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CIVIL ENGINEERING

Construction Planning and Management & Construction Materials

Text Book & Work Book: Theory with worked out Examples and Practice Questions)

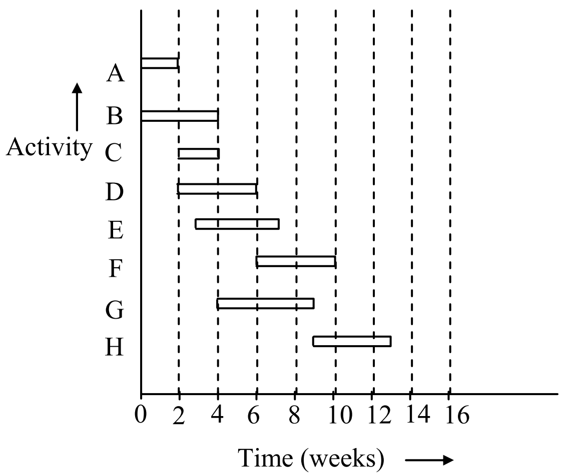
Construction Material & Management

(Solutions for Text Book Practice Questions)

03. Construction Project Scheduling

07. Ans: 13 weeks

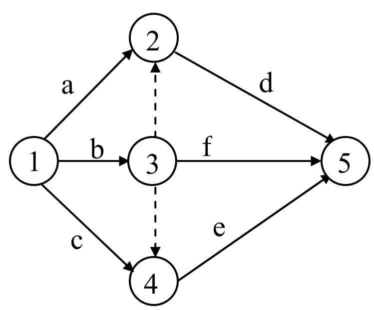
Sol:



Total completion time of period = 13 weeks

28. Ans: (c)

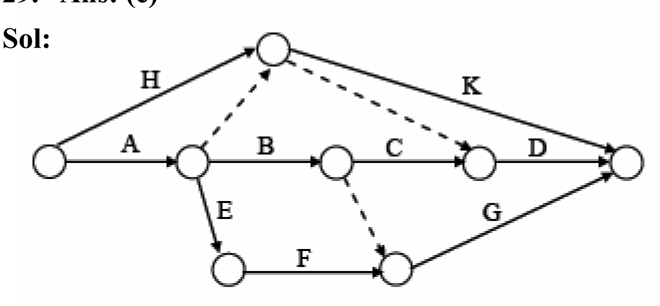
Sol:



2 dummy activities are required in AOA diagram.

29. Ans: (c)

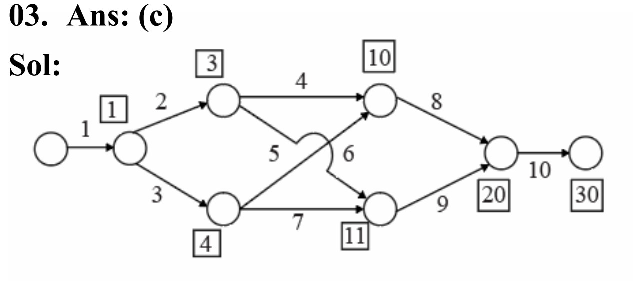
Sol:



04. CPM Network

03. Ans: (c)

Sol:



Critical Path

1 – 3 – 7 – 9 – 10

Critical path duration = 1 + 3+ 7 + 9 + 10

= 30 days

04. Ans: (c)

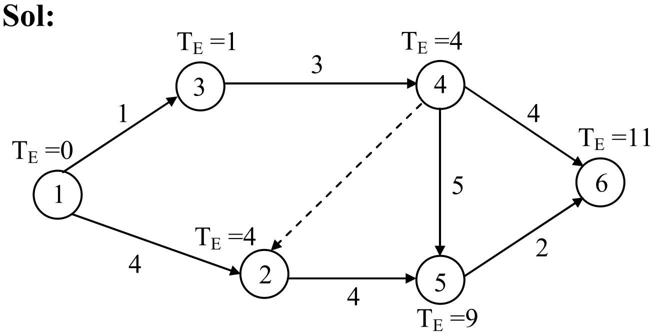
Sol:

Path	**Duration**
1-2-4-7-9	6 + 4 + 8 + 10 = 28
1-3-5-7-9	8 + 9 + 14 + 10 = 41
1-3-6 -8 -9	8 + 10 + 13 + 15 = 46

∴ Critical path is 1-3- 6 -8 - 9

06. Ans: (c)

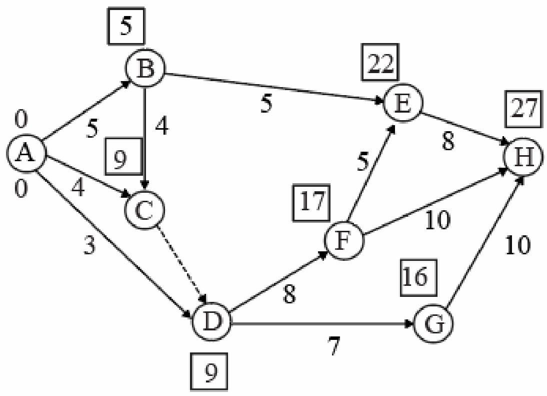
Sol:



$\therefore$ Earliest start time for activity 5 – 6 = 9 days

08. Ans: (b)

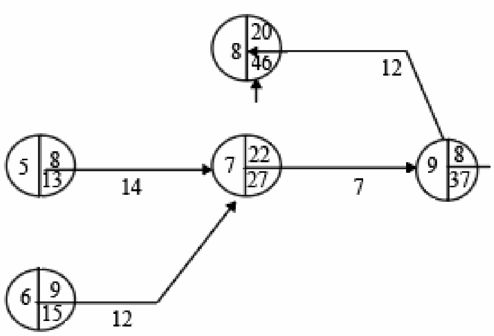
Sol:



27 days is earliest expected completion

10. Ans : (c)

Sol :



Total float = 15 – 9 = 6

Free float = 22 – 12 – 9 = 1

05. PERT Network

02. Ans: (b)

Sol: $t_0 = 8$ min, $t_m = 10$ min, $t_p = 14$ min

$$t_E = \frac{t_0 + 4t_m + t_p}{6} = \frac{8 + 4(10) + 14}{6} = 10.33 \text{ min}$$

03. Ans: (a)

Sol: Given $T_S = 27$ days

From the network given $T_E = 23$ days

$$\sigma = \sqrt{2^2 + 2.8^2 + 2^2} = 3.98 \simeq 4$$

$$Z = \frac{T_S - T_E}{\sigma} = \frac{27 - 23}{4} = 1$$

For Z = 1

P = 0.841

05. Ans: (c)

Sol: $t_E = 36$ days

$\sigma^2 = 4 \Rightarrow \sigma = 2$

$T_S = 36$ days

$$Z = \frac{T_S - T_E}{\sigma} = \frac{36 - 36}{2} = 0;$$

$Z = 0 \Rightarrow$ 50% probability

06. Ans: (c)

Sol: $\sigma = \sqrt{\text{sum of variances of critical path}}$

$$\sigma = \sqrt{4 + 16 + 4 + 1}$$

$$= \sqrt{25}$$

$\sigma = 5$ units

07. Ans: (d)

Sol: Given , $\sigma^2 = 4 \Rightarrow \sigma = 2$

$T_S = 24$ days

$T_E = ?$

From the given network diagram, $T_E = 20$ days

$$Z = \frac{T_S - T_E}{\sigma} = \frac{24-20}{2} = 2$$

For Z = 2, probability of completion = 97.7%

13. Ans: (a)

Sol: $t_E = \dfrac{t_o + 4t_L + t_P}{6}$

$$= \frac{8 + 4\times 9 + 13}{6} = 9.5$$

Variance, $\sigma^2 = \left(\dfrac{t_P - t_o}{6}\right)^2 = \left(\dfrac{13-8}{6}\right)^2$

