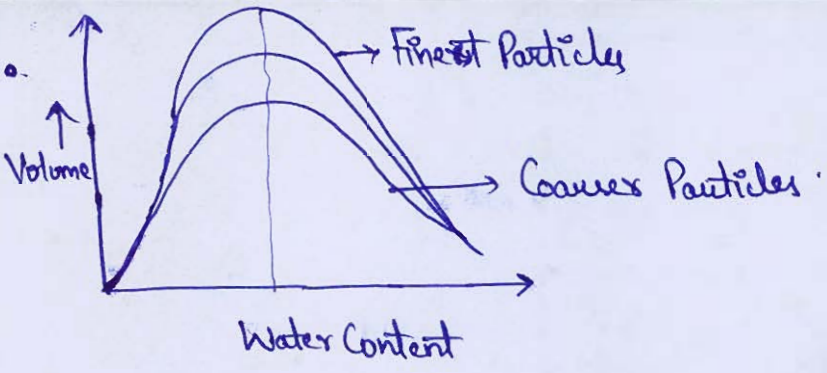
Plasticizers:

- Examples are: Polyglycol Ester, Carboxylic Acid, Carbohydrates
- They are water reducers which helps in increasing workability at same water content & for same workability water can be reduced upto 15%.

9

(ii) Bulking of Sand refers to a condition when there is suitable amount of moisture in sand particles & due to surface tension forces, the particles are not allowed to come in contact so volume increases.

- What happens is when water in suitable amount is added to sand then surface tension forces become active & an apparent cohesion is developed which causes increase in volume of the whole mix.



- From the Graph we can judge more the size of aggregate lesser would be the volume increase and vice versa.

- A easy method to measuring bulking of sand is to take some into cylindrical container & add moisture note reading (h_1) then indundate it to reverse bulking again note (h_2)

$$\% \text{ Bulking} \Rightarrow \frac{h_1 - h_2}{h_2} \times 100\%.$$

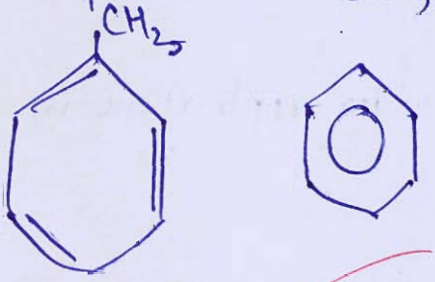
8

(c) (i) Explain the various engineering or mechanical properties of glass.

(ii) Differentiate between thermosetting and thermoplastic resins.

[10 + 10 = 20 marks]

(ii)

Thermosetting	Thermoplastic
• Formed by Condensation Reaction	• Addition Polymerisation.
• By product is formed	• No By product formed.
• Cross-linked Polymer	• Linear or Branched.
• Cannot be remoulded into other shape.	• Can be remoulded
• Cannot be melted & once set they are very strong	• It can be melted and once set can be again used for other purposes.
• Example are: Bakelite, Melamine 	• Polyethylene, Polybutadiene. ⇒ $H_3C=CH_3$.
• Used in electrical appliances	• Used in making plastic, buckets, Chairs, tables etc.

10

(1) Physical & Mechanical Properties of Glass:

→ Glass is Brittle

→ It can resist compressive load much better than tensile load

→ Impact loading can be resisted by Glass if it's of good quality.

→ Glass fibres are sufficiently thin & very strong in tension as compared to glass itself.

→ Glass cannot resist Alkali Aggregate reaction as silica present in glass can initiate and react with alkalis in cement along with silica rich aggregates.

→ Glass can be used as outer-surface in many buildings and provide penetration of sunlight inside being transparent in nature.

→ Glass being brittle in nature has wider applications in Ceramic industries.

