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	35
Q.2	
Q.3	38
Q.4	
Section-B	
Q.5	48
Q.6	
Q.7	50
Q.8	42
Total Marks Obtained	213

Signature of Evaluator: Sheryas

Cross Checked by: .....

Keep 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.

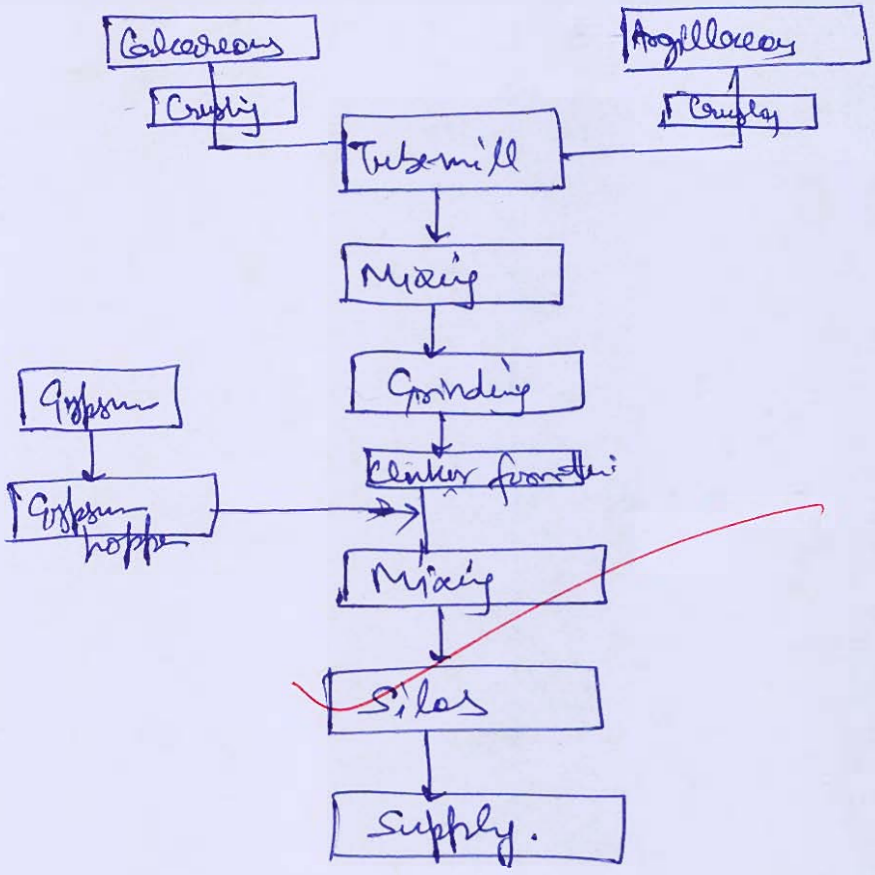
DO'S

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]



+ Dry process is cheap.
+ Calcareous & argillaceous material are crushed and mixed in tube mill.
+ Proper mixing is done followed by grinding
+ Gypsum is added to prevent flash set of Cement due to formation of C_3A
+ After formation of clinker, Gypsum is added and throughly mixed.
+ It is stored in silos and then supplied as per requirement.

09

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 :- It is time elapsed since water is added to cement to time when cement start losing its plasticity, in other words, it is time taken by cement paste to loose its plasticity. in vicat apparatus when needle is allowed to pierce to point (5 to 6mm) above the bottom of mould,

And setting time : It is time Elapsed since water is added to cement to time when cement has lost plasticity and gaining strength. In other words, it is time taken by cement paste to lose its plasticity in vicat apparatus when annual core is failed to mark an impression on paste/ mould.

07

For OPC, it is 30 min → I.S.T.

600 min → F.S.T.

Q.1 (c) Differentiate between seasoning of timber and preservation of timber. Explain any two methods of each of them.

[12 marks]

Seasoning refers to reduction of water Content in timber to prevent its decay and increase life and dimensi and stability of timber and to increse density of timber.

→ It Can be ① Natural Seasoning
② Artificial Seasoning

- Kiln Seasoning
- Chemical Seasoning
- Electric Seasoning

① Natural Seasoning: It is cheap, easy and less-skilled supervision is required

2) timber are placed in log in alternate course perpendicular to each other.

3) Different amount of moisture content obtained in every timber

4) More time consuming

② Electric Seasoning: ① Costlier timber obtained.

Timber is passed by alternating DC current to reduce moisture content

→ Initially, resistance is less due to more moisture content.

2) but resistance increases with dryness of timber.

08

Preservation: refers to application of chemical / ~~pesticide~~ / insecticide to timber to prevent its decay, and increase its life.

→ It is done to increase life of timber & to prevent it from Dry Rot, wet Rot

1) ASCu treatment: 6 part by weight of ASCu by 100 part by weight of water to render timber insect proof

ASCu ($As_2O_5 \cdot 2H_2O$: $CuSO_4 \cdot 5H_2O$: $K_2Cr_2O_7$)

2) Creosoti Oil: It is applied over timber to prevent its decay

1) It is non-toxic, non-corrosive, good against termite & insect.

