

**17th NATIONAL CERTIFICATION EXAMINATION
FOR
ENERGY MANAGERS & ENERGY AUDITORS – September, 2016**

**PAPER – 1: GENERAL ASPECTS OF ENERGY MANAGEMENT & ENERGY
AUDIT**

Date: 24.09.2016 Timings: 0930-1230 HRS Duration: 3 HRS

General instructions:

- Please check that this question paper contains **11** printed pages
- Please check that this question paper contains **64** questions
- The question paper is divided into three sections
- All questions in all three sections are compulsory
- All parts of a question should be answered at one place

Section – I: OBJECTIVE TYPE

1.	Which of these is not true of payback period a. Simple to calculate b. Considers cash flow beyond the payback period c. Shorter the period the better d. Does not take into account, time value of money
2.	Which of the following statements regarding ECBC are correct? i) ECBC defines the norms of energy requirements per cubic metre of area ii) ECBC does not encourage retrofit of Energy conservation measures iii) ECBC prescribes energy efficiency standards for design and construction of commercial and industrial buildings iv) One of the key objectives of ECBC is to minimize life cycle costs (construction and operating energy costs) a) i b) ii c) iii d) iv
3.	Which of the following sector is not covered under PAT? a) Chlor-alkali c) Cement b) Aluminum d) Commercial buildings
4.	Which of the following enhances the energy efficiency in buildings? a) Light pipes b) Triple glaze windows c) Building integrated solar photovoltaic panels d) All of the above
5.	Which energy source releases the most climate-altering carbon pollution per kg?

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	a). Oil b). Coal c). Rice husk d). Bagasse
6.	Which amongst the following sources of electricity has the highest installed capacity in India ? a) Gas b) Nuclear c) Oil d) Renewables
7.	Which among the following is a green house gas? a) Sulphur Dioxide b) Carbon Monoxide c) NO ₂ d) Methane
8.	Which among the following factor(s) is most appropriate for adopting EnMS? a) To improve their energy efficiency b) To reduce costs c) To increase productivity d) Systematically manage their energy use
9.	What is the future value of Rs.1000/- after 3 years, if the interest rate is 10% a) Rs. 1331 b) Rs.1610 c) Rs.3221 d) none of the above
10.	What is the expected power output in watts from a wind turbine with 6m diameter rotor, a coefficient of performance 0.45, generator efficiency 0.8, a gear box efficiency 0.90 and wind speed of 11m/sec a. 4875 watts b. 1100 watts c. 7312 watts d. 73.12 kW
11.	Verification and Check-verification under PAT will be carried out by a) Designated consumers b) Accredited energy auditors c) Certified energy auditor d) Empanelled accredited energy auditors
12.	To judge the attractiveness of any investment, the energy auditor must consider a) Initial capital cost b) Net operating cash inflows c) salvage value d) all the above
13.	The quantity of heat required to raise the temperature of a given substance by 1 °C is known as: a) sensible heat b) specific heat c) heat capacity d) latent heat
14.	The producer gas is basically a. CO, H₂ and CH₄ b. Only CH ₄ c. CO and CH ₄ d. Only CO and H ₂
15.	The Metric Tonne of Oil Equivalent (MTOE) value of 125 tonnes of coal having GCV of 4000 kcal/kg is