8

Section B : Planning and Management + Tunnelling

.5 (a) Information on the activities required for a medium-size civil engineering project is as follows :

Activity	Node No.	Duration (in months)
A	1-2	02
B	1-3	07
C	1-4	08
D	2-5	03
E	3-5	06
F	3-6	10
G	3-7	04
H	4-6	06
I	5-7	02
J	6-8	05
K	7-8	06

Draw the network and calculate the following :

(i) Earliest and latest event time

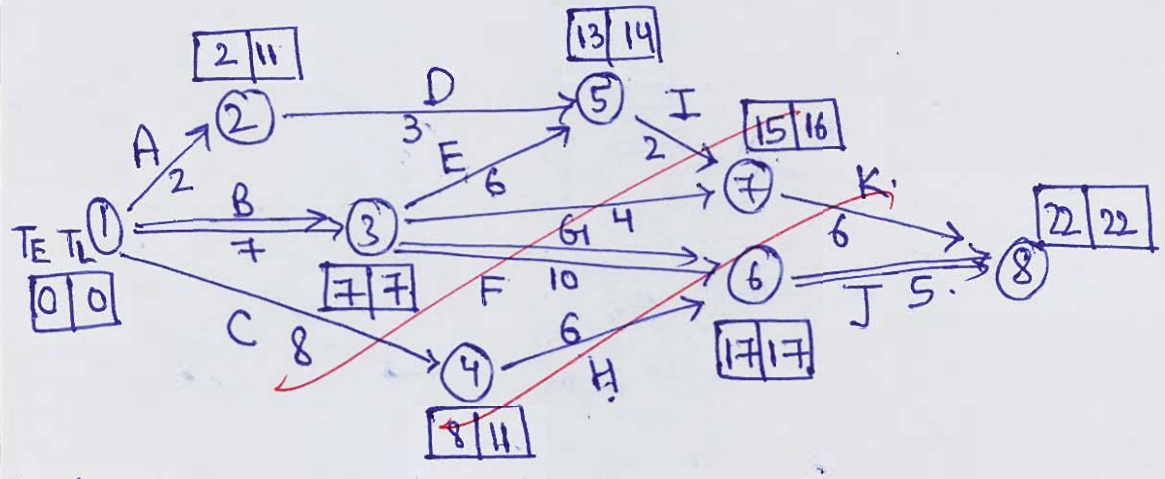
(ii) Earliest and latest start time

(iii) Earliest and latest finish time

(iv) Total, free and independent float

(v) Critical path

[12 marks]



(1) Given in boxes of each event.

Activity	Duration (t_{ij})	EST	EFT	LST	LFT	T_F	F_F	I_F
A	02	0	2	9	11	9	0	0
B	7	0	7	0	7	0	0	0
C	8	0	8	3	11	3	0	0
D	3	2	5	11	14	9	8	-1
E	6	7	13	8	14	1	0	0
F	10	7	17	7	17	0	0	0
G	4	7	11	12	16	5	4	4
H	6	8	14	11	17	3	3	0
I	2	13	15	14	16	1	0	-1
J	5	17	22	17	22	0	0	0
K	6	15	21	18	22	1	1	0

For A: EST = 0

EFT = EST + t_{ij} ⇒ 0 + 2 = 2

LFT = 11

EFT = LFT - t_{ij} ⇒ 9.

T_F = LFT - (EFT).

⇒ 2.

FF = LST - (EST + t_{ij})

C.P ⇒ BFJ.

12

5 (b) Write short notes on the following:

(i) Liquidated damage

(ii) Tender drawing and working drawing

(iii) Percentage rate contract

(iv) Scaffolding

(v) Turnkey contracts

[12 marks]

(1) • The damages that are not in control of any one either the contractor or the hirer are liquidated damage

• Example are Floods, Earthquake, Unseen circumstances.

• The contractor is exempted from this under a force majeure clause.

(II). The drawing issued during tender work for bidding is tender drawing.
The drawing with due modifications that are used for designing & in practice is this drawing.

(III) Percentage Rate Contract:
- The contractor quote the price of the work as percentage up as the profit and therefore profit is dependent upon cost of project.

(IV) Scaffolding:
- These are used for elevated platforms working by persons when such a work which require enough space or platform for materials, man then it is used.

(V) Turnkey Contract:
- These contract are majorily dependent upon Project manager as the project sponser/owner will only interfere during taming of key of Project.
- Higher authority is there with Project Manager.
- Example: In a Film, the Producer act as a project sponser but the Director is the Project Manager.

5 (c) (i) Define slack. What does negative slack indicate in PERT network analysis?

(ii) Life of a building is 80 years and two choices are available for a particular component of the building.

Choice A: Initial and replacement cost as Rs. 4000 and life of component is 20 years.

Choice B: Initial and replacement cost as Rs. 6000

Life of the component is 40 years

Money worth is 5% determine the most economical choice.