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) Impurities:

1) Magnesium Carbonate :- It reduces slaking of lime and decrease its hydraulicity

2) Sulphide :- It should be avoided as it increase setting time

3) Alkali :- It should not be present as it causes more setting time.

4) Pyrites :- Should not be present as it infers in slaking operation.

(ii).

(A) Class A lime (Hydraulic lime) :

1) have strength around (1.75 N/mm² to 2.80 N/mm²).

2) High compressive strength

3) Resistant to atmospheric action

4) Suitable for Masonry work

(B) Class B (lime) :-

1) have strength less than 1.5 N/mm²

2) Suitable for normal brickwork.

3) Resistant to atmosphere but vulnerable to attacks

(C) Class C line (fat lime):

1) require CO_2 for setting action
2) not suitable in damp situation and underwater condition
3) when added with water, high volumetric increase or slaking action takes place
4) suitable for plastering work

(D) Class D-line (poor lime):

1) have poor hydraulic properties
2) Not suitable for masonry work.

10

(E) Class E line (Hydrated lime)

1) have slow slaking action
2) poor hydraulic property
3) very less compressive strength

(F) Class F line (Ca based lime)

1) generally avoided in construction work
2) minor compressive strength
3) Not suited for plaster work.

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) It has more adhesion

(2) Surface to be prefared smooth

(3) surface should not have undulated/swelling

1

(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]

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]

(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

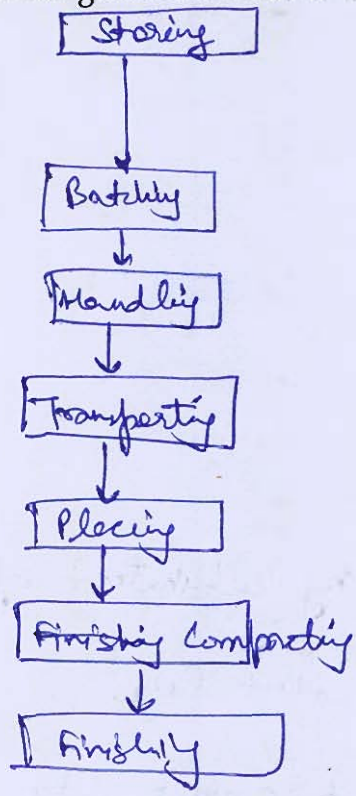
(ii) Differentiate between bound water and gel water, and explain their roles in hydration of cement.

[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]



Storing :- Material are stored as per specification

Batching :- Material are mixed as per design mix

Handling :- It is then handed over to Client for dep.

Transporting :- transported through suitable transit mixer additives added.

Placing :- placed suitably at required place

Compacting :- Compaction done through vibrators

Finished :- After Compaction, it is finished.

Cil lime is obtained by calcination of $CaCO_3$

$$CaCO_3 \longrightarrow CaO + CO_2$$

When water is added, it convert into hydraulic lime ($Ca(OH)_2$. It is generally environmental friendly material.

→ In historical building, lime was used as binding material as it is non-toxic, and non-poisonous.

→ It sets slowly by absorbing CO_2 (in case of fat lime)

→ Hydraulic lime has high compressive strength (upto 2.8 N/mm²) and when mixed with 20% PPC, resemble natural Cement

- It has less skilled supervision required
- cheap, durable and easily available
- high compressive strength
- prevent rain penetration and donot absorb moisture
- has good adhesive bond
- act as good binder
- is non toxic, non corrosive.

07+6

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]

(i) Good building Stone

(1) Specific Gravity > 2.7

(2) Should have sharp clear fracture.

(3) Compressive Strength > 1000 N/mm²

(4) coefficient of hardness > 13

(5) coefficient of toughness > 19 (for hard stone)

< 13 (Rejected)

(6) Should have fine crystal texture

(7) Should not have water absorption > 0.6% by weight in 24 hours

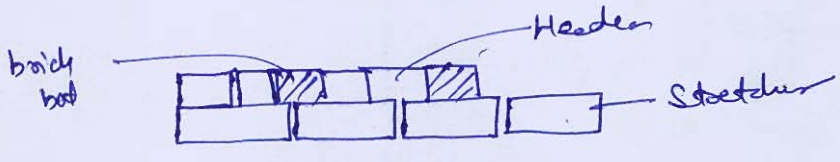
(8) Should have less impact value, less crushing value

(9) Should not have more calcium carbonate.