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	a) 40 b) 50 c) 100 d) 125
16.	The lowest theoretical temperature to which water can be cooled in a cooling tower is a. Difference between DBT and WBT of the atmospheric air b. Average DBT and WBT of the atmospheric air c. DBT of the atmospheric air d. WBT of the atmospheric air
17.	The kilowatt-hour is a unit of a) power b) work c) time d) force.
18.	The internal rate of return is the discount rate for which the NPV is a. Positive b. Zero c. Negative d. Less than 1
19.	The essential elements of monitoring and targeting system is a) Recording b) Reporting c) Controlling d) All of the above
20.	The energy intensity of countries that rely on import of carbon-intensive goods when compared with those producing it, would in all probability be a) Higher b) Lower c) Almost equal d) No correlation
21.	Red wood seconds is a measure of a) Density b) Viscosity c) Specific gravity d) Flash point
22.	One energy saving certificate (ESCerts) under PAT is equivalent to a. one ton of carbon b. one MWh of electricity c. one ton of coal d. one ton of Oil equivalent
23.	M & V audit under PAT is carried out a) Immediately after the baseline audit b) Every year following the baseline audit c) At the end of each PAT cycle d) Before the baseline audit
24.	Liquid fuel density is measured by an instrument called a) Tachometer b) hygrometer c) anemometer d) None of the above
25.	ISO 50001:2011 provides a framework of requirements for organizations to: a) Develop a policy for more efficient use of energy b) Measure the results c) Fix targets and objectives to meet the policy d) all of the above
26.	In an industry the billed electricity consumption for a month is 5.8 lakh kWh. The fixed electricity consumption of the plant is 30000kWh and with a variable electricity consumption of 11 kWh/ton. Calculate the production of the industry a) 50000 tonnes b) 60000 tonnes c) 58000 tonnes d) None of the above
27.	In a solar thermal power station , molten salt which is a mixture of 60% sodium nitrate and 40% potassium nitrate is used. It is preferred as it provides an efficient low cost

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	<p>medium to store _____</p> <p>a. Electrical energy b. Thermal energy c. Kinetic energy d. Potential energy</p>
28.	<p>In a drying process product moisture is reduced from 60% to 30%. Inlet weight of the material is 200 kg. Calculate the weight of the outlet product.</p> <p>a) 80 b) 120.5 c) 114.3 d) none of the above</p>
29.	<p>In a cumulative sum chart if the graph is going up, it means</p> <p>a. Energy consumption is going up b. Energy consumption is going down c. Specific energy consumption is coming down d. No inference can be made</p>
30.	<p>In a coal fired boiler, hourly consumption of coal is 1300 kg. The ash content in the coal is 6%. Calculate the quantity of ash formed per day. Boiler operates 24 hrs/day.</p> <p>a) 216 kg b) 300 kg c) 1872 kg d) none of the above</p>
31.	<p>In a chemical process two reactants A (300 kg) and B (400 kg) are used. If conversion is 50% and A and B react in equal proportions, the mass of the product formed is.</p> <p>a) 300 kg b) 350 kg c) 400 kg d) none of the above</p>
32.	<p>If the reactive power drawn by a particular load is zero it means the load is operating at</p> <p>a) Lagging power factor b) Unity power factor c) Leading power factor d) none of the above</p>
33.	<p>If Heat Rate of Power plant is 3000 kCal/kWh then efficiency of Power plant will be</p> <p>a) 28.67% b) 35% c) 41% d) None of the above</p>
34.	<p>If a 2 KW immersion heater is used to heat 30litres of water at 30°C, what would be the temperature of water after 15 minutes? Assume no losses in the system.</p> <p>a) 87.3 °C b) 44.3°C c) 71.3 °C d) none of the above</p>
35.	<p>Having a documented energy policy in industry</p> <p>a) Satisfies regulations b) Reflects top management commitment c) Indicates availability of energy audit skills d) None of the Above</p>
36.	<p>Greenhouse effect is caused by natural affects and anthropogenic effects. If there is no natural greenhouse effect, the Earth's average surface temperature would be around _____°C.</p> <p>a) 0 b) 32 c) 14 d) - 18</p>
37.	<p>For every 10°C rise in temperature, the rate of chemical reaction doubles. When the temperature is increased from 30°C to 70°C, the rate of reaction increases _____ times.</p> <p>a) 8 b) 64 c) 16 d) none of the above</p>
38.	<p>Energy is consumed by all sectors of the economy but at different proportions. Which</p>

