Sustainable and Renewable Energy Development Authority (SREDA)
Power Division, Ministry of Power, Energy and Mineral Resources

2nd Energy Auditor Certification Examination-2022

| **Paper- 1** | **Candidate's Roll No.** | 2 | 0 | 2 | 2 | 0 | 3 | | |

Examinee's Name _____

A

Paper 1: Fundamentals of Energy Management and Energy Audit
Total Marks- 150, Time- 3.00 Hours, Date: 4 March 2022

- ### Important Instruction:

1. This Paper has 50 MCQs + 8 Short Questions + 6 Long Questions = Total 64 Questions.
2. Mark indicated on the right side of each question.
3. Fill in correct circle with permanent ink ballpoint pen shown on the top sheet only corresponding to the MCQ given in Section A.
4. Answer in the blank space provided after each question (short/long).
5. Do not put any sign or write anything on the answer script except written answer.
6. Any unfair means, peer talking, keeping any communication device and misbehavior will lead to cancellation of examination.

MCQ Answer (Section A):

1	18	35
2	19	36
3	20	37
4	21	38
5	22	39
6	23	40
7	24	41
8	25	42
9	26	43
10	27	44
11	28	45
12	29	46
13	30	47
14	31	48
15	32	49
16	33	50
17	34	

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MCQ	:	[ ]	
Short Question	:	[ ]	
Long Question	:	[ ]	
Total Marks	:	[ ]	Signature of Examiner

Do not write or mark anything in this page

Section A: MCQ

$$1 \times 50 = 50$$

1   An electric kettle has a resistance of 30 Ω and it is connected to a 220 V supply. What is the power rating (kW) of the kettle?

    A) 1.61   C) 2.0

    B) 1.5   D) 1.0

2   Wind speed is measured by

    A) aerovelocity meter   C) anemometer

    B) odometer   D) hygrometer

3   The most of the primary energy consumption by the world comes from

    A) natural Gas   C) coal

    B) oil   D) nuclear

4   The major consumer of the natural gas in Bangladesh is

    A) power plants   C) residential sector

    B) fertiliser plants   D) transport sector

5   LPG mainly consists of

    A) butane and pentane   C) propane and butane

    B) natural gas condensate   D) ethane and propane

6   What is PDCA in energy management cycle?

    A) Plan-Do-Check-Act   C) Plan-Do-Check-Achieve

    B) Performance-Do-Check-Achieve   D) Perceive-Design-Check-Achieve

7   How is "goodness-of-fit" checked in regression analysis?

    A) correlation coefficient   C) variance

    B) R2 value   D) predicted values

8   For a particular project, PERT estimates the time to completion of the project as 6 months more likely, 13 months pessimistically and 5 months optimistically. What is the expected time to completion of the project?

    A) 7 months   C) 8 months

    B) 6 months   D) 5 months

9   Which of the following is usually not included in the direct cost of a project?

    A) Salaries   C) Office leasing rents

    B) Equipment rentals   D) Cost for training of related employees

10 Which of the following is related to certification of energy management system?

A) ISO 50001

C) ISO-9000

B) ISO-45000

D) ISO-45001

11 What is the energy efficiency calculated from the following energy balance diagram?

A) 0.225

C) 1.0
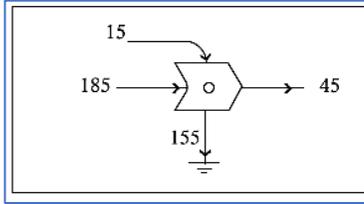
B) 0.775

D) 0.525

12 If 50 wt% ten kilogram aqueous sugar solution is to be diluted to 20 wt% aqueous sugar solution, how much water (kg) is to be added?

A) 10

C) 12.5

B) 15

D) 10

13 Preliminary energy audit typically requires

A) 1 day

C) 7 Days

B) 3 Days

D) 15 days

14 What is the world benchmark energy consumption (mmscf/ton of urea) for urea manufacturing?

A) 20

C) 30

B) 25

D) 44

15 How much power generation potential (kW) is available in a run of river mini hydropower plant for flow of 40 litres/second with a head of 12 metres? Assume system efficiency of 60%.