(ii) English bond : Strongest bond

1) formed of Stretcher and header in alternate course

2) to avoid verticality of joint, half-brick bat provided



English bond

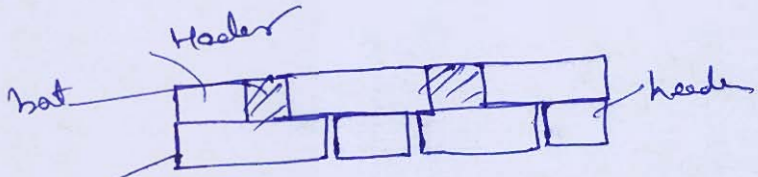
3) available in all thickness greater than full width.

(iii) Flemish bond :

1) Formed of Stretcher and header bond in same course.

2) It is less stronger than English bond

3) It has good appearance than English bond



→ It has Steigth of English bond and appearance of flemish bond

(iv) Double flemish bond :

1) formed of Stretcher and header bond in same course

2) Used for wall thickness > 1.5 B.

3) It has best appearance in bond.

(iv) Dutch bond:

+ It has poor strength
+ Not suitable for masonry work.

6+7

(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]

(a) plastering is done

(1) to safeguard the masonry from harsh environment

(2) to prevent voluminous expansion/swelling of brickwork

(3) to maintain joints in situ and prevent its degradation.

(b) type of plaster :-

1) It can be 6mm plaster (thickness) over RCC structure like columns

2) It can be 12mm thick plaster & 15mm thick plaster

Plaster can be Cement based, lime based, Gypsum based, in multiple thickness.

(iii) Defect:
(1) It may be due to inadequate quantity of material used
(2) poor workmanship
(3) Inferior quality of material used.
(4) More time is taken for applying plaster after losing mix plasticity.
(5) Improper mixing of various ingredients of plaster

(iv) Characteristics:
1) It should have strength.
2) It should be cheap, easily available
3) semi skilled person can apply this plaster
4) It is Envt. friendly and took. less properties thus
5) It should be non toxic, nonodourless and apply in multiple layer
6) should absorb water.

(v) Gel Space ratio = $\frac{0.67\alpha}{0.319\alpha + \frac{w_0}{\rho_w}}$

$\frac{w}{c} = 0.48$

all full hydration $w_0 = 450 \times 0.48 = 216$

$$y = \frac{0.67 \times 450}{0.319 \times 450 + 216}$$

$$y = 0.822$$

(iii) If 25% hydrated

$w_o = 0.25 \times 450 \times 0.48 = 162\text{gm}$

$\gamma = 0.967$

G+6

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]

(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]

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

(ii) Differentiate between thermosetting and thermoplastic resins.

[10 + 10 = 20 marks]

Section B : Planning and Management + Tunnelling

(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

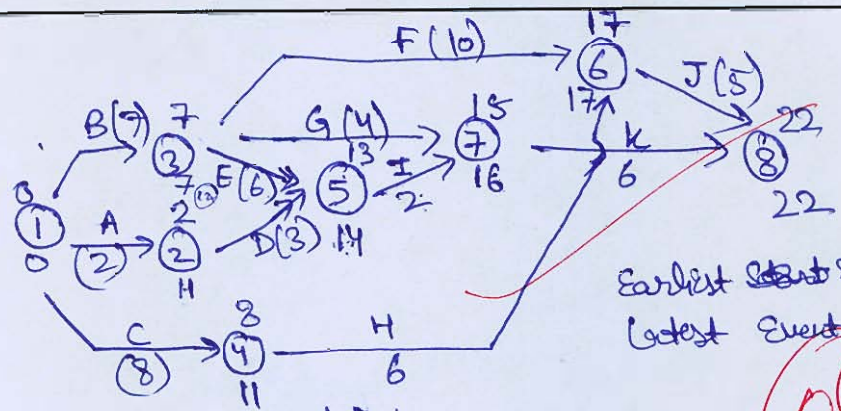
(ii) Earliest and latest start time

(iii) Earliest and latest finish time

(iv) Total, free and independent float

(v) Critical path

[12 marks]



Earliest Event time (EVT)
Latest Event time (LVT)

06

Act	t	EVT	LVT	EST	EFT	LST	LFT	F_T	F_F	F_D
A	2	0	2	0	2	0	11	9	9	9
B	7	0	7	0	7	0	7	0	0	0
C	8	0	8	0	8	0	11	3	3	3
D	3	2	13	2	13	11	14	9	8	
E	6	7	13	7	13	7	14	1	1	
F	10	7	17	7	17	8	14			
G	4	7	15	7	15	7	16			
H	6	8	17	8	17	11	17			
I	2	13	15	13	15	14	16			
J	5	17	22	17	22	17	22			
K	6	15	22	15	22	16	22			

Do work on the concept

Critical path is 1 – 3 – 6 – 8 (22 days)

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]

(i) Liquidated damages refers to loss in profit of firm due to non-fulfilment of milestone, poor quality of work, delay in completion of project. This covers under outage loss of indirect cost of project and renders firm accountable to project/ agreement terms & conditions.

