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	25
Q.2	28
Q.3	
Q.4	
Section-B	
Q.5	39
Q.6	
Q.7	47
Q.8	54
Total Marks Obtained	193

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

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.

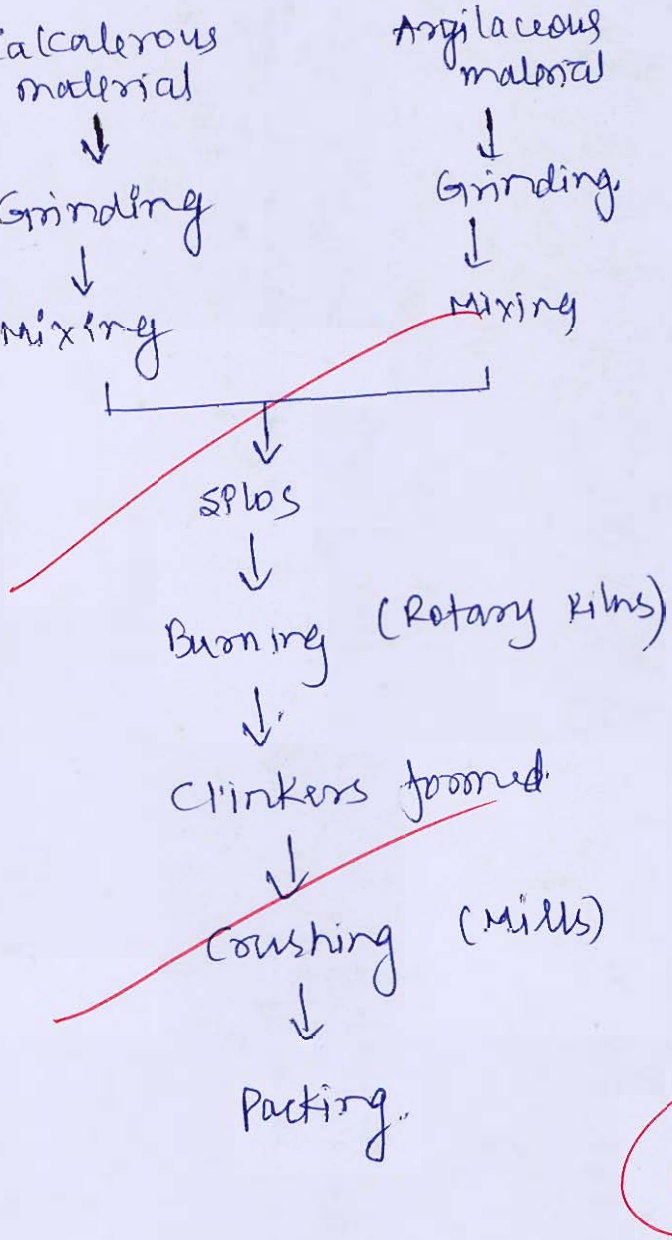
DO'S

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]



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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

In this test a cement sample is taken & IST is found by Vicat apparatus test. Then a water content 0.85P (normal consistency) is take & cement sample is made by 1:3 (cement : sand) ratio

This sample is transfered in the vicat apparatus & the plunger is lowered down, when the plunger attached with needle penetrate the sample by 5±1 mm from downward in the sample, that time is initial setting time.

For OPC, IST = 30 min

Final setting time

Some sample is left for hardening & the needle is changed with annular collar & at that time when impression

is just made that time is FST

for opc, FST = 6 hrs

9

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

[12 marks]

* Seasoning of timber :- It is a process in which water content of the timber is reduced to a certain extent so that the timber doesn't get infected with fungis or get soft after some time.

Methods of seasoning

a) Chemical Seasoning - In this method.

Timber is dipped in the chemical salts solution & left for some time & due to osmosis, water content of the timber gets reduced.

Electrical Seasoning :- In this method, Alternating currents are passed through them due to which heat is generated & water inside gets to a lower content

Preservation of timber

It is a method in which the seasoned timber is preserved from further decays or drying.