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	sector in India is the largest consumer? a) Agriculture b) Industrial c). Commercial d). Domestic
39.	Energy Intensity is the ratio of a) Fuel Consumption / GDP b) GDP/Fuel Consumption c) GDP/ Energy Consumption d) Energy Consumption / GDP
40.	Doppler effect principle is used in the following instrument a) lux meter c) infrared thermometer b) ultrasonic flow meter d) flue gas analyzer
41.	Diagrammatic representation of input and output energy streams of an equipment or system is known as a) mollier diagram c) psychrometric chart b) sankey diagram d) balance diagram
42.	Capital cost are associated with a) Design of Project b) Installation and Commissioning of Project c) Operation and Maintenance cost of project d) both a and b
43.	At Standard Atmospheric Pressure, specific enthalpy of saturated water, having temperature of 50°C will be _____ kCal/kg. a) 1 b) 50 c) 100 d) none of the above
44.	Any management would like to invest in projects with a) Low IRR c) Low NPV of future returns b) Low ROI d) none of the above
45.	Absolute pressure is a. Gauge pressure b. Gauge pressure + Atmospheric pressure c. Atmospheric pressure d. Gauge pressure - Atmospheric pressure
46.	A three phase induction motor is drawing 16 Ampere at 440 Volts. If the operating power factor of the motor is 0.90 and the motor efficiency is 92%, then the mechanical shaft power output of the motor is a) 12.04 kW c) 10.97 kW b) 10.09 kW d) None of the above
47.	A solar _____ is connected and packaged in a solar _____, which in turn is linked with others in sequence in a solar _____. a) module, cell, array b) array, module, sequence c) module, array, sequence

	d) cell, module, array
48.	A sling psychrometer is capable of measuring a) only dry bulb temperature b) only wet bulb temperature c) both dry and wet bulb temperature d) absolute humidity
49.	A mass balance for energy conservation does not consider which of the following a. Steam b. water c. Lubricating oil d. Raw material
50.	A comparison of the trapping of heat by CO ₂ and CH ₄ is that a)CH₄ traps 21 times more heat in the atmosphere than does CO₂ b) CO ₂ traps 21 times more heat in the atmosphere than does CH ₄ c) the same amount of heat is trapped by both CO ₂ and CH ₄ d) none of the above

..... **End of Section – I**

Section – II: SHORT DESCRIPTIVE QUESTIONS

S-1	In a textile manufacturing unit, wet cloth is dried in a stenter. The cloth entering the stenter has a moisture of 52% while that leaving the stenter is 96% dry. If the production rate (output) from the stenter is 200 Kg/hr, what is the quantity of steam required per hour, if the steam enters the stenter with an enthalpy of 660 kcal/kg. The condensate leaving the stenter is at 150°C. Consider drying to take place at atmospheric pressure where the latent heat of water is 540 Kcal/Kg.
Ans	Stenter output = 200 kgs/hr Bone dry cloth in output = 200 X 0.96 = 192 kgs. Moisture in output = 8 kgs. Moisture in input = 52% Bone dry cloth in input = 48% Total weight of input cloth = 192/0.48 = 400 kg/hr Quantity of water evaporated = 400 – 200 = 200 kg/hr Assuming sensible heat in steam at 150 °C = 150 kcal/kg Quantity of steam required = (200 X 540)/(660 – 150) = 211.8 kg/hr
S - 2	The average monthly electricity consumption in an Aluminium producing unit is 12.35 lakh kWh. The other energy sources used in the manufacturing process are Furnace oil (GCV- 9660 Kcal/Ltr) and HSD (GCV-9410 Kcal/Ltr). If the annual fuel oil consumption is 5760 KL of Furnace oil (sp. gr. 0.92) and 500 KL of HSD (sp. gr. 0.88), determine if the unit qualifies as a Designated Consumer under the EC Act?
Ans	1 Mtoe = 1 x 10 ⁷ kcal Annual electrical energy consumption = 12.35 x 12 = 148.2 lac Kwh Equivalent heat energy = (148.2 x 10 ⁵ x 860)/(1 x 10 ⁷)