(ii) Tender drawing & working drawing :

Tender drawing : When ~~Cost~~ tender is invited, contractor is asked to well-versed with

drawing of ~~tender~~ ~~to be~~ of work of tender to be executed and understood well for execution.

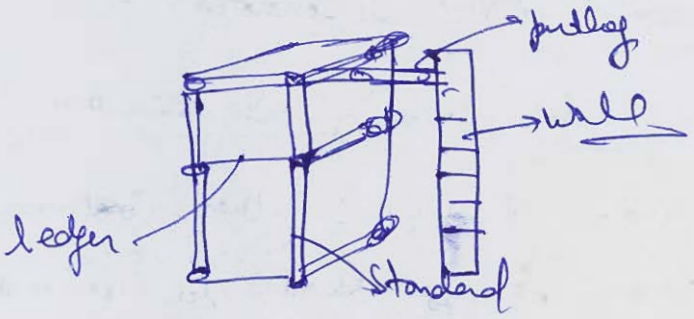
with percentage Rate Contract: It is contract awarded by govt agencies. Schedule is floated on website and Contractor is asked to quote rate of all items of contract either above or below in percentage to carry out work.

→ If Contract quote rate above than Estimated Cost, it is called Above-percentage Rate Contract and Comparative analysis is prepared ~~to~~ of before awarding of work to lowest tenderer(L1).

(v) Scaffolding: is combination of ledger and putlog and standard.

→ It is used to execute work when it is out of range such as greater height more than 6m.

→ It can be wooden based or steel based.



When scaffolding used is single framed, it is called Single Scaffolding and when double frame is used, it is double Scaffolding

(iv) Turnkey Contracts: When contractor has upper hand to execute contract i.e. Contractor can use value engineering to execute work from starting to end. and when work is finished, it is handed over to client or keys given to client at end of work, hence, called turnkey Contracts

08

.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]

(ii) Slack : Slack refers to difference between latest allowable Event time (T_L) and Earliest Started Event time (T_E)

$$S = T_L - T_E$$

Negative slack refers that project is running behind schedule and material resources available are not adequate enough to complete/execute event on time.

Choice A :

(ii) $$A = \frac{4000}{(1.05)^0} + \frac{4000}{(1.08)^{20}} + \frac{4000}{(1.05)^{40}} + \frac{4000}{(1.05)^{60}}$$

$$A_A = \text{Rs } 6289.88$$

12

Choice B :-

$$A = \frac{6000}{(1.05)^0} + \frac{6000}{(1.05)^{40}}$$

$$A_B = \text{Rs } 6852.27.$$

Since $A_A < A_B$, So, choice A is most Economical

5 (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) $Z = \frac{T_S - T_E}{\sigma}$ $\sigma = 3$ months (Given) $T_E = 15$ month (Given)

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

So, probability = 50%. Ans

(ii) 21 months

$Z = \frac{6}{3} = +2.$

So, probability = 97.72%

(iii) $Z = \frac{12-15}{3} = -1$

So, probability = 15.87% A

(iii) Advantages:

(1) Event have no place, not suitable for Pert.

(2) Pre and post operation activities can be carried out Easily.

(3) System ~~Enable~~ is self sufficient, All activities that are written in box, enable controlling in efficient ways

(4) Dont have dummy activity 6+4

(5) Review and modifications can be carried out easily

5 (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	–		

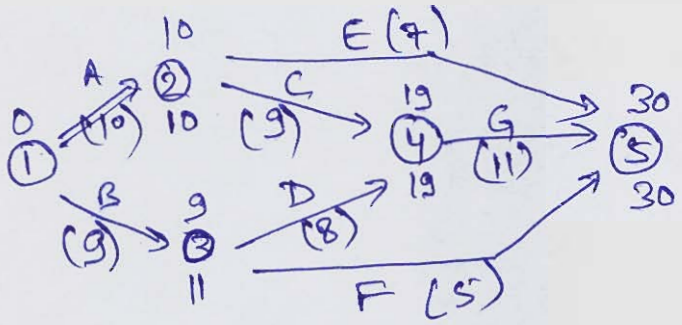
The time estimates (in days) for each activity are as given below.

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]



Network diagram

Expected time (t_A) = $\frac{t_o + 4t_m + t_p}{6}$ = 10 days

Similarly, B = 9 days.

So, Critical path is 1 – 2 – 4 – 5.

T_E = 30 days.

T_S = 35 days.

$\sigma = \sqrt{\sigma_A^2 + \sigma_C^2 + \sigma_G^2}$

$\sigma_A = \frac{t_p - t_o}{6}$ = 2 days

σ_C = 3 days

σ_G = 3 days

$\sigma = \sqrt{4 + 9 + 9}$ = 4.69 days.