8

Methods

Charring :- Timber is placed in fire due to which at certain depth, charcoal is formed & preserves the timber

AS CU Treatment :- It is a solution made by forest institute to prevent the timber from white Ants.

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 in Lime

a) Clay

b) Silica

c) Organic impurities

d) Sulphur

e) Magnesia

f) Potash & Soda.

g) High Iron contents

1

ii) Lime can be classified as

a) Hydraulic Lime :- Low percent of pure lime used in plastering made of Kankar

b) Fat Lime :- High content of CaO
CaO > 95%

for

c) Slaked Lime.

Lean lime or poor lime :- Low content of pure lime.

Not of much use.

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]

i) proper coating should be done

ii) NO Graining should be there

iii) Sufficient opacity

iv) NO Bulk storing.

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]

w/c = 0.45

Quantity of cement = $\frac{165}{0.45} = 366.67 \text{ kg/m}^3$

vol. of cement = $\frac{366.67}{3.10 \times 10^3} = 0.1183 \text{ m}^3$

vol of water = 0.165 m^3

Total vol^n of cement + water = 0.2833 m^3

vol^m of mortar = $0.58 \times 1 = 0.58 \text{ m}^3$

vol^n of coarse agg = $1 - 0.58 = 0.42 \text{ m}^3$

vol^n of fine agg = 0.2967 m^3

Mass of fine agg = $0.2967 \times 2.68 \times 10^3$
= 795.16 kg/m^3

Mass of coarse agg = $0.42 \times 2.74 \times 10^3$
= 1150.8 kg/m^3

10

ii) Factors affecting workability

a) Size of agg :- Since coarse agg have lesser specific surface area than fine agg. the coarser aggregate will make more workable concrete if taken in equal quantity. Voids present in finer agg are more due to which water present for cement particles are less in fine agg which makes the concrete more harsh.

b) Cement content :- If there is more cement content than the max^{m} cement content the concrete will be less workable. Due to the fine nature of the cement the water is consumed by the cement which makes less water availability for the concrete

c) w/c ratio :- w/c ratio b/w 0.4 - 0.5 is best suited for workable concrete. w/c ratio less than 0.4 can make concrete less workable & greater than that can make concrete bleed or the aggregate gets separated

Entrained air :- Entrained air increases the workability of the concrete. As entrained air is composed of series of air voids which don't allow the water to get entrapped in the voids. &

5

(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]

i) Source Portland cement is made of different material like, Lime (60-65%), Silica, Alumina, Fe_2O_3, magnesia etc., When these items are mixed & heated different types of Bogues compound are made like

C_3S [Alite] → Tricalcium Silicate

C_2S [Belite] → Dicalcium "

C_3A [celite] → Tricalcium Aluminate

C_4AF [Felite] → Tetra " " ferrite

So, Due to excessive presence of C_3A & C_4AF heat of hydration occurs.

Hydration means when water is added to cement different compounds start to react with water & form C-S-H (gel) or tobermite gel.

Due to excess of C_3A, high heat of hydration is released & early set occurs

Role of Bogues compound

C_3S

Strength development :- Due to C_3S, early strength is developed due to high heat of hydration

Setting :- Major amount of Bogue compound is found for C_3S (40-50%) so it contributes in initial setting

HOH → High

C_2S

Final strength is developed

Sufficient for setting contribution (30-40%)

Low HOH

C_3A

Not much contribution in strength

Early setting

High HOH

C_4AF

NO contribution in strength

Early setting

High Rate of hydration

Portlandite

$Ca(OH)_2$ + Pozzolana + H_2O → C-S-H (gel)

Tobermite gel

CaS + H_2O → C-S-H (gel)

10

ii) Bound water :- It is the water which do not get involved in the reaction of cement particles with the applied water. It is chemically inert & bound in the structure of cement particles.

Gel water :- It is the water which takes part in hydration of cement.

Generally we take 15% of water as gel water.

3

Gel water consumes water, so it is important to consider gel water for calculating w/c ratio.