[4 + 8 = 12 marks]

(i) Slack is the difference of Earliest Event time from Latest Event time & defined for an event.

- A negative slack indicate that event is well behind the schedule & require proper care & attention.
- A path connecting zero slack events can be critical but not necessarily as it should have longest duration also.
- In PERT, where events plays a key role determination of slack of events helps in finding the shortest duration required & max^m duration permissible
- "Head Slack" can be used in finding Interfering float while Tail slack can be used to relate Total float & Free Float.

4

(ii) Present Worth of A: $\frac{4000}{(1+i)^{20}} + \frac{4000}{(1+i)^{40}} \cdots \frac{4000}{(1+i)^{80}}$

$\Rightarrow \frac{4000}{1.05} + \frac{4000}{1.05^2} \cdots \frac{4000}{1.05^{20}}$

$\Rightarrow \frac{4000}{1.05}\left[\frac{\left(\frac{1}{1.05}\right)^{20} - 1}{\frac{1}{1.05} - 1}\right] = 49848.8$

B: $\frac{6000}{(1.05)^{40}} \cdots \frac{6000}{(1.05)^{80}} + \frac{6000}{(1.05)^{80}} \Rightarrow \frac{6000}{1.05}\left[\frac{\left(\frac{1}{1.05}\right)^{40} - 1}{\frac{1}{1.05} - 1}\right]$

⇒ ₹102954.518

$\frac{4000}{(1.05)^{20}} \ldots + \frac{4000}{(1.05)^{80}} \xrightarrow{+4000} A \Rightarrow \frac{4000 \times \left[\left(\frac{1}{1.05^{20}}\right)^4 - 1\right]}{\left[\frac{1}{1.05^{20}} - 1\right]}$

$\frac{6000}{(1.05)^{40}} + \frac{6000}{(1.05)^{80}} + 6000 \longrightarrow B \Rightarrow \frac{6000}{(1.05)^{40}} \left[\frac{\left(\frac{1}{1.05^{40}}\right)^3 - 1}{\left[\frac{1}{1.05^{40}} - 1\right]}\right]$

A → 2370.6 + 4000 = ₹6370.6

B → 990.53 + 6000 = ₹6990.53

Economical Choice is 'A'.

6

(d) (i) A project is expected to take 15 months along the critical path, having a standard deviation of 3 months. What is the probability of completing the project in (i) 15 months, (ii) 21 months, and (ii) 12 months? The probability percentage for different values of probability factor are as below:

15.87% for – 1; 50.00% for 0; 97.72% for + 2.

(ii) What are the main advantages of A-O-N over A-O-A?

[6 + 6 = 12 marks]

(i) $Z = \frac{T_S - E_E}{\sigma}$ $T_E = 15$ months, $\sigma = 3$ months.

For $T_S = 15$ months

$Z = \frac{15-15}{3} = 0$

For 0, P% = 50%

For $T_S = 21$ months

$Z = \frac{21-15}{3} = 2$

For 2, P% = 97.72%

$T_S = 12$ months

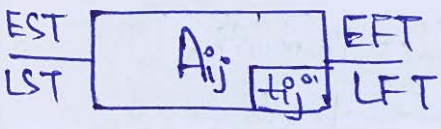
$Z = \frac{12-15}{3} \Rightarrow -1$

P% = 15.87%

6

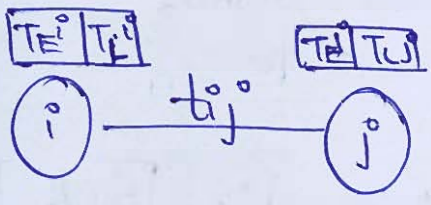
AON

- All the activities duration are represented in the network itself like EST EFT, LST, LFT
- The diagram itself is self-sufficient & explainatory
- There is no need of dummy activity.
- The Grammetical and logical relationship is automatically understood when activites are placed on nodes.



AOA.

- We need to prepare separate table for Calculation
- Not self explainatory.
- There is no self logical & grammetical relations in the network without dummy.
- Dummy is essential.



6

(e) The interdependence of a job consisting of seven activities A to G is given in table below.