(12)

$Z = \frac{T_S - T_E}{\sigma} = \frac{5}{4.69} = 1.066$

$\frac{x - 84.13}{86.43 - 84.13} = \frac{1.06 - 1.0}{0.1}$

So, probability = 85.5% ✓ A

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

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

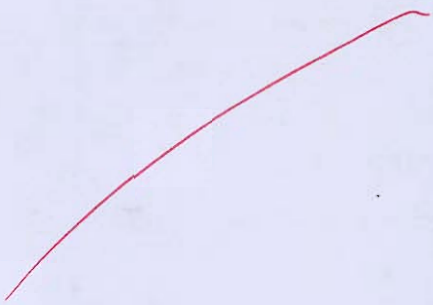
(iii) List the factors which affect output of a dragline.

[20 marks]

6 (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

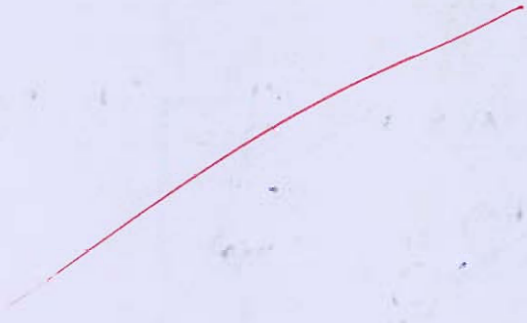
Details of speed on each two successive passes:

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]

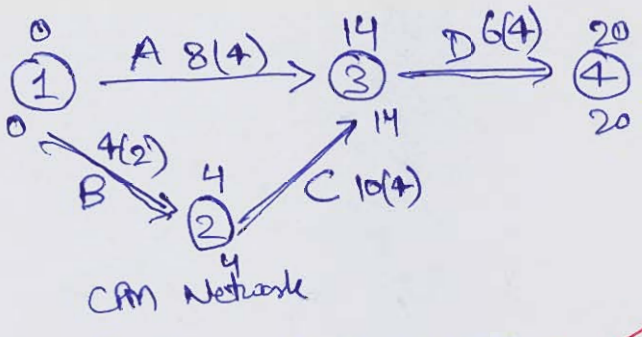


Q.7 (a) *A*, *B*, *C* and *D* are the activities of a CPM network. Their normal and crash durations and associated costs are given in the table below:

Activity	Normal duration (in days)	Normal cost (Rs.)	Crash duration (in days)	Crash cost (Rs.)	$(\Delta C/\Delta T)$
A	8	6,000	4	12,000	1500
B	4	2,000	2	14,000	6000
C	10	4,000	4	8,000	666.66
D	6	4,000	4	8,000	2000

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]



So, Critical path is 1-2-3-4,

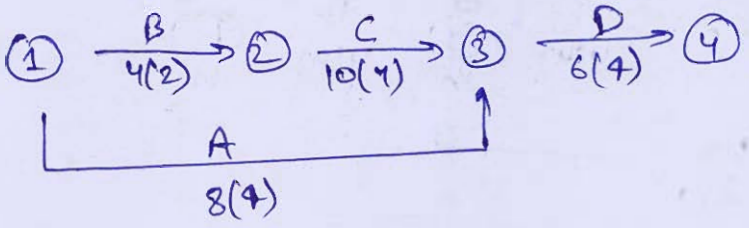
Project Duration (PD) = 20 days

Direct Cost (DC) = Rs 16,000

Indirect Cost (IC) = Rs 1000×20 = Rs 20,000

Total Cost (TC) = Rs 36,000

Point (A)



Time Scale Diagram

Style-1 Crashing (from fig.)

Cost Slope of B = 6000 Rs

C = 666.66 Rs

D = 2000 Rs

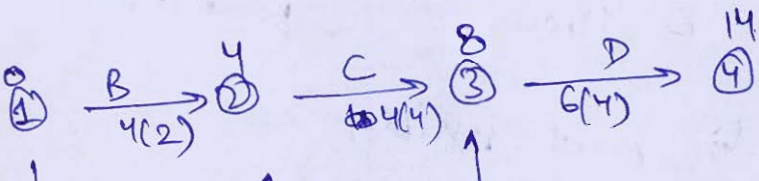
So, Crash activity C by 6-Days

New P.D = 14 days

D.C = Rs 14,000 + 6×666.66 = Rs 20,000

I.C = Rs 14×1000 = Rs 14,000

T.C = Rs 34,000 Point (B)



Style-2 Crashing

Now both 1-2-3-4 & 1-3-4 are Critical path.

So, C/s of B & A = Rs 75,00

C/s of D = Rs 2,000

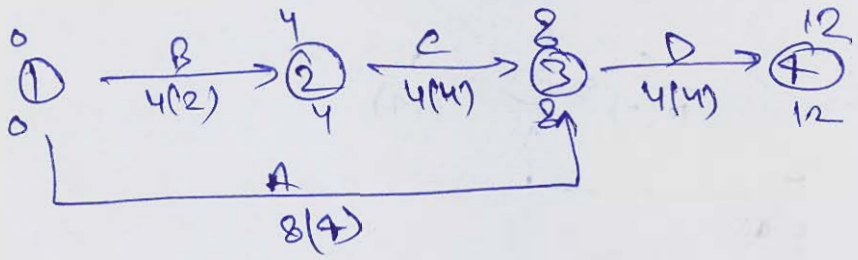
So, Crash activity D by 2-days.