Bound water doesn't take part in hydration

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]

(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]

(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

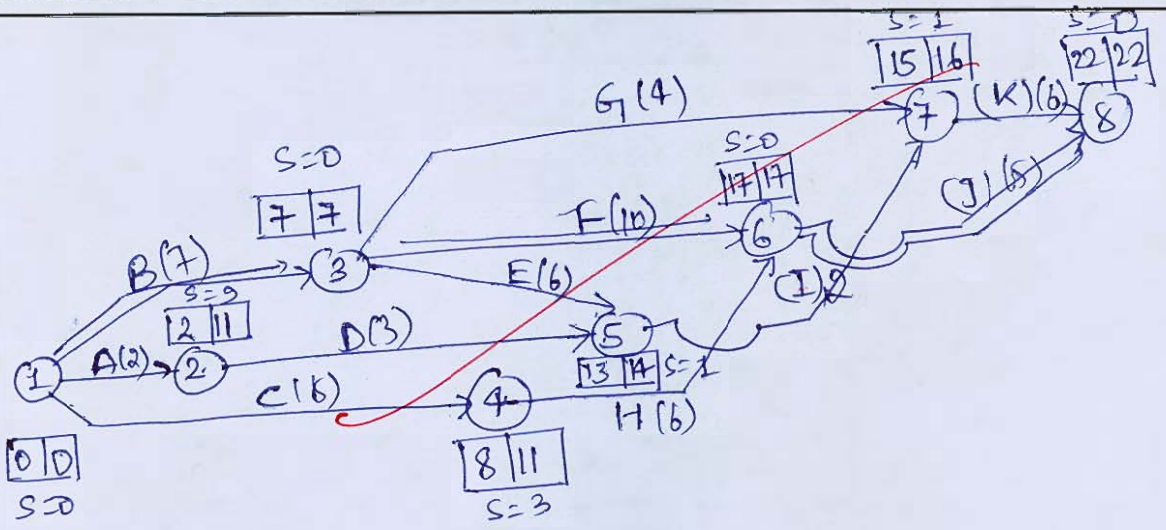
(ii) Earliest and latest start time

(iii) Earliest and latest finish time

(iv) Total, free and independent float

(v) Critical path

[12 marks]



Activity	Duration (months)	EST	EFT	LST	LFT	FT (=LFT-EFT)	FF (LFT-Sj)	(TD)i = (FF-Si)
A	2	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	16	22	1	1	0

Critical path = (B-F-J)

10

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]

Soln:

1) Liquidated damage :- These are the predetermined compensation which any party will give if any of the party breach the contract. This is done by mutual understanding by both the client & contractor. It is mentioned in contract about the compensation to be given by either of the parties

if anyone breach.

ii) Tender drawing :- It is a primiary drawing or just the layout of the site which is enclosed at the time of applying tender which gives the idea of the site where the work is going to be executed

working drawing :- It is the detailed drawing with the help of this drawing the work is executed at the site. In this prepar c/s Area & Reinforcement details is given.

iii) Percentage rate contract :- It is a type of contract that is done between client & contractor to execute the work given by the client. In this contract, the contractor gets a certain percentage of the contracted Amount as profit upon completion of work.

iv) Scaffolding :- It is a mechanism through which the Labours or the mistris work at a certain height of the building. It is combination of rods placed in vertical & horizontal direction on by which the labours reach at

certain height to do the civil work.

v) Turnkey contract :- It is a type of contract b/w client & contractor. In this the contractor do all the work without any intervention of the client & after completion of work, the client only comes to turn the key of the project to ~~start~~ inaugrate the work.

This type of contract is mainly for small type of projects

9

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.

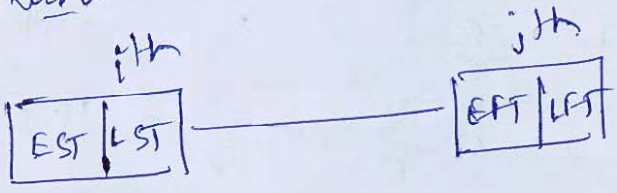
Choice B: Initial and replacement cost as Rs. 6000

Life of the component is 40 years

Money worth is 5% determine the most economical choice.

[4 + 8 = 12 marks]

i) Slack :- It is the difference b/w the Early start time and Latest start time of ith. event & also difference of EFT - EFT of jth event



$S_i = LST - EST$, $S_j = LFT - EFT$

Negative slack indicates there is insufficient time or resources to do the work.