Activity	A	B	C	D	E	F	G
Predecessor activity	–	–	A	B	A	B	C,D
Succeding activity	C,E	D,F	G	G	–		

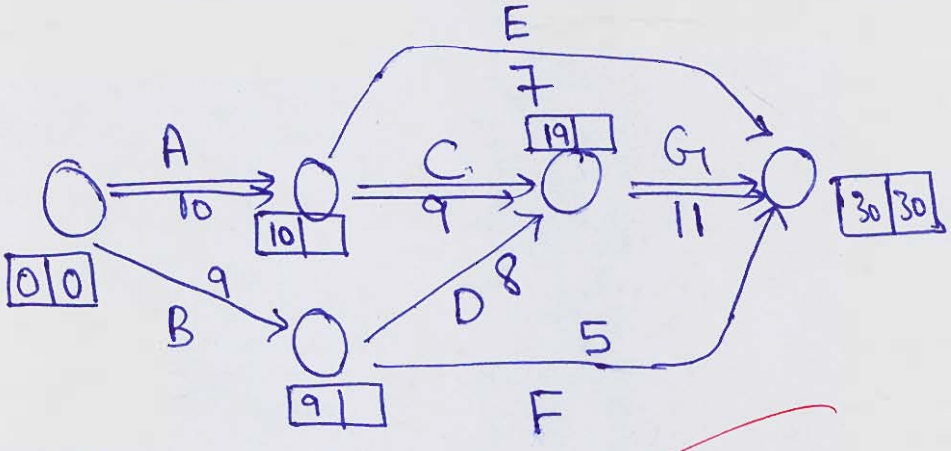
The time estimates (in days) for each activity are as given below.

Activity	Time estimates
A	6 – 9 – 18
B	5 – 8 – 17
C	4 – 7 – 22
D	4 – 7 – 16
E	4 – 7 – 10
F	2 – 5 – 8
G	4 – 10 – 22

Z(+)	% Probability
0.8	78.81
0.9	81.59
1.0	84.13
1.1	86.43
1.2	88.49

Draw the network and determine the probability of completing the job in 35 days.

[12 marks]



For 'A': $T_E = \frac{6+4+9+18}{6} = 10$

Comp. Time ⇒ 30 days. , $\sigma = \sqrt{\sigma_A^2 + \sigma_C^2 + \sigma_G^2}$

$Z = \frac{T_S - T_E}{\sigma} = \frac{35-30}{\sigma}$ $= \sqrt{2^2+3^2+3^2}$

⇒ 4.69 d

⇒ 1.066.

P% ⇒ $84.13 + \frac{(86.43-84.13)}{1}(0.066)$

⇒ 84.2818%.

10

(a) (i) Explain the purpose of dragline alongwith its advantages.

(ii) Draw schematic diagram showing various components of a dragline.

(iii) List the factors which affect output of a dragline.

[20 marks]

(b) (i) For preparing 1 cum brick ballast of 40 mm gauge from overburnt bricks; one uses 1.1 cum of overburnt bricks; and 4 labour-days are assignable for 3 cum of ballast. Cost of bricks is Rs. 250 per cum; labour is costed at Rs. 19 per head per day. Prepare in tabular form a rate analysis providing for other necessary details at your discretion.

(ii) What is Break Even Analysis? Write functions and limitations of break even analysis.

[10 + 10 = 20 marks]

Q.6 (c) (i) Calculate the time required to grade and finish 60 km of a National Highway in two phases of 30 km length covered in each. Width of road formation is 8 lanes of 3.75 m each.

Width of motor grader = 3.0 m

No. of passes = 20

Details of speed on each two successive passes:

Passes	1 and 2	3 and 4	5 and 6	7 and 8	9 and 10	11 and 12	13 and 14	15 and 16	17 and 18	19 and 20
Speed	5 kmph	6 kmph	7 kmph	9 kmph	6 kmph	8 kmph	9 kmph	11 kmph	11 kmph	8 kmph

Operator efficiency is found to be an average of 70% and machine efficiency and working conditions efficiency is 85%.

(ii) List the sequence of operations to be carried out during the construction of a tunnel.