$$\sigma^2 = \frac{25}{36}$$

18. Ans: (*)

Sol: $t_o = 9$ days

$t_p = 21$ days

$t_m = 15$ days

$T_S = 13$ days

$$t_E = \frac{t_0 + 4t_m + t_p}{6} = \frac{9 + 4(15) + 21}{6} = 15 \text{ days}$$

$$\sigma = \frac{t_p - t_o}{6} = \frac{15-9}{6} = 1 \text{ day}$$

$$Z = \frac{t_s - t_e}{\sigma} = \frac{13-15}{1} = -2$$

For Z = –2, probability ≈ 2.30%

19. Ans : (b)

Sol : Z = 1.647 for 95%

$\sigma^2 = 9$ weeks $\sigma = 3$

$T_\varepsilon = 70$ weeks

$T_s = ?$

$$Z = \frac{T_s - T_\varepsilon}{\sigma}$$

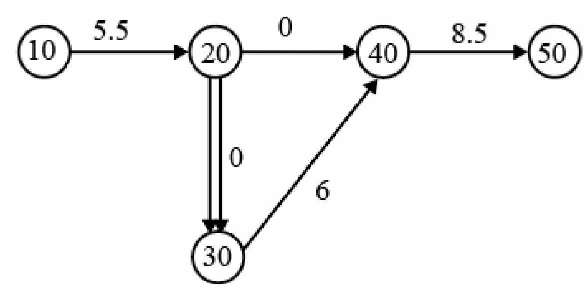
$$1.647 = \frac{T_s - 70}{3}$$

$T_s = 70 + 4.941 = 74.94$ weeks

20. Ans : (d)

Sol :

	T_E	σ
10 – 20	5.5	1.167
20 – 30	0	0
30 – 40	6	1
40 – 50	8.5	1.167

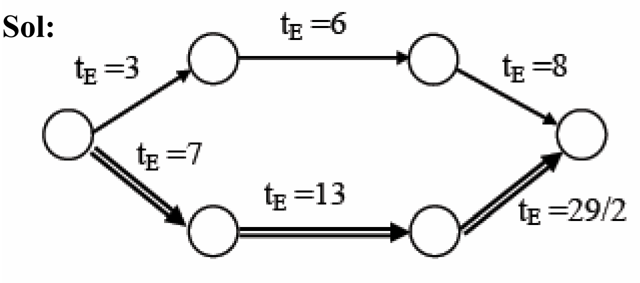


Total duration = 5.5 + 6 + 8.5
= 20 days

Standard deviation = $\sqrt{1.167^2 + 1^2 + 1.167^2}$
= 1.93

22. Ans: (d)

Sol:



$$t_E = \frac{t_o + 4t_m + t_p}{6}$$

$$t_E = \frac{6 + 4(7) + 8}{6} = 7$$

$$t_E = \frac{12 + 4(12) + 18}{6} = 13$$

$$t_E = \frac{9 + 4(15) + 18}{6} = \frac{29}{2}$$

Project duration = 7 + 13 + 14.5 = 34.5

$$\sigma_{cp} = \sqrt{\left(\frac{8-6}{6}\right)^2 + \left(\frac{18-12}{6}\right)^2 + \left(\frac{18-9}{6}\right)^2}$$

$$= \sqrt{\left(\frac{1}{3}\right)^2 + 1 + \left(\frac{3}{2}\right)^2}$$

$$= \sqrt{\frac{1}{9} + 1 + \frac{9}{4}}$$

$$= \sqrt{\frac{4 + 36 + 81}{36}} = \frac{11}{6}$$

06. Project Crashing & Resource Allocation

11. Ans: (a)

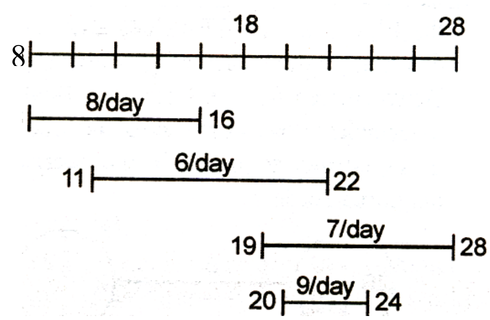
Sol:

Week	Parallel Activities	Total Resource Load
9^{th}	A	6
11^{th}	A + B	6 + 4 = 10
13^{th}	A + B+ D	6 + 4 + 7 = 17
15^{th}	A + B + C + D	6 + 4 + 3 + 7 = 20

From the above, the maximum resource load per week is 20

12. Ans: (a)

Sol:



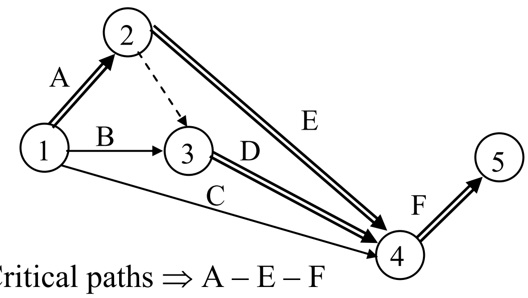
From the given diagram, on the 21^{st} & 22^{nd} day three concurrent activities are there with a total resources of 6 + 7 + 9 = 22.

Minimum resource occurs when only one activity exists. In the present case it is 6 per day.

∴ Maximum resources is 22 and minimum is 6

15. Ans: (b)

Sol:



Critical paths ⇒ A – E – F

A – D – F

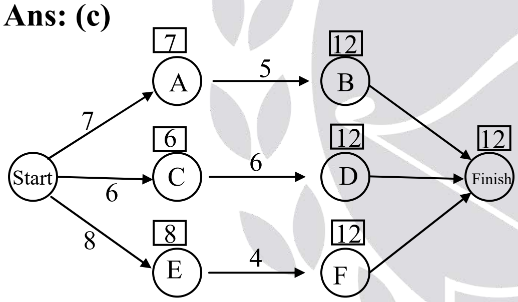
Activities E & D should be crashed by one day to reduce project duration by one day.

∴ Minimum amount to be spent to reduce the project duration by 1 day = 40 + 20

= Rs. 60

19. Ans: (c)

Sol:



Number of activities that need to be crashed to reduce project duration by one day is 3

21. Ans: (d)

Sol:

Day	Parallel Activities	Total resource load
1st	A + C + D	6 + 4 + 8 = 18
5th	B + C + D	5 + 4 + 8 = 17
6th	B + C + E	5 + 4 + 2 = 11
11th	E	2

Maximum resource in a day = 18 units.

22. Ans: (a)

Sol: On 11th day, activities

B – E, B – F & D – E are under execution.

Total resources = 6 + 5 + 10 = 21

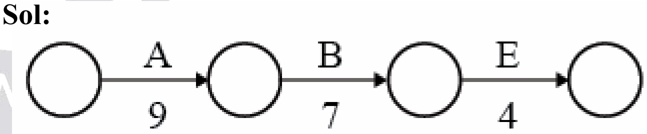
On 16th day, activities

C – F & E – F are in progress.

Total resources = 4 + 6 = 10

23. Ans: (c)

Sol:



The time corresponding to the minimum direct cost for each activity is shown in the above network. The total optimum duration is 9 + 7 + 4 = 20 days

25. Ans: (C)

Sol: Task involved of fixing timber formwork = 160 sq.m

Time required for completion = 4 days (8 hrs/day)

$\Rightarrow 4 \times 8 = 32$ hrs.

Team consists of 2 skilled & 1 unskilled worker

Rate of work = 1.25 sq.m/ team/hr

Number of workers required $= \dfrac{160}{32 \times 1.25} = 4$

26. Ans: (a)

Sol: Quantity of excavation work = 3000 m^3

Output of a man = 100 m^3/day

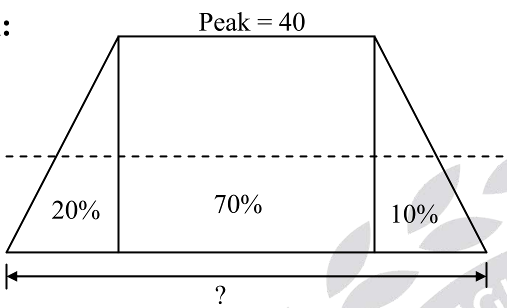
6 men are employed

Duration of excavation activity $= \dfrac{3000}{100 \times 6}$

$= 5$ days

27. Ans: (a)

Sol:



Average number of workers/day

$= \dfrac{1}{2} \times 0.2 \times 40 + 0.7 \times 40 + \dfrac{1}{2} \times 0.1 \times 40$

$= 34$

Working time/week = over time ×number of working days = 1.5 × 5 = 6.5 days

No. of man days available = 6.5 × 34 = 221

No. of man days required = 1200

No. of weeks required $= \dfrac{1200}{221}$

$= 5.42 \simeq 5.5$ weeks

28. Ans: (c)

Sol: Labour cost $= 100 \times \dfrac{20}{100} = 20$ Cr

Non-productive cost $= \dfrac{60}{100} \times 20 = 12$ cr

Productive cost $= \dfrac{40}{100} \times 20 = 8$ cr

15% of wastage resulting from Non-productive time is eliminated

$= \dfrac{15}{100} \times 12 = 1.8$ cr

% of saving $= \dfrac{1.8}{8} \times 100 = 22.5\%$

29. Ans: (b)

Sol: Crew : 2 carpenters

1 helper

Hourly rate of crew = (2 × 85 + 69.5)= 239.5

Average hourly rate per worker $= \dfrac{239.5}{3}$

$= 79.83 \simeq 80$

07. Engineering Economics and Depreciation

01. Ans: (a)

Sol: P = Rs. 1000

i = 12%

n = 5 years

$F = P(1 + i)^n = 1000\,(1 + 0.12)^5 =$ Rs. 1762.34

02. Ans: (b)

Sol: i = 18%

n = 10 years

Equal payment series compound amount factor (F/A, i, n)

$$= \left[\frac{(1+i)^n - 1}{i}\right]$$

$$= \left[\frac{(1+0.18)^{10} - 1}{0.18}\right] = \frac{4.23}{0.18} = 23.52$$

03. Ans: (d)

Sol: i = 14%

n = 10 years

Equal payment series sinking found factor

$$(A/F, i, n) = \left[\frac{i}{(1+i)^n - 1}\right]$$

$$= \left[\frac{0.14}{(1+0.14)^{10} - 1}\right]$$

$$= \frac{0.14}{2.707} = 0.051$$

04. Ans: (a)

Sol: P = Rs. 20,000

i = 14%

n = 5 years

$$A = P\left[\frac{i(1+i)^n}{(1+i)^n - 1}\right]$$

$$= 20{,}000\left[\frac{0.14(1.14)^5}{(1.14)^5 - 1}\right]$$

A = Rs. 5825

05. Ans: (c)

Sol: P = 10,000

n = 5 years

F = 20,000

i = ?

$F = P(1+i)^n$

$20000 = 10000\,(1+i)^5$

$(2)^{1/5} = 1 + i$

i = 1.14 – 1

$i = 0.14 \approx 14\%$

06. Ans: (a)

Sol: i = 18%

n = 10 years

F = Rs. 20000

$$P = F\left[\frac{1}{(1+i)^n}\right] = 20000\left[\frac{1}{(1.18)^{10}}\right]$$

P = Rs. 3821

07. Ans: (a)

Sol: P = ?

A = 10,00,000

i = 18%

n = 20 years

$$P = A\left[\frac{(1+i)^n - 1}{i(1+i)^n}\right] = 1000000\left[\frac{(1+0.18)^{20} - 1}{0.18(1.18)^{20}}\right]$$

= Rs. 53,52,746

Given initial outlay of project = Rs. 5000000

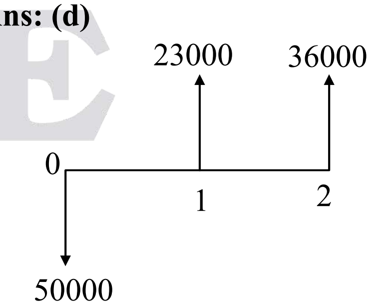
Present worth of the project

= 53,52,746 – 50,00,000

= Rs. 3,52,746

09. Ans: (d)

Sol:



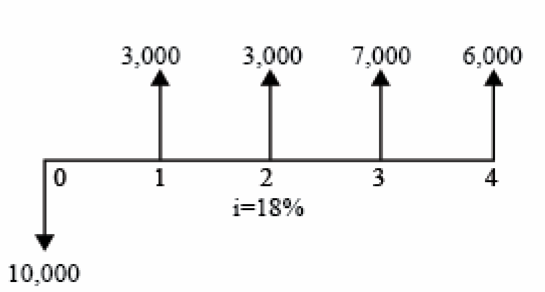
Net present value

= –50000 + 23000 (`P/F, 16%, 1) + 36000 (P/F, 16%, 2)

= –50000 + 19827 + 26753 = – 3420

11. Ans: (B should be selected)

Sol: Present worth of A at *i* = 18%. The cash flow diagram of proposal A is shown in Fig



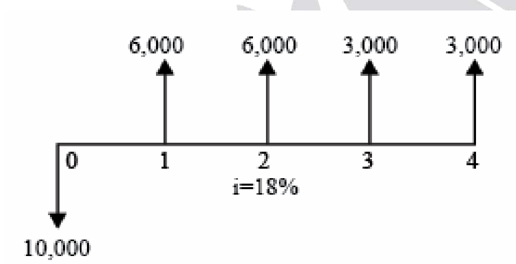
Present worth of 'A'(PW_A)

PWA(18%) = –10,000 + 3,000 (P/F, 18%, 1)
+ 3,0000(P/F, 18%, 2) + 7,000(P/F, 18%, 3)
+ 6,000(P/F, 18%, 4)

= –10,000 + 3,000 (0.8475) + 3,000(0.7182)
+ 7.000(0.6086) + 6,000 (0.5158)

= Rs. 2,052.10

Present worth of B at *i* = 18%. The cash flow diagram of proposal B is shown in Fig



Present worth of 'B'(PW_B)

PWB(18%) = –10,000 + 6,000 (P/F, 18%, 1)
+ 6,0000(P/F, 18%, 2) + 3,000(P/F, 18%, 3)
+ 3,000(P/F, 18%, 4)

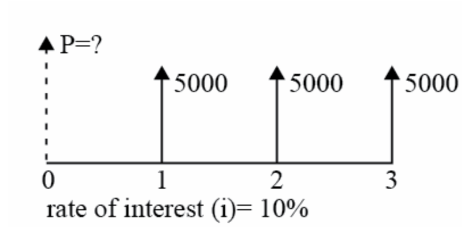
= –10,000 + 6,000 (0.8475) + 6,000(0.7182)
+ 3.000(0.6086) + 3,000 (0.5158)

= Rs. 2,767.40

The present worth of B is greater than the present worth of A. Hence, B is the best choice.

14. Ans: (a)

Sol:



$$P = \frac{5000}{(1+0.1)} + \frac{5000}{(1+0.1)^2} + \frac{5000}{(1+0.1)^2}$$

= 5000 × 0.909 + 5000 × 0.826 + 5000 × 0.7511

= 12431/-

19. Ans: (b)

Sol:

R = 12% p.a

R = 12% per annum (12 months)

R = 3% per Quarterly (3 months)

Effective rate of interest when compounded Quarterly is

3 months	3 months	3 months	3 months
3%	3%	3%	3%

103% × 103% × 103%× 103%

$$= \frac{10609}{10000} \times \frac{10609}{10000} \approx \frac{112550}{100} \approx 112.6\% = 12.6\%$$

20. Ans: (a)

Sol: Compound Quarterly

(Interest added to principal every Quarter)

For 2 years = 24 months, R = 10% p.a

R = 10% per annum

R = 2.5% per quarterly (3 months)

Rs.1000 After 2 years.

Amount = $1000 \times (102.5\%)^8$

$= 1000 \times (1.025)^8$

$= 1000 \times 1.2184$

Amount ≈ 1218.4

21. Ans: (c)

Sol: $d = \frac{2}{n} = \frac{2}{5}$

$BV_m = P(1-d)^m$

$= 200000\left(1-\frac{2}{5}\right)^2$

= 72,000

22. Ans: (b)

Sol: $SFF = \frac{i}{(1+i)^n - 1} = \frac{0.04}{(1+0.04)^5 - 1}$

= 0.184

23. Ans: (c)

Sol: Annual depreciation $= \frac{25000-1600}{8}$

= 2925

Residual book value at beginning of 6th year

= 25000 – (2925 × 5)

= 10375

24. Ans: (c)

Sol: Initial cost = P

Salvage value = SV

Annual depreciation

$$= \frac{P-SV}{n} = \frac{(P-0.4P)}{5} = \frac{0.6P}{5}$$

Annual accounting rate of return

$$= \frac{\text{Annual savings} - \text{Annual depreciation}}{\text{Initial cost}}$$

$$0.2 = \frac{50000 - \frac{0.6P}{5}}{P}$$

$$0.2P = 50000 - \frac{0.6P}{5}$$

$$0.2P = \frac{5\times 50000 - 0.6P}{5}$$

1.6P = 5 × 50000

P = 1,56,250

Cost of two machines = 2 × 156250 = 3,12,500/-

25. Ans: (c)

Sol: Annual depreciation $= \frac{10000-1000}{5}$

= 1800

Book value = 10000 – (1800 × 2)

= Rs. 6400

08. Construction Contracts and Tendering

04. Ans: (a)

Sol: In cost plus fixed fee contract, the owner pays the contractor an agreed amount over and above the documented cost of work

05. Ans: (a)

Sol:

- Guaranteed maximum price contract is a cost-type contract where the contractor is compensated for actual costs incurred plus a fixed fee subject to ceiling price.
- Savings, if any, are returned to the owner.
- It is different from lump-sum contract where cost savings are retained by contractor.

07. Ans: (c)

Sol: Turn key contract:

An agreement under which a contractor completes a project, then hands it over in fully operational form to the client, which needs nothing to do but 'turn a key' to set it in motion.

Generally 'turnkey' refers to ready for immediate use.

08. Ans: (d)

Sol: When work is to be completed very quickly (or) no contractor prefers to accept the work (The tender is floated) then a notice with short duration is again published by the client. Such a tender notice is called 'Short tender notice'. The terms and conditions remain the same as that of ordinary tender notice.

09. Ans: (b)

Sol: Limited or Closed tender:

In limited tenders, only pre-qualified bidders are allowed to participate. These tenders are not advertised in newspapers.

11. Ans: (a)

Sol: Earnest money deposit (E.M.D)

While submitting a tender the contractor is to deposit a certain amount, about 2% of the contract value, as EMD as guarantee of the tender. The amount is for a check so that the contractor may not refuse to accept the work or run away when his tender is accepted.

12. Ans: (b)

Sol: Security deposit:

On acceptance of the tender, the contractor has to deposit 10% of the tendered amount as security deposit which is inclusive of the earnest money already deposited.

It is refunded to the contractor after the satisfactory completion of the whole work after a specified time (generally after maintenance period).