New P.D = 12 days

D.C = Rs 24,000

I.C = Rs 12,000

T.C = Rs 36,000 Point (C)



Step-3 Crashing:

Now both 1-2-3-4 & 1-3-4 are critical activity

Since C & D can't be crashed,

So, crash activity (B & A) by 2 days,

Cost slope of B & A = Rs 75,000

New P.D = 10 days

D.C = Rs 24,000 + 15,000 = Rs 39,000

I.C = Rs 10,000

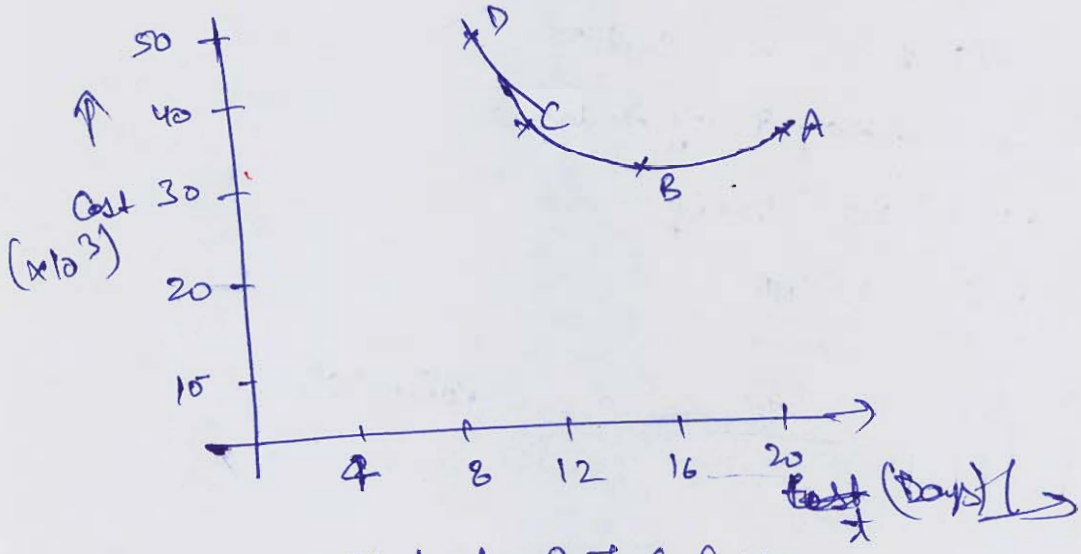
T.C = Rs 49,000. Point D

Further crashing is not possible,

So, optimum cost = Rs 34,000

optimum duration = 14 days,

20



Plot of P-T-C Curve

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]

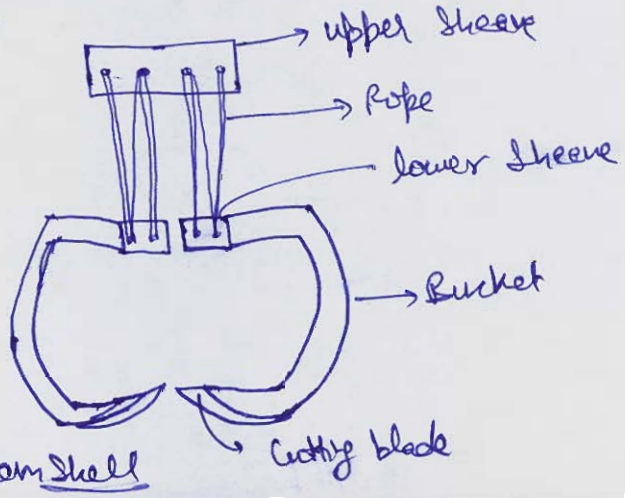
(i) Clamshell :- is Earth Excavating / Shifting / Transporting Equipment.

→ It is combination of Dragline and Crane.

→ It is used to lift muddy / soft / wet Earth or rocky debris.

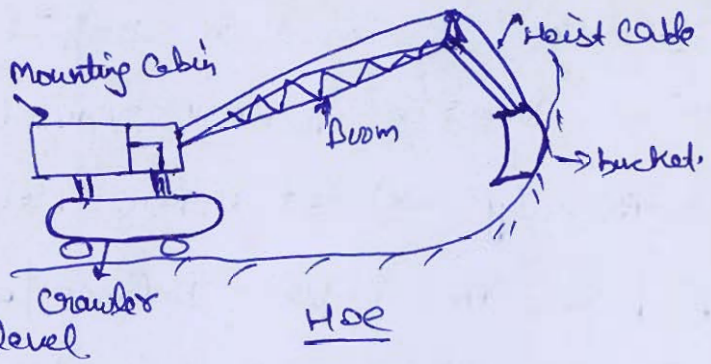
→ It can be Electric operated or diesel operated.