A) 2.8

C) 4.8

B) 1.4

D) 288

16 25. What is the net calorific value of methane (CH_4) in kJ/kg, if the Gross Calorific Value of methane is 890 kJ/mol and the heat of vaporization of water is 44 kJ/mol?

A) 44,556

C) 40,000

B) 50,000

D) 45,500

17 Broadly, energy can be classified as

A) Potential, chemical and stored mechanical energy

C) Radiant, motion, sound and electrical energy

B) Kinetic, gravitational and nuclear energy

D) Potential and kinetic energy

18 A machine requires a force of 500N to move it 1km in 5minutes. Average power utilized is

A) 2kW

C) <2kW

B) >3kW

D) None of the above

19 Direct Current (DC) is

A) a measure of electric potential or electromotive force

B) non-varying unidirectional current

C) current reverses in regular and recurring intervals of time

D) product of volt and power

20 Electric conductance is measured in

A) Watt

B) Volt

C) Amp

D) Mho

21 In a coil electric heater, power is measured in

A) W-h

B) Volt

C) W or kW

D) A-h

22 Power factor is unity for

A) inductive circuit

B) resistive circuit

C) capacitive circuit

D) inductive-capacitive circuit

23 A 70W fan PF 0.7, runs for 10h/day in a 230V line taking current 0.5A from supply. Power consumption of the fan per day is

A) >800W

B) <800W

C) =800W

D) none of the above

24 In Fahrenheit Scale, freezing and boiling temperature in degree at air pressure are

A) 0 & 100

B) 100 & 212

C) 0 & 32

D) 32 & 212

25 At atmospheric pressure, Gauges are calibrated to read

A) 212

B) 100

C) 76

D) 0

26 1 kCal can raise the temperature of x kg water by 1°C where

A) 0.5

B) 1

C) 1.5

D) 2

27 Specific heat of water is

A) 2400J/kg°C

B) 4200J/kg°C

C) 2300J/kg°C

D) 3200J/kg°C

28 Change of state of a material from one state to another is known as

A) melting point

B) boiling point

C) vaporization

D) phase change

29 The viscosity of a fluid is decreasing with

A) increasing pressure

B) increasing temperature

C) decreasing temperature

D) none of the above

30 Heat is transferred from hot to cold body by

A) 5 primary modes   C) 3 primary modes

B) 4 primary modes   D) none of the above

31 Conduction is the primary mode of heat transfer through

A) air   C) solid

B) gas   D) liquid

32 Molten salt is a mixture of

A) 60% sodium nitrate and 40%   C) 60% potassium nitrate and 40%
potassium nitrate   sodium nitrate

B) 60% calcium nitrate and 40% sodium D) 60% potassium nitrate and 40%
nitrate   calcium nitrate

33 The first law of thermodynamics is concerned with

A) absolute zero   C) the natural direction of energy process

B) the total amount of energy in the D) all of the above
system must remain constant

34 Renewable energy sources are

A) inexhaustible   C) limited

B) exhaustible   D) depletion able

35 In Bangladesh, the solar window is the period, typically

A) 06:30AM – 05:30PM   C) 09:00AM – 03:00PM

B) 07:30AM – 05:00PM   D) 10:00AM – 02:30PM

36 Renewable energy sources include

A) nuclear, wind, hydro, HFO etc.   C) geothermal, potential difference of sea-
                                      level, diesel etc.

B) sunlight, bio-mass, sea-tide, wave etc.   D) natural gas, falling water, crude oil etc.