2

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) $TE = 15$ months, $\sigma = 3$

ii) $z = \frac{TS - TE}{\sigma} = \frac{0}{3} = 0$, $P = 50\%$

iii) $z = \frac{21 - 15}{3} = 2$, $P = 97.72\%$

iv) $z = \frac{12 - 15}{3} = -1$, $P = 15.87\%$

6

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	–		

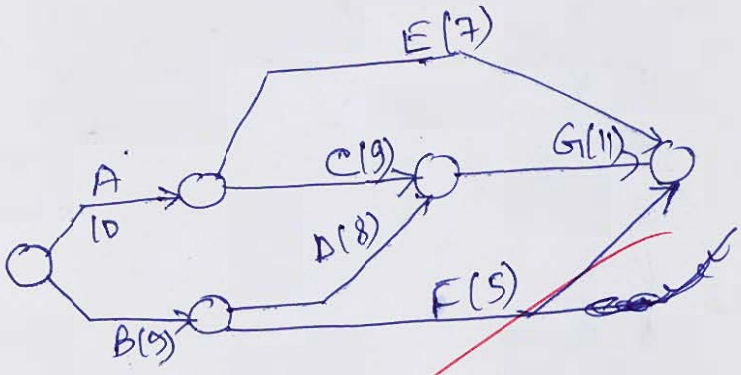
The time estimates (in days) for each activity are as given below.

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]



Activity	to	tL	tp	$t_E = \frac{t_o + 4t_m + t_p}{6}$	$\sigma = \frac{t_p - t_o}{6}$	σ^2
A	8	9	18	10	2	4
B	5	8	17	9	2	4
C	4	7	22	9	3	9
D	4	7	14	8	2	4
E	4	7	10	7	1	1
F	2	5	8	5	1	1
G	4	10	22	11	3	9

Critical path = A – C – G = 30 days

$\sigma_E = \sqrt{\sigma_A^2 + \sigma_C^2 + \sigma_G^2} = 4.69$

$T_S = 35$ days

$z = \frac{T_S - T_E}{\sigma} = 1.066$

12

By Interpolation

∴ Probability = 85.648 %

5 (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.

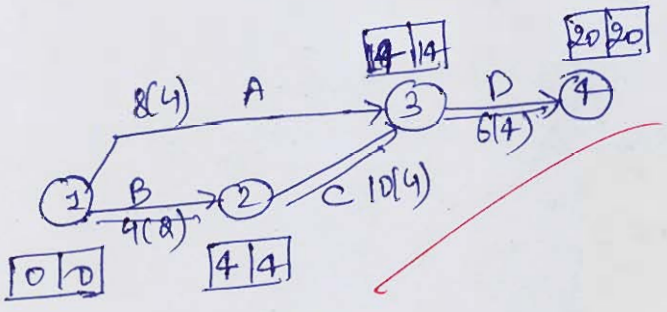
[12 + 8 = 20 marks]

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]



Activity	t_n	t_c	C_n	C_c	Cost slope = $\frac{C_c - C_n}{t_c - t_n}$
A	8	4	6000	12000	1500
B	4	2	2000	14000	6000
C	10	4	4000	8000	666.67
D	6	4	4000	8000	2000
			16000		