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	$= 1274.52 \text{ Mtoe} \quad \text{_(i)}$ <p>Annual Furnace oil consumption = 5760 kL Equivalent heat energy = $(5760 \times 1000 \times 9660)/(1 \times 10^7)$ $= 5564.16 \text{ Mtoe} \quad \text{_(ii)}$</p> <p>Annual HSD consumption = 500 kL Equivalent heat energy = $(500 \times 1000 \times 9410)/(1 \times 10^7)$ $= 470.5 \text{ Mtoe} \quad \text{_(iii)}$</p> <p>Total annual energy consumption = $1274.52 + 5564.16 + 470.5$ $= 7309.18 \text{ Mtoe}$</p> <p>To be a designated consumer, the minimum annual energy consumption (in aluminium sector) should be 7500 Mtoe. As the plant energy consumption doesn't exceed this threshold limit, it is not qualifies to be a designated consumer. 1 mark</p>
S-3	The annual fuel cost of boiler operation in a plant is Rs.8 Lakhs. The boiler with 65% efficiency is now replaced by a new one with 78% efficiency. What is the annual cost savings?
Ans	<p>Existing efficiency =65%</p> <p>Proposed efficiency=78%</p> <p>Annual fuel cost =Rs. 8 Lakhs</p> <p>Annual cost savings = annual fuel cost * (1-(Eff_O/Eff_N))</p> $= 8x((1-(0.65/0.78))$ $=Rs. 1,33,333.6 \text{ per annum}$
S-4	Give relationship between Absolute and Gauge pressures. Give 4 different units used in pressure measurement.
Ans	<p><i>Absolute pressure</i> is zero-referenced against a perfect vacuum, so it is equal to <i>gauge pressure</i> plus <i>atmospheric pressure</i>.</p> <p><i>Gauge pressure</i> is zero-referenced against ambient <i>air pressure</i>, so it is equal to <i>absolute pressure</i> minus <i>atmospheric pressure</i>. (Negative signs are usually omitted)</p> <p>Absolute Pressure = Prevailing Atmospheric Pressure + Gauge Pressure</p> <p>(NOTE: also please refer guide book-1 pg-70)</p> <p>The four units of pressure measurement are:</p> <ul style="list-style-type: none"> i) Pascal ii) kg / cm² iii) Atmospheric iv) mm of mercury v) Meters of water column vi) Pounds / inch²
S – 5	A plant is using 6 tonnes/day of coal to generate steam . The calorific of coal is 3300 kcal/kg. The cost of coal is Rs 4200/tonne . The plant substitutes coal with agro-residue , as a boiler fuel, which has a calorific value of 3100 kcal /kg and cost Rs 1800/tonne. Calculate the annual cost savings at 350 days of operation ,assuming the boiler efficiency remains same at 72% for coal and agro residue as fuel.