37 The wattage output of a PV module is rated in term of

A) Peak voltage   C) Peak Watt

B) Peak Ampere   D) Peak kVAr

38 Series of wind circulations in both northern and southern latitude is due to

A) temperature difference   C) coriolis force

B) pressure variation   D) none of the above

39 In Furling speed, a wind turbine needs to

A) run smoothly   C) run in rated load

B) shut down   D) start running

40 Typical capacity factor of a wind turbine is

A) 20-25%   C) 31-40%

B) 26-30%   D) 41-45%

41 For the below project network diagram, critical path is
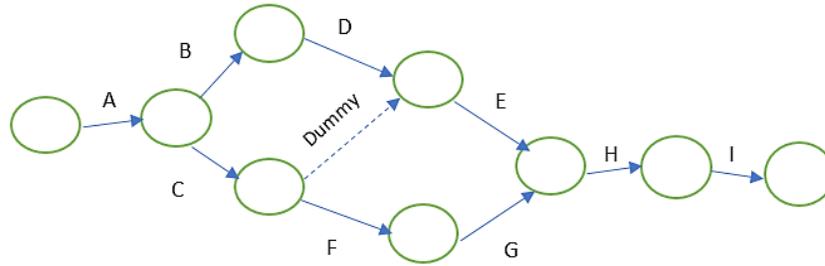
A) A – B – D – E – H – I   C) A – C – F – G – H – I

B) A – C – E – H – I   D) none of the above

42 Instrument measures air velocity in ventilation, air-conditioning and refrigeration systems etc. is known as

A) oscilloscope   C) lux meter

B) multimeter   D) thermo-anemometer

43 For measuring the rotational speed of a shaft or wheel is called

A) Tachometer   C) Voltmeter

B) Ammeter   D) Multimeter

44 A Sankey diagram represents

A) heat balance   C) temperature balance

B) energy balance   D) pressure balance

45 Model Energy Policy will not deal with

A) reduce energy per unit production   C) support all kind of energy resources regardless of social impact

B) uphold legal & other requirements regarding energy   D) improve energy performance

46 Gantt chart shows

A) progress of a work   C) cost of different components of a project

B) schedule of different components of a project   D) risk analysis of a project

47 The following is an equation of straight line

A) $y^2 = a^2 + b^2x$ C) $y = ax + b$

B) $y = ab + cx^2$ D) $y = ax + bx^2 + c$

48 Energy generation is represented by
A) MW   C) Kcal
B) MWh   D) none of the above

49 The first step of a planning process will be
A) WBS   C) CPM
B) Gantt Chart   D) PERT

50 Detailed Energy Audit does not require

A) plant layout   C) source of energy
B) energy tariff   D) production data

Section B: Short Question

		Marks
		Marks
01	Five kg water is to be heated from -10ºC to 200ºC at atmospheric pressure. How much heat in kJ is required? List all assumptions, if any. [Given: Specific Heat for ice, liquid water and water vapor are 2.1 kJ/kg, 4.2 kJ/kg and 2.1 kJ/kg respectively. Latent heat of melting and latent heat of vaporization are 334 kJ/kg and 2265 kJ/kg, respectively]	5
02	Distinguish between preliminary energy audit and detailed energy audit.	5

03	List ten equipment used in energy audit work.	5
04	An experiment on the growth rate of certain organism requires an environment of humid air enriched in oxygen. Three input streams are fed into an evaporation chamber to produce an output stream with the desired composition. Three input streams are, A: Liquid water fed at rate of 20 cm^3/min, B: Air (21% O_2 and 79% N_2) and C: Pure O_2 with a molar flow rate one-fifth of the molar flow rate of stream B. The output gas is analyzed and is found to contain 1.5 mole% water. Draw and label the flowchart of the process, and calculate all unknown stream variables.	5

05	What is energy? State the relationships of work, energy and power with examples.	5

06	A 3phase water pump motor's measured parameters are 400V, 7 Amp and 0.8 PF. Find monthly energy consumption of machine running 2h/day.	5
07	Briefly describe the final energy consumption sectors in Bangladesh. What is consumption of final energy in % of each sector?	5

| 08 | In a textile mill, an evaporator concentrates a liquor containing solids of 6% by w/w to produce an output containing 30% solids w/w. Calculate the evaporation of water per 100kg of feed to evaporator? | 5 |

Section C: Long Question

		Marks
01	Work Breakdown Structure (WBS) is the process of dividing complex projects to simpler and manageable tasks. The project managers use this method for simplifying the project execution. The WBS to manufacture a component consisting of part X and Y is given below. Draw the project network diagram and find the time to complete the project using CPM method.	10