Total cost = 16000 + 20 × 1000 = RS 36000

(1) Crashing Activity 'C' by 6 days

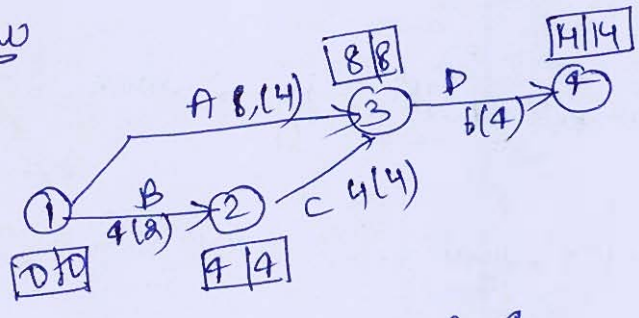
Increase in DC = 666.67 × 6 = 4000

Decrease in IDC = 6 × 1000 = 6000

Total cost = 36000 + 4000 − 6000

= RS 34000 , t = 14 days

Now



Two CP → 1 - 3 - 4

&

1 - 2 - 3 - 4

Crashing Activity 'D' by 1 day

Total cost = 34000 + 2000 − 1000 = 35000

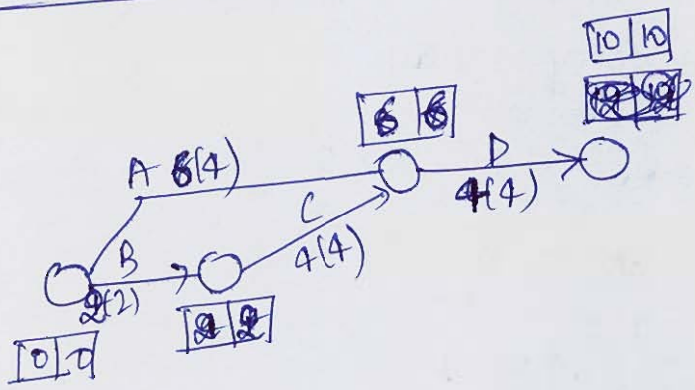
So, Cost Increases

∴ Optimum cost = RS 34000

Optimum duration = 14 days

20

Now for min^m duration



* Crashing Activity D by 2 days

TC = 34000 + 4000 − 2000 = Rs 36000

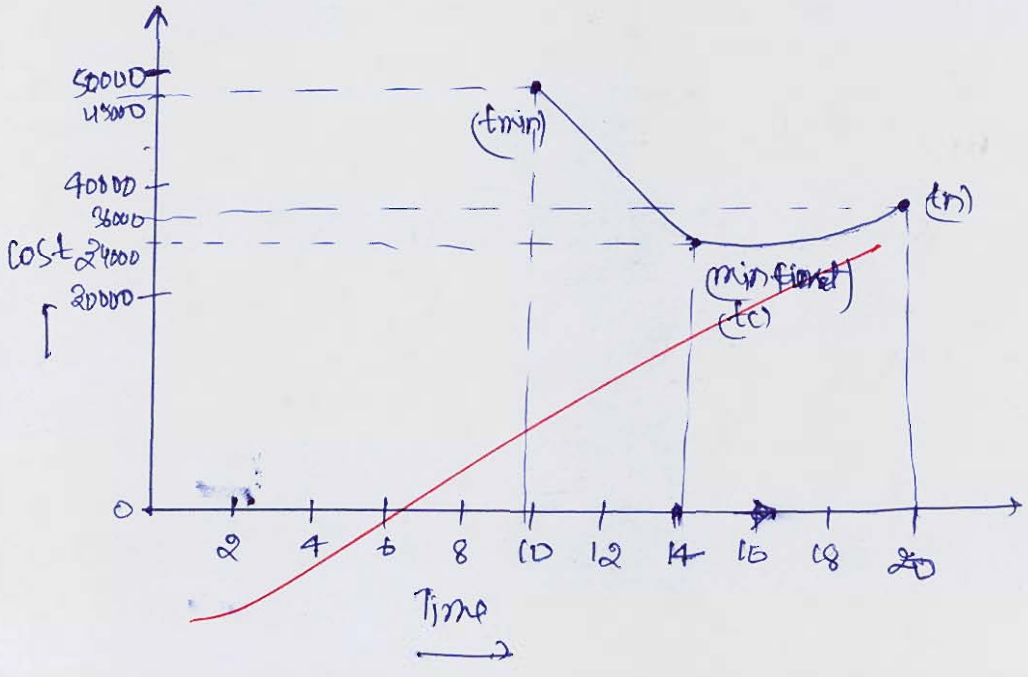
* Crashing Activity A & B both by 2 days

TC = 36000 + 2×1500 + 2×6000 − 2×1000

= Rs 49000

Max^m cost = Rs 49000

Min^m day = 10 days



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) 1) Clamshell :- It is an earth excavation equipment. This type of excavating equipment mainly do vertical excavation upto certain ~~height~~ depth. This equipment can excavate medium-hard soils.