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Ans	<p>Useful energy to generate steam by 6 tonnes of coal per day $= 6000 \times 3300 \times 0.72 = 14256000 \text{ kcal/day}$</p> <p>To deliver 14256000kcal/day , daily amount of rice husk required $= \frac{14256000}{3100 \times 0.72} = 6387 \text{ kg/day}$</p> <p>Daily saving = $\frac{6000}{1000} \times 4200 - \frac{6387}{1000} \times 1800$ $= 25200 - 11497$ $= \text{Rs } 13703/-$</p> <p>Annual saving = 13703×350 $= \text{Rs } 47,96,050/-$</p>
S-6	Explain how an ESCO model works?
Ans	<p>ESCOs are usually companies that provide a complete energy project service, from assessment to design to construction or installation, along with engineering and project management services and financing.</p> <p>The ESCO will usually offer the following performance contract options.</p> <ul style="list-style-type: none"> • Fixed fee • Shared Savings • Guaranteed savings <p><i>(Note: Please refer page no: 177-179 of Paper 1, candidates can write relevant things about ESCO operation model)</i></p>
S – 7	<p>A tank containing 500 kg of kerosene is to be heated from 10°C to 40°C in 20 minutes, using 4 bar (g) steam. The kerosene has a specific heat capacity of 2.0 kJ/kg °C over that temperature range. Latent heat of steam (hfg) at 4.0 bar g is 2 108 kJ/kg. The tank is well insulated and heat losses are negligible. Determine the steam flow rate in kg/hr.</p>
Ans	<p>$Q = 500 \text{ kg} \times 2 \text{ kJ/kg}^\circ\text{C} \times (40-10)^\circ\text{C}/(1200)$</p> <p>$= 25 \text{ kJ/sec}$</p> <p>Therefore mass of steam = $25 \text{ kJ/sec} \times 3600 / 2108 \text{ kJ/kg}$</p> <p>$= 42.69 \text{ kg/h}$</p>
S – 8	<p>Feed water is provided to a boiler at 70°C from the feedwater tank. The temperature of condensate water returning to the tank is 86°C, while the temperature of makeup water is 27°C. Determine the amount of condensate water that can be recovered?</p>
Ans	<div style="text-align: center;"> </div> <ul style="list-style-type: none"> • Performing a mass & heat balance yields,

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	<ul style="list-style-type: none"> • (i.e : $mCpdT_{Cond} + mCpdT_{MakeUp} = mCpdT_{FeedWater}$) $(27)(x)(1) + (86)(1-x)(1) = 70(1)(1)$ • Therefore, $x = 0.27$ or 27% of make-up water. • Hence, condensate recovered = 73%
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..... **End of Section – II**

Section – III: LONG DESCRIPTIVE QUESTIONS

L - 1	<p>A 20 kW, 415V, 38A, 4 pole, 50 Hz, 3 phase rated squirrel cage induction motor has a full load efficiency and power factor of 88% and 0.85 respectively. An energy auditor measures the following operating data of the motor.</p> <ol style="list-style-type: none"> 1) Supply voltage= 408V 2) Current drawn= 28A 3) PF=0.83 <p>.Find out the following at motor operating conditions.</p> <ol style="list-style-type: none"> 1) Power input in kW 2) % motor loading <p>b) List five energy saving measures in your home</p>
Ans	<p>a)</p> <ol style="list-style-type: none"> 1) Power input = $1.732 \times 408 \times 28 \times 0.83$ = 16.42 kW 2) % motor loading = $16.42 / (20 / 0.88) \times 100$ = $(16.42 / 22.73)$ = 72.24% <p>b)</p> <ul style="list-style-type: none"> • Replacement of inefficient electric lamps with efficient electric lamps • Using star labeled household appliances like A/c's, Refrigerator, Lamps, Fans • Using Solar water heating systems for hot water requirements to minimize use of electric geysers • Using Solar PV systems for electricity generation • Proper ventilation maximizing the use of natural light • Switching off all equipment when not required • Using pressure cooker for cooking food • Maximizing the use of low fire burner (SIM) in the gas stove • Using A/Cs at setpoint of 21°C-23°C instead of 16°C • Placing the fridge so that the rear (condenser coils) are located where there is proper air flow. <p>Note : Any five of the above and also give marks for other relevant options</p>
L – 2	<p>The integrated paper plant has produced 134241 MT of paper during the year 2012-13. The management has implemented various energy conservation measures as part of PAT scheme and reduced the specific energy consumption from 53 GJ/ tonne of product to 49 GJ/tonne of product. The actual production during the assessment year (2014-15) is 124141 MT. Calculate the plant energy performance and state your inference.</p>
Ans	<p>Reference year production = 134241 MT</p>