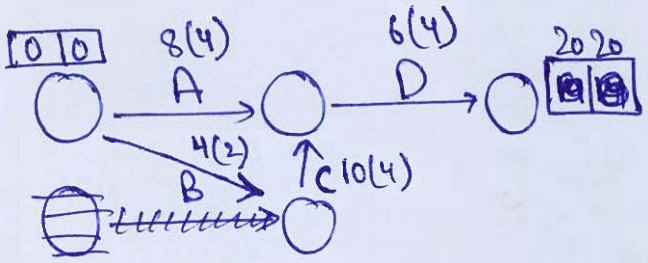
[12 + 8 = 20 marks]

Q.7 (a) *A*, *B*, *C* and *D* are the activities of a CPM network. Their normal and crash durations and associated costs are given in the table below:

Activity	Normal duration (in days)	Normal cost (Rs.)	Crash duration (in days)	Crash cost (Rs.)
A	8	6,000	4	12,000
B	4	2,000	2	14,000
C	10	4,000	4	8,000
D	6	4,000	4	8,000

For the entire project the indirect cost is Rs. 1000 per day. *A* and *B* are starting activities; *C* follows *B*; *D* follows *A* and *C*; *D* is the finishing activity. Draw CPM Network. Calculate points for PTC graph and plot the same. Determine the optimum cost and optimum duration for the project. [PTC is Project-Time-Cost-Trade-Off graph].

[20 marks]



Activities	Cost Slope $= \frac{C_c - C_n}{t_n - t_c}$ (₹/d.)
A	1500
B	6000
C	$\frac{2000}{3} = 666.67$
D	2000

Ist stage: C.P ⇒ ~~A D~~

Crash 'C' by 6 days:

Increase in Direct Cost ⇒ 6667 × 6.

⇒ ₹4000

Decrease in Indirect Cost ⇒ ₹1000 × 6

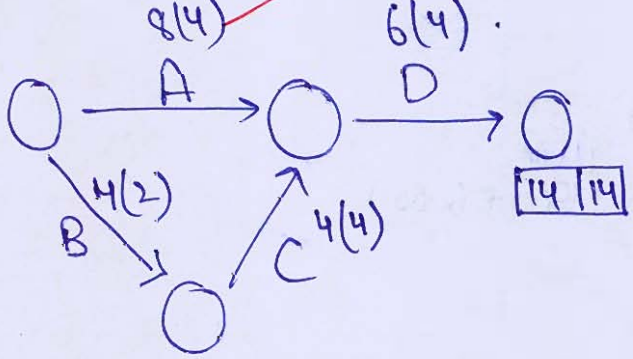
= ₹6000

Normal Cost ⇒ 6000 + 2000 + 4000 + 4000 + 20 × 1000.

⇒ ₹36000

After Crashing: 36000 + 4000 − 6000

= ₹34000



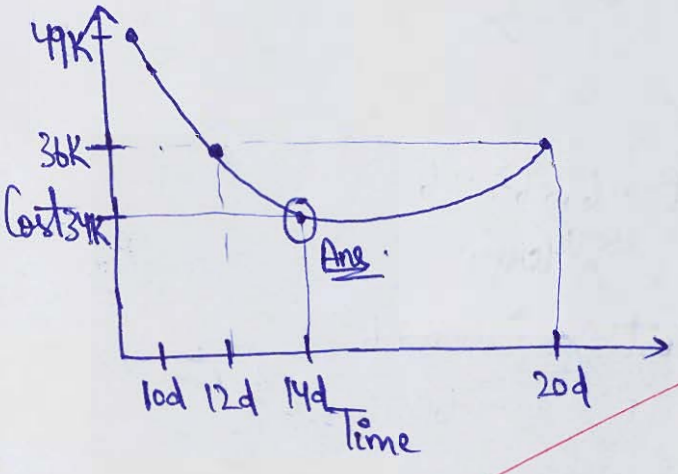
IInd stage: Either AB, AC or D.

Crash 'D' of min^m cost slope by 2d.

Cost ⇒ 34000 + 2 × 2000 − 2 × 1000.

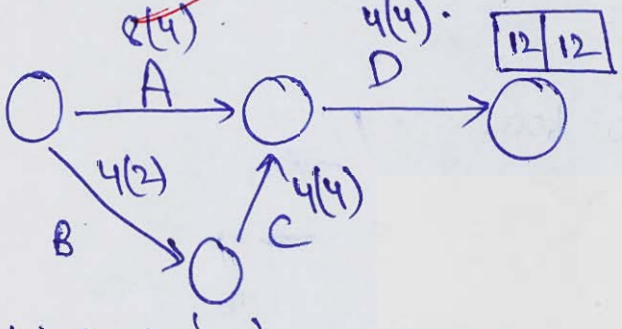
⇒ ₹36000

No further Crashing Required.