→ Available in different size of bucket



Clamshell

② Hoe:-



Hoe

① It is used to dig/ Excavate Earth below footing level or ground level

① It Consist of Mounting Cabin, Crawler, Boom, Bucket, Hoist Cable

② It work efficiently in close range to excavation.

④ It can excavate efficiently when boom is at right angle to excavation.

⑤ It is can be electric operate or diesel operate.

⑥ Works well in muddy areas / Rocky formations since it has greater floating power.

⑦ Available in multiple sizes such as $1 cuft^3$, $1.5 cuft^3$, $2.5 cuft^3$ etc

(iii) Revised Estimate :- refers to estimate prepared in supersession to earlier preliminary estimate given due to major change in scope of work, Quantity Execution or change in drawing of project.

→ It is given to client to let him know the expected expenditure of project is likely to increase because of additional scope of work to be executed.

Supplementary Estimate :- It is estimate prepared in addition to preliminary estimate because earlier,

Estimate was based on original scope of work in which quantity of work required to be done additionally werenot taken. Hence, this estimate is prepared to complete balance/unforseen work which can't be completed in running tender.

(iii) Escalation refers to increase in cost of labour and material in projects having time greater than one year.

This clause is provided to cope-up with rising prices of material and wages of labour which may ~~as~~fluctuate during course of execution of project.

→ Any additional liability on part of increase in prices may have severe ~~effe~~ impact on quality/quantity of work since contractor will try to runaway or reduce quality due to price enhancement. Hence, this clause inserted to protect contractor without any impact on project quality

(iv) EPF is employment provident fund and it is given to temporary construction worker to protect their future by contributing some amount (generally 13% of labour wages per month) by employer and 12% deducted from salary of worker.

→ This protect worker in case some unforeseen accident happen with worker. So, it act as pension to worker and worker can withdraw amount whenever they wish to.

→ It is similar to National provident fund Scheme (NPS) framed by Govt. Sector to Regular Employees of Govt.

4+6+3+3

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

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

[12 + 8 = 20 marks]

Contract Refer to agreement executed between two parties and executed before law. It is final and binding on both parties

→ Contract Can be :

1) Lumpsum Contract
2) Bill of Quantity Contract
3) Schedule of Quantity Contract
4) Item Rate Contract
5) Cost plus percentage Contract

→ Essentials :

① ~~Both~~ Each party should be of sound mind in view of law.

② Each party should have proper Govt. registration, licence,

③ Each party should have insolvency certificate

④ Each party should have valid GST registration, EPF, ESI Certificate registration.

⑤ Both party should abide by terms and condition of agreement and all clauses as per rules & regulations of firm / Govt.

(a) Economic Order Quantity refers to quantity that is always available and there is no empty of stock.

It is given by $EOQ = \sqrt{\frac{2DC_o}{C_h}}$

C_o = Cost of ordering stock

C_h = Cost of holding stock

→ Certain stock should always be available in factory to account for any shortage.

→ there is no-lead time.

8+6

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]

(i) Straight line method :-

$C_i = 2,00,000$ Rs , $n = 5$ years

$C_S = $ Rs $50,000$, $i = 0.08$

Depreciation $(D) = \frac{C_i - C_S}{n} = 30,000$ Rs/annually. $= D_1 = D_2 = D_3 = D_4 = D_5$

Book value: $(B_1) = C_i - D_1 = 1,70,000$ Rs

$B_2 = B_1 - D_2 = 1,40,000$ Rs

$B_3 = B_2 - D_3 = 1,10,000$ Rs

$B_4 = B_3 - D_4 = 80,000$ Rs

$B_5 = B_4 - D_5 = 50,000$ Rs

(ii) Sum of Declining Balance digit Method :- $FDB = 1 - \left(\frac{C_S}{C_i}\right)^{1/n}$

$= 0.242$

Depreciation (D_1) = $C_i \times FDB$ = ₹48,400

Book value (B_1) = $C_i - D_1$ = ₹1,51,600

D_2 = ₹3,66,87.2 = $B_1 \times FDB$

B_2 = ₹1,14,912.8

D_3 = ₹27,808.89

B_3 = ₹87,103.91

D_4 = ₹21079.15

B_4 = ₹66024.76

D_5 = ₹15977.99

B_5 = ₹50,000

17

avoid Calculation Error

(c) Double declining Balance Method:

$FDDB = \frac{2}{n} = 0.4$

$D_1 = C_i \times FDDB$ = ₹,80,000

$B_1 = C_i - D_1$ = ₹1,20,000

$D_2 = B_1 \times FDDB$ = ₹48,000

$B_2 = B_1 - D_2$ = ₹72,000

$D_3 = B_2 \times FDDB$ = ₹28,800

$B_3 = B_2 - D_3$ = ₹43,200

$D_4 = B_3 \times FDDB$ = ₹17,280

$B_4 = B_3 - D_4$ = ₹25,920

$D_5 = B_4 \times FDDB$ = ₹10,368

$B_5 = B_4 - D_5$ = ₹15,552

(d) Sinking fund: $D = (C_i - C_s) \times \left[\frac{i}{(1+i)^n - 1}\right]$ = 25,568.46