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Reference year specific energy consumption = 53 GJ/tonne of product
 Assessment year production = 124141 MT
 Assessment year specific energy consumption = 49 GJ/tonne of product

$$\text{Production Factor} = \frac{\text{Assessment year's production}}{\text{Reference year's production}}$$

production factor = (124141 / 134241) = 0.92

Reference year's energy consumption, GJ

$$= \text{Reference year's specific energy consumption, } \frac{\text{GJ}}{\text{MT}} \times \text{Reference year's Production, MT}$$

= 53 x 134241 = 7114773 GJ

Assessment year's energy consumption, GJ

$$= \text{Assessment year's specific energy consumption, } \frac{\text{GJ}}{\text{MT}} \times \text{Assessment year's Production, MT}$$

= 49 x 124141 = 6082909 GJ

Reference year's equivalent energy use, GJ

$$= \text{Reference year's energy consumption, GJ} \times \text{Production factor}$$

= 7114773 GJ x 0.92 = 6545591.16 GJ

Plant Energy performance, %

$$= \frac{\text{Reference year's equivalent} - \text{Assessment years energy}}{\text{Reference year's equivalent energy}} \times 100$$

= ((6545591.16 - 6082909) / 6545591.16) x 100

= 7.07%

Inference : plant energy performance is positive and hence the plant is achieving energy savings.

- L - 3 **The cash flows in two different energy conservation projects are given in the table below. Please help the management of an infrastructure company to decide which project to invest in as the management is interested in investing in only one project. The company is likely to consider any project which gives a minimum return on investment of 19%. Please justify your choice.**

(Amount in Rs.)

	Project A		Project B	
Investment	17,50,000/-		12,00,000/-	
Year	Expenses	Savings	Expenses	Savings
1		4,00,000		4,50,000
2		4,00,000		4,00,000
3		4,00,000		3,50,000
4		4,00,000		3,00,000
5	30,180	6,00,000		2,50,000
6		6,00,000		2,00,000
7		6,00,000		1,16,650
8		3,80,300		

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Ans	<p>As the investments required in both the cases as well as their durations are different, the prudent method to compare the two projects would be to calculate their NPV.</p> <p>a) NPV of Project A @ 19% = $(-1750000 / (1+0.19)^0) + (4,00,000 / (1+0.19)^1) + (4,00,000 / (1+0.19)^2) + (4,00,000 / (1+0.19)^3) + (4,00,000 / (1+0.19)^4) + ((6,00,000-30180) / (1+0.19)^5) + (6,00,000 / (1+0.19)^6) + (6,00,000 / (1+0.19)^7) + (3,80,300 / (1+0.19)^8) = 27,622$</p> <p>b) NPV of Project B @ 19% = $(-1200000 / (1+0.19)^0) + (4,50,000 / (1+0.19)^1) + (4,00,000 / (1+0.19)^2) + (3,50,000 / (1+0.19)^3) + (3,00,000 / (1+0.19)^4) + (2,50,000 / (1+0.19)^5) + (2,00,000 / (1+0.19)^6) + (1,16,650 / (1+0.19)^7) = 27,622$</p> <p>Since both the projects are having the same NPV at 19%, both the projects are worth considering. However, by increasing the rate 20% if one of the projects shows higher NPV, that project would be the choice between the two.</p> <p>c) NPV of Project A @ 20% = $(-1750000 / (1+0.2)^0) + (4,00,000 / (1+0.2)^1) + (4,00,000 / (1+0.2)^2) + (4,00,000 / (1+0.2)^3) + (4,00,000 / (1+0.2)^4) + ((6,00,000-30180) / (1+0.2)^5) + (6,00,000 / (1+0.2)^6) + (6,00,000 / (1+0.2)^7) + (3,80,300 / (1+0.2)^8) = (-) 28,675$</p> <p>d) NPV of Project B @ 20% = $(-1