2) Hoe :- It is an earth excavation equipment. This equipment excavate the soil from ground level to certain depth. operating efficiency

depends on cycle time, which includes loading time, unloading time, Gear shifting time etc.

Revised estimate :- It is an estimate which is made due to the unforeseen circumstances like increase in material cost, Labour cost, site modifications etc. When an earlier estimate is made & there is change in the quantities of the material or addition of new plans that estimate is called revised estimate.

For this revised estimate, Engineers have to take approval from senior authorities again & the earlier estimate will be nullified

Supplementary estimate :- This estimate is made in addition to the current estimate upon which work is going on. This estimate is made due to addition of new works in the same site or plan in which work is going on.

For this the Engineers have to also get approval from senior authorities.

3.) Escalation :- It is a clause in the construction contracts which tells about the increase in payment or wages of the labours if the economic condition changes. Due to inflation, the cost of the material can also increase & a big project can take several years to get complete & due to inflation the material cost or labour cost can increase. Then, the client had to do payment on escalated price.

4) EPf :- Employee Provident Funds

It is a welfare scheme for the employees or the labours of a company.
In this some amount of the wages of the employee is cut & some amount

from its own side company contributes to the provident fund.

A cumulative amount is saved every month for the employee for the future requirements

An Employee can use this amount at any certain time by easy withdrawal method from the goverment website.

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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]

i) Contracts :- It is a legal binding of the two parties ie client and contractor which explain the diffrent requirment of the client which contractor has to fulfill & which type of material to be used, which equipments & diffrent technology the client want to pursue during the construction.
It is formidable by the law. If any one of the parties breach the clause of the contract one can go to court for the breaching.

* Essentials of contract

i) Offer ii) Acceptance iii) Consideration

iv) legally competent parties v) meeting of minds

vi) Terms of contract vii) Purpose of construction

For contract to be secured bitween two or more parties

There must be an offer from the client to get the work completed

After that, a contractor must accept the work to do the certain work.

Both the parties should be competent enough to get the work complete.

The terms of contract should be mutually considered.

9

Economic order Quantity = $\sqrt{\frac{2DC}{H}}$

H = Holding cost

D = ordering cost

C = No of units

1

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]

Soln:

I.C = 2,00,000 , SV = 50,000 , t = 5yrs

1) Straight line method

$D = \frac{I.C - S.V}{t} = 20,000$, $B_1 = I.C - D_1 = 1,70,000$

$D_2 = 30,000$, $B_2 = 1,40,000$

$D_3 = 30,000$, $B_3 = 1,10,000$

$D_4 = 30,000$, $B_4 = 80,000$

$D_5 = 30,000$, $B_5 = 50,000$

Sum of Declining method

$$D_m = \frac{(n-m+1)}{n(n+1)/2} \times (C_i - C_s)$$

$$D_1 = \frac{5-1+1}{5\times 6/2} \times (2,00,000 - 50,000) = 50,000$$

$D_2 = 40,000$

$D_3 = 30,000$

$D_4 = 20,000$

$D_5 = 10,000$

$B_1 = 2,00,000 - 50000 = 1,50,000$

$B_2 = 1,10,000$

$B_3 = 80,000$

$B_4 = 60,000$

$B_5 = 50,000$

Double declining method

Rate of declining $= \frac{2}{n} = \frac{2}{5} = 0.4$

$D_1 = 1,50,000 \times 0.4 = 1,20,000$

$D_2 = 1,20,000 \times 0.4 = 48,000$

$D_3 = 72,000 \times 0.4 = 28,800$

$B_1 = 72,000$

$B_2 =$

$B_3 =$

$D_1 = 2,00,000 \times 0.4 = 80,000$, $B_1 = 1,20,000$

$D_2 = 1,20,000 \times 0.4 = 48,000$, $B_2 = 72,000$

$D_3 = 72,000 \times 0.4 = 28,800$, $B_3 = 43200$

But, Salvage value $= 50,000$

So, $D_3 = 72,000 - 50000 = 22,000$, $B_3 = 50,000$

$D_4 = 0$, $B_4 = 50000$

$D_5 = 0$, $B_5 = 50000$

iv) Sinking fund factor

$$D_0 = \frac{(C_i - C_s) \times i}{(1+i)^n - 1} = \text{RS } 25568.468$$

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

$D_1 = D = 25568.468$

$D_2 = \text{Rs } 27613.94$

$D_3 = \text{Rs } 29823.06$

$D_4 = \text{Rs } 32208.90$

$D_5 = \text{Rs } 34785.618$

$B_1 =$ RS 174431.53

$B_2 =$ RS 1,46,817.58

$B_3 =$ RS 116904.518

$B_4 =$ RS 84785.61

$B_5 =$ RS 50,000

20

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]

$V = 296000 m^3$

Power shovel

$V = 0.955 m^3$

output $= 126 m^3/hr$, $\eta_0 = 0.86 \times 0.8 = 0.688$

Total working hr per year $= 42 \times 46 = 1932$ hrs

One cycle time $= 45$ min/hr

Actual output $= 126 \frac{m^3}{hr} \times \eta_0 = 86.688 \frac{m^3}{hr}$

Total time req for excavation $= \frac{296000}{86.688}$

$= 3414.54$ hr

Time req in yrs to complete the work $= \frac{3415.54}{1932} = 1.767$ yrs

No. of power shovels (Cycle time $= \frac{45 \text{ min}}{1 \text{ hr}} = 0.75$)

Output of shovel in 1000 hrs $= 86.688 \times 0.75 \times 1000$

$= 65016 m^3$

No. of power shovel $= \frac{296000}{65016} = 4.55$

≈ 5 shovels

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Do not write this

Do 11)

Factors affecting the selection of equipment

a) cost of the equipment

b) Site conditions

c) operating efficiency

d) Depreciation of the equipment

e) Investment to be done per year for proper functioning

f) Maintenance requirements

g) Availability of different parts in local areas

h) Person to operate the equipment.

Economic life

It can be determined by the calculating the depreciation of the equipment. Initial cost is known & salvage value is also known from this we can calculate the economic life. Also, Investment which we have to make per year to maintain the equipment is also considered while calculating the life

8

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

[20 marks]

Various method of Tunneling in hard rock

Heading & Benching method

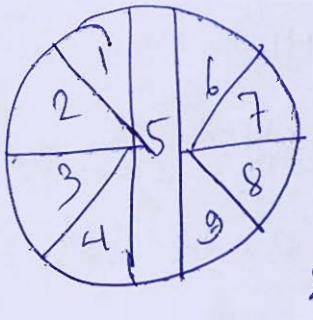
Drift method.

Tunnel Boring machine

Drill & Blast method.

Heading & Benching method :- In this method a top portion of the tunnel is excavated that is called Heading which is resting on bottom portion called as Benching

Drift method :- In this method different Sections is made & a narrow portion is selected for drilling & then the excavation is started from that



portion & Section by section drilling starts.

→ Tunnel Boring machine :- It is most used equipment for tunnelling. In this the TBM starts from one side of the tunnel & starts drilling towards the other side. It has self mechanised system in which water is sprayed from TBM which helps in drilling.

→ Drill & Blast method :- In this method, explosive are used to make a section clear from the hard rocks & make hard rocks soft for easier drilling purpose.

Explosives used are Ammonium Nitrate etc.

Advantages

Heading & Benching :- More area of tunnel is drilled at a time

Disadvantage :- Very complicated process &

different types of woods are used for excavation.

Drift method

Advantages :- Easier in comparison to other method

Disadvantages :- Very lengthy process

TBM

Disadvantage :- i) Cost of the equipment
ii) How to properly use

Advantage :- i) No need of labours for excavating
ii) Less time taken

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Drill & blast

Advantage :- i) Less time

Disadvantage :- i) Explosives can break the rock due to which Land slide can occur
ii) cost of explosive is high

■■■■

Space for Rough Work

Space for Rough Work

Space for Rough Work

Space for Rough Work

Space for Rough Work