Job #	Description	Immediate Predecessors	Time [min]
A	Start		0
B	Get materials for X	A	10
C	Get materials for Y	A	20
D	Turn X on lathe	B,C	30
E	Turn Y on lathe	B,C	20
F	Polish Y	E	40
G	Assemble X and Y	D,F	20
H	Finish	G	0

| 02 | A fuel gas containing 95 mole% methane and the balance ethane is burned completely with 25% excess air. The stack gas leaves the furnace at 900 ºC and is cooled to 450ºC in a heat exchanger in which heat lost by cooling gases is used to produce steam from liquid water for heating, power generation, or process applications. Perform the following:

a) Taking as a basis of calculation 100 mol of the fuel gas fed to the furnace; calculate the amount of heat (kJ) that must be transferred from the gas in the waste heat boiler to accomplish the indicated cooling.

b) How much saturated steam at 50 bar can be produced from boiler feedwater at 40ºC for the same basis of calculation? (Assume all the heat transferred from the gas goes into the steam production.) [necessary data tables are attached] | 10 |

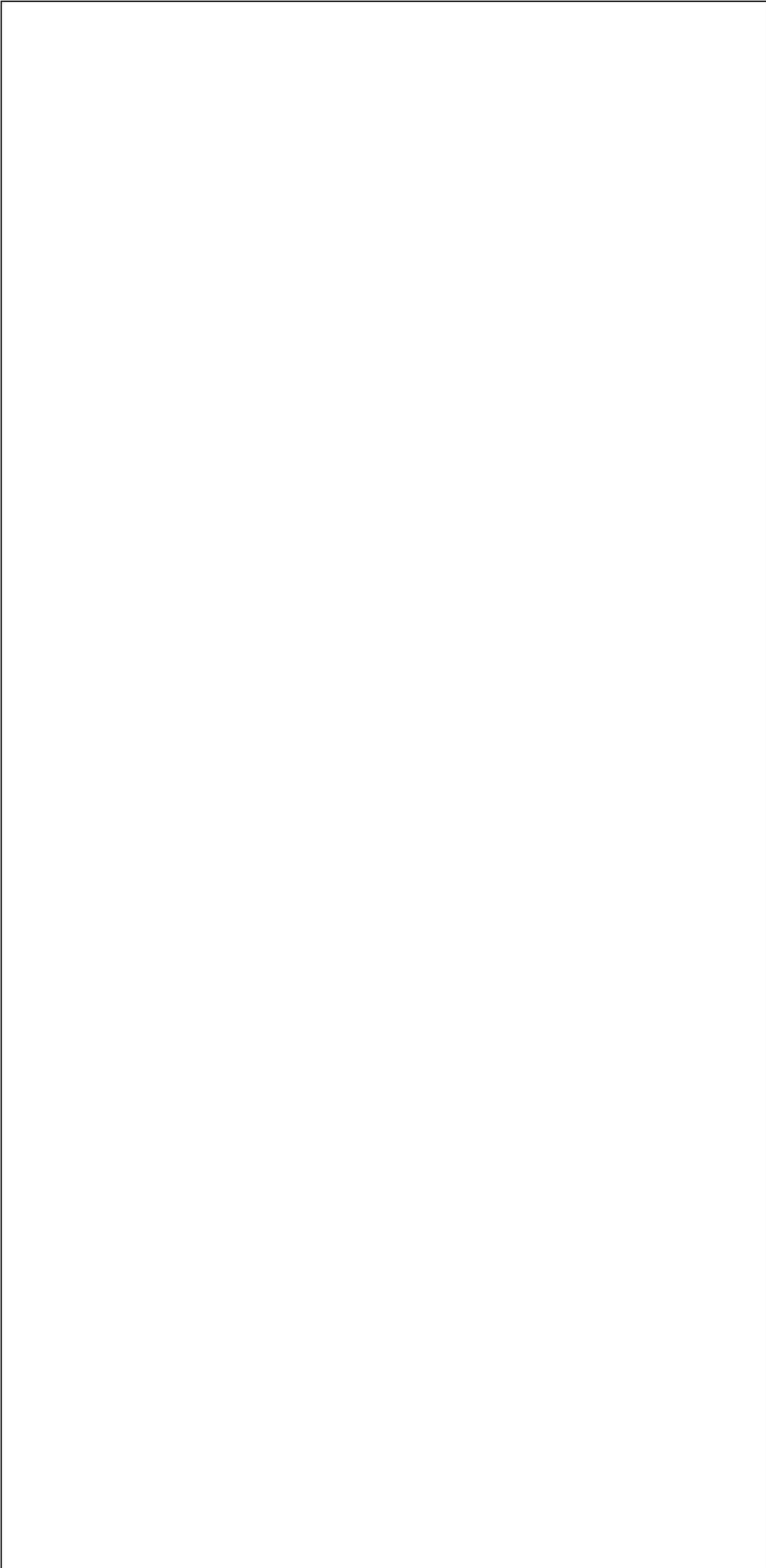| 03 | Energy consumption and production data collected for furnace in a foundry over a period of 18 months. During month 9, a heat recovery system was installed. Using the plant monthly data and CUSUM techniques, estimate the savings made with the heat recovery system. The plant data is given in Table for Q-03: | 10 |