$D_m = D(1+i)^{m-1}$

D_1 = 25568.46 , $B_1 = C_i - D_1$ = ₹174431.54

D_2 = 27613.96 , $B_2 = B_1 - D_2$ = ₹146817.58

$D_3 = 29823.05$, $B_3 = B_2 - D_3 = ₹\ 1,16,994.53$

$D_4 = 32,208.89$, $B_4 = B_3 - D_4 = ₹\ 84785.60$

$D_5 = 34785.60$, $B_5 = B_4 - D_5 = ₹\ 50,000$

Concept not ok

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]

Ideal output = 126 cum/hr

Available output = $126 \times 0.86 \times 0.80 = 86.688$ cum/hr

Corrected output = $86.688 \times 42\frac{h}{w} \times 46\frac{w}{y} \times \frac{45 \text{ min}}{60 \text{ hr}}$

$= 125810.912 \frac{\text{kg/year} \times \text{cum}}{\text{hr}} \cdot \frac{\text{cum}}{\text{year}}$

time req'd = $\frac{296000}{125810.912} = 2.35$ years Ans (6)

No. of power shovel =

(ii) factors affecting.

(1) Country of origin of Equipment
(2) Use of Standard Equipment
(3) ~~Versatility~~ Versatility of Equipment
(4) should be operator friendly
(5) Should be Environmental friendly. / Electric drives.
(6) type of work.
(7) Cost aspect.
(8) ~~(8)~~ type of material to be used

Economic life refers to life that equipment is running with having moderate repair and maintenance to it include Investment cost, Downtime Costs, Maintenance Cost, obsolesence cost. :P

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

[20 marks]

Tunneling : Methods are :

(1) Full face Method.

(2) NATM Method

(3) Shield tunneling Method.

(4) Norwegian Method

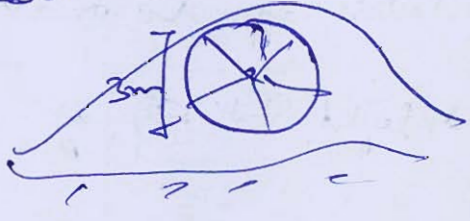
(5) Australian Method.

(6) Drift Method.

Full face Method : In this, full face is attacked at same time by explosive method.

(1) Full face is Excavated

(2) Around 3m die face is exploded



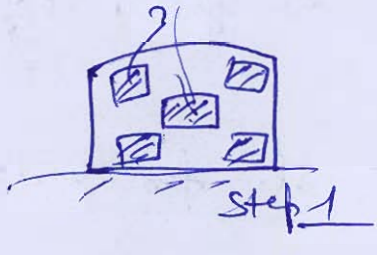
(3) quick, ~~cost~~

(4) Costlier

(5) Skilled supervision Required.

Drift Method :

(1) In this, some face is excavated and then, it is widened to obtain full face.

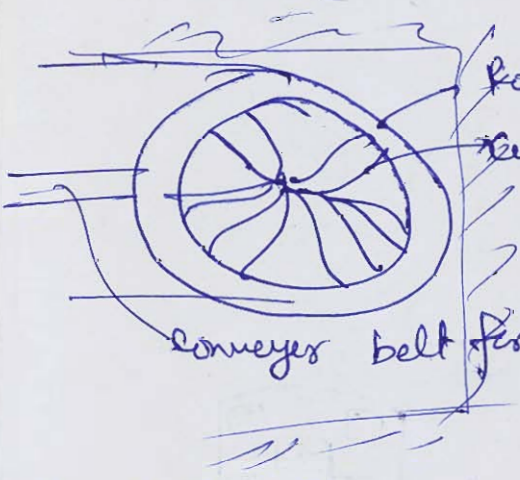


(2) Drilling & muching operation are easier

→ took more time.
→ Costlier
→ Not suitable if suitable ventilation system is not provided.

(3) NATM Method :- in this, cutting shield is rotated in forward direction and muching and transporting are carried out simultaneously

→ It is costlier
→ less time consuming
→ widely used in Delhi Metro, Indian Railways
→ Use of ventilation system is required
→ light intensity of 200 lumen is required.



→ suitable for underground drilling

(9) Shielded Method: in this, full face is attacked by shield and mucking operations are done before tunnelling

- worker life is at risk
- Costlier
- More time consuming
- Power is req. for cutting operations
- Use of ventilation System (blow in - blow out) is required.
- Suitable for tunnelling in hard rock.

12

■■■■

Space for Rough Work

Space for Rough Work

Space for Rough Work

Space for Rough Work

Space for Rough Work