Optimum Time = 14d
Cost ⇒ 34K.

For other Points: Lets crash more.



20

Let Crash 'AB' by 2 days.

Cost ⇒ 36000 − 2×1000 + 2×(1500 + 6000)

⇒ ₹49000

Q.7 (b) (i) Write short notes on the following construction equipment:

1. Clamshell
2. Hoe

(ii) What is a revised estimate and what is a supplementary estimate? In what contexts are they respectively prepared?

(iii) What is 'escalation' in the context of construction contracts?

(iv) What is EPF in the context of welfare measures for construction workers?

[4 + 8 + 4 + 4 = 20 marks]

(1)

1. Clamshell : It is an excavating equipment which works like Crane and Power shovel.

→ It can do vertical excavation.

2. Hoe : It is an equipment used for digging in backward direction

→ Also known as Back hoe

(11) Revised Estimate is an estimate prepared after Preliminary estimate when there is a variation of more than 10% in cost of estimate.

- Revised estimate considers more precise cost of materials, works other than the Plinth Area Rate Basis.
- Supplementary estimate are required when there is some addition of components or some revision/ deviation from the original plan.
- Revised and Supplementary may resemble the same but are distinct in their nature & the period of formation.
- Revised Estimate is almost necessary to prepare as Cost may deviate & not be accurate acc. to Plinth Area so Cubic Rate Basis & other approaches may be adopted.
- Supplementary Estimate are prepared as the Project demands not compulsorily.

(iii) 'Escalation' refers to change in the price of commodities mentioned in the Bill of Quantities & as quoted by contractor.

- The causes of Escalation can be any strike, War, disruption in supply chain network.
- In these circumstances, Contractor can ask for re-escalation in the prices of material

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Q.7 (c) (i) Define contracts. What are essentials of a contract?

(ii) Explain in detail Economic Order Quantity (EOQ)?

[12 + 8 = 20 marks]

(1) Contracts are defined as an aggrement enforcable by law as to Indian Contract Act 1872.

- Contracts can be oral, written but is binding on the individual, entity which is in play.
- Before contract is issued various other documents & money deposits are taken to check the suitability of a contractor
- like Earnest Money Deposit, Security Deposit and Letter of Aggrement.
- There are various essentials of a contract like

→ Both the parties should mutually aggree to the terms & conditions issued under it.

→ Contractor can't violate any provision once it is enforced.

→ An Arbitration can take place for any dispute or clarity on any matter.

→ There is a provision of force Majeure Clause for the benefit of contractor.

→ Certain amount of money is not given even after completion of work so as to check the quality & given under contract

→ It should not be null or void.

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(11) Economic Order Quantity is the Quantity which can be ordered so that that cost of ordering and holding is the least.

Example: Let 'Q' is the quantity Purchased.
'Ch' is holding Capacity
'Co' is ordering Capacity
'D' is total Demand.

Then Total Inventory Cost (TIC) $\Rightarrow \frac{D}{Q} C_o + \frac{Q}{2} C_h$.

$TIC_{min^m} \Rightarrow \frac{d(TIC)}{dQ} = 0 : \quad \frac{-D}{Q^2} C_o + \frac{C_h}{2} = 0$

$$Q^* = \sqrt{\frac{2DC_o}{C_h}}$$

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- It minimizes the losses and lead time becomes effective

Q.8 (a) For an asset having initial cost of Rs. 2 lakh and a salvage value of Rs. 50,000 at the end of economic life of 5 years, determine the annual depreciation and the book value at the end of each year during economic life of asset from the following methods:

(i) Straight line method

(ii) Sum of declining digit method

(iii) Double decline balance method

(iv) Sinking fund factor method

(Assume rate of interest for sinking fund as 8%.)

[20 marks]

(1) $D \Rightarrow \frac{C_i - C_s}{5} = ₹30000$

D → Total Depreciation

$D_1 = D_2 = D_3 = D_4 = D_5 = ₹30000$

$B_1 = C_i - D_1 = 1.7$ Lakh.