Table for Q-03: Month Wise Production with Energy Consumption

Month	E_{act} - Monthly Energy Use (toe / month)	P - Monthly Production (tonnes / month)
1	340	380
2	340	440
3	380	460
4	380	520
5	300	320
6	400	520
7	280	240
8	424	620
9	420	600
10	400	560
11	360	440
12	320	360
13	340	420
14	372	480
15	380	540
16	280	280
17	280	260
18	380	500

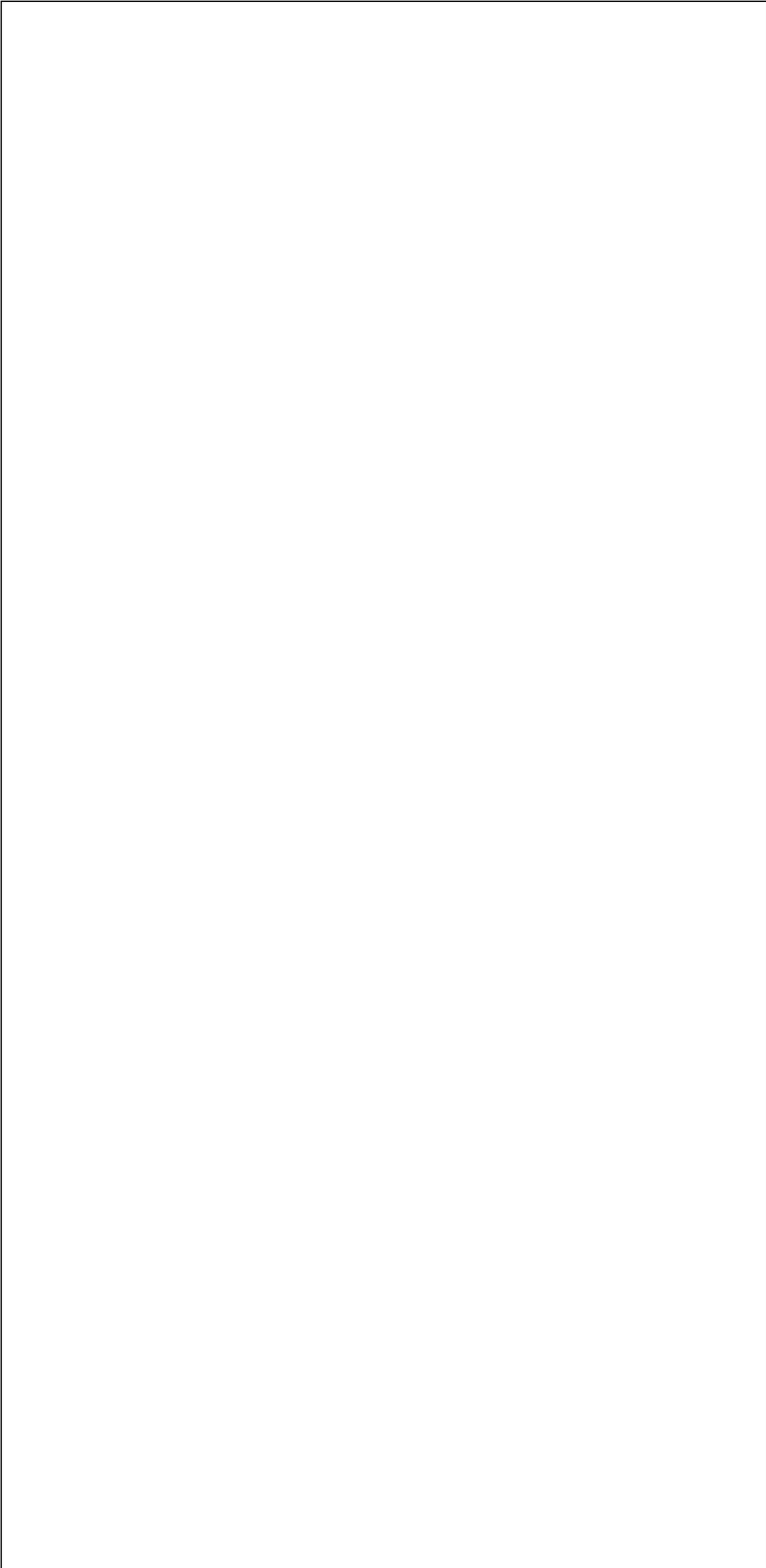|		
04	a) What is a project? Briefly describe Project Development Cycle (PDC) steps. b) "Gantt Chart is a tool for displaying the progress of a project" – explain. What is the limitation of Gantt Chart?	5+5

| 05 | a) Briefly Describe Plan-Do-Check-Act (PDCA) cycle. | 5+5 |
| | b) A 3phase 10kW motor has actual input 415V, 12 A, and 0.7PF when measured during motor running. If the nameplate details of the motor are 415V, 18.2A and 0.9PF, find out the motor loading and the actual input power of the motor. | |

06	Using the given data in the activity table,	2 x 5

a) Draw the network

b) Calculate expected time for all tasks

c) Calculate variance for all tasks

d) Determine all possible path and their estimated durations

e) Identify the critical path.

Ambient temperature = 30°C.

Activity Description	Immediate Predecessor(s)	Optimistic (Week)	Most Likely (Week)	Pessimistic (Week)
A	---	4	7	10
B	A	2	8	20
C	A	8	12	16
D	B	1	2	3
E	D, C	6	8	22
F	C	2	3	4
G	F	2	2	2
H	E, G	4	8	12
I	H	1	2	3

Data Table -01: Specific Enthalpies of Selected Gases: SI Units

$$\hat{H}(\text{kJ/mol})$$
Reference state: Gas, $P_{\text{ref}} = 1$ atm, $T_{\text{ref}} = 25°C$

T	Air	O_2	N_2	H_2	CO	CO_2	H_2O
0	−0.72	−0.73	−0.73	−0.72	−0.73	−0.92	−0.84
25	0.00	0.00	0.00	0.00	0.00	0.00	0.00
100	2.19	2.24	2.19	2.16	2.19	2.90	2.54
200	5.15	5.31	5.13	5.06	5.16	7.08	6.01
300	8.17	8.47	8.12	7.96	8.17	11.58	9.57
400	11.24	11.72	11.15	10.89	11.25	16.35	13.23
500	14.37	15.03	14.24	13.83	14.38	21.34	17.01
600	17.55	18.41	17.39	16.81	17.57	26.53	20.91
700	20.80	21.86	20.59	19.81	20.82	31.88	24.92
800	24.10	25.35	23.86	22.85	24.13	37.36	29.05
900	27.46	28.89	27.19	25.93	27.49	42.94	33.32
1000	30.86	32.47	30.56	29.04	30.91	48.60	37.69
1100	34.31	36.07	33.99	32.19	34.37	54.33	42.18
1200	37.81	39.70	37.46	35.39	37.87	60.14	46.78
1300	41.34	43.38	40.97	38.62	41.40	65.98	51.47
1400	44.89	47.07	44.51	41.90	44.95	71.89	56.25
1500	48.45	50.77	48.06	45.22	48.51	77.84	61.09