$B_2 = 1.4L$

$B_3 = 1.1L$

$B_4 = 80K$

$B_5 = 50K$

(ii) $x = 1 - \left(\frac{C_s}{C_i}\right)^{1/n} = 0.242$

$B_1 = 200000\,(1-0.242)$

$= ₹151600$

$D_1 = ₹48400$

$B_2 = 2L(1-0.242)^2$

$\Rightarrow 1.149L$

$D_2 = 0.8508L$

$B_3 = 2L \times (1-0.242)^3$

$B_3 \Rightarrow 0.8710L$

$D_3 = 0.2779L$

$B_4 = 0.66L$

$D_4 = 0.211L$

$B_5 = 50K$

$D_5 = 0.16L$

(iii) $x = 2/n = 2/5 = 0.4$

$B_1 = 200000 \times (1-0.4)$

$\Rightarrow ₹120000$

$D_1 = ₹80000$

$B_2 = 2L(1-0.4)^2$

$\Rightarrow 72K$

$D_2 = 48K$

$B_3 = 0.432L = 43.2K$

$D_3 = 28.8K$

$B_4 = 0.2592L$

$D_4 = 0.1728L$

Actual $D_3 \Rightarrow 22K$ only

as $C_s > B_3$.

So don't find other.

(iv) $D \Rightarrow (2L - 0.5L) \times \frac{i}{(1+i)^n - 1}$

$\Rightarrow 0.2557L$

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$D_1 = D(1+i)^{n-1}$ where $n=1$

$D_1 = D = 0.2557L$

$B_1 = 1.7443L$

$D_2 = 0.2762L$

$B_2 = 1.4681L$

$D_3 = 0.2982L$

$B_3 = 1.17L$

$D_4 = 0.3221L$

$B_4 = 0.8479L$

$D_5 = 0.3478L$

$B_5 = 0.50L \Rightarrow 50{,}000$

Q.8 (b) (i) On a road project, a power shovel is to be used for the excavation of 296000 cum (BMV) of common earth. The ideal output of a power shovel with 0.955 cu. m bucket is 126 cum/hour. The depth-swing correction factor and job-management factor can be taken as 0.86 and 0.80 respectively. Assuming 42 working hours per week and operating time per year as 46 weeks, find the time required in years to complete the project. Also find the number of power shovels needed with above specifications if the same work is to be completed in 1000 working hours.

(Assume operating efficiency as 45 min/hour)

(ii) List down the factors which affect the selection of a construction equipment. How will you determine the economic life of an equipment? Explain with the help of a suitable example.

[10 + 10 = 20 marks]

(11) Easily Available
Cost Effective.
Easily Replacable
Lesser Maintainence.
Some Scrap value.

2

c) Discuss the various methods of tunneling in hard rocks and their advantages and disadvantages (if any).

[20 marks]

Various methods of tunneling in Hard Rocks are;

• Drift Method →

→ In this method a drift is made anywhere in the cross-section of tunnel & then full length is excavated.

→ It is suitable upto 3m diameter cross-section.

Advantages & Disadvantages :

→ For longer & Broad diameter it is not suitable.

→ Ventilation is there as whole length is excavated.

→ Drift can be located anywhere, at the ends, centre or top, bottom so suitable.

• Heading and Benching Method →

→ In this first a ~~bench~~ head portion of the tunnel is excavated & then bench portion.

→ The method derive its name from the fact that a bench shape is seen at intervals when only benching/heading is excavated.

Advantage & Disadvantage

→ Mucking and Blasting can be simultaneously carried out

→ Good method for non-cohesive cross-section types.

→ Though ventilation problem is there but still very effective from workers point of view.

Full-Face Method :

→ Here full face of the cross-section is attacked at once.

→ Mucking cannot be simultaneously taken out so trolleys are there to carry.

Advantages & Disadvantage

→ There is problem of Ventilation.

→ Extra care is required as full face is attacked so shoring is required before blasting.

→ Can be used for smaller cross-section.

Conclusion: There are various methods of tunnelling in hard rocks but as far as ventilation is concerned Drift is preferred & when simultaneous work is desired, Heading & Benching is preferred

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Space for Rough Work

Space for Rough Work

Space for Rough Work

Space for Rough Work

Space for Rough Work