Data Table -02: Properties of Saturated Steam: Temperature Table

T(°C)	P(bar)	$\hat{V}$(m³/kg)		$\hat{U}$(kJ/kg)		$\hat{H}$(kJ/kg)		
		Water	Steam	Water	Steam	Water	Evaporation	Steam
0.01	0.00611	0.001000	206.2	zero	2375.6	+0.0	2501.6	2501.6
2	0.00705	0.001000	179.9	8.4	2378.3	8.4	2496.8	2505.2
4	0.00813	0.001000	157.3	16.8	2381.1	16.8	2492.1	2508.9
6	0.00935	0.001000	137.8	25.2	2383.8	25.2	2487.4	2512.6
8	0.01072	0.001000	121.0	33.6	2386.6	33.6	2482.6	2516.2
10	0.01227	0.001000	106.4	42.0	2389.3	42.0	2477.9	2519.9
12	0.01401	0.001000	93.8	50.4	2392.1	50.4	2473.2	2523.6
14	0.01597	0.001001	82.9	58.8	2394.8	58.8	2468.5	2527.2
16	0.01817	0.001001	73.4	67.1	2397.6	67.1	2463.8	2530.9
18	0.02062	0.001001	65.1	75.5	2400.3	75.5	2459.0	2534.5
20	0.0234	0.001002	57.8	83.9	2403.0	83.9	2454.3	2538.2
22	0.0264	0.001002	51.5	92.2	2405.8	92.2	2449.6	2541.8
24	0.0298	0.001003	45.9	100.6	2408.5	100.6	2444.9	2545.5
25	0.0317	0.001003	43.4	104.8	2409.9	104.8	2442.5	2547.3
26	0.0336	0.001003	41.0	108.9	2411.2	108.9	2440.2	2549.1
28	0.0378	0.001004	36.7	117.3	2414.0	117.3	2435.4	2552.7
30	0.0424	0.001004	32.9	125.7	2416.7	125.7	2430.7	2556.4
32	0.0475	0.001005	29.6	134.0	2419.4	134.0	2425.9	2560.0
34	0.0532	0.001006	26.6	142.4	2422.1	142.4	2421.2	2563.6
36	0.0594	0.001006	24.0	150.7	2424.8	150.7	2416.4	2567.2
38	0.0662	0.001007	21.6	159.1	2427.5	159.1	2411.7	2570.8
40	0.0738	0.001008	19.55	167.4	2430.2	167.5	2406.9	2574.4
42	0.0820	0.001009	17.69	175.8	2432.9	175.8	2402.1	2577.9
44	0.0910	0.001009	16.04	184.2	2435.6	184.2	2397.3	2581.5
46	0.1009	0.001010	14.56	192.5	2438.3	192.5	2392.5	2585.1
48	0.1116	0.001011	13.23	200.9	2440.9	200.9	2387.7	2588.6

Data Table -03: Properties of Saturated Steam: Pressure Table

P(bar)	T(°C)	$\hat{V}$(m³/kg)		$\hat{U}$(kJ/kg)		$\hat{H}$(kJ/kg)		
		Water	Steam	Water	Steam	Water	Evaporation	Steam
40	250.3	0.001252	0.0497	1082.4	2601.3	1087.4	1712.9	2800.3
42	253.2	0.001259	0.0473	1096.3	2600.7	1101.6	1697.8	2799.4
44	256.0	0.001266	0.0451	1109.8	2599.9	1115.4	1682.9	2798.3
46	258.8	0.001272	0.0430	1122.9	2599.1	1128.8	1668.3	2797.1
48	261.4	0.001279	0.0412	1135.6	2598.1	1141.8	1653.9	2795.7
50	263.9	0.001286	0.0394	1148.0	2597.0	1154.5	1639.7	2794.2
52	266.4	0.001292	0.0378	1160.1	2595.9	1166.8	1625.7	2792.6
54	268.8	0.001299	0.0363	1171.9	2594.6	1178.9	1611.9	2790.8
56	271.1	0.001306	0.0349	1183.5	2593.3	1190.8	1598.2	2789.0
58	273.3	0.001312	0.0337	1194.7	2591.9	1202.3	1584.7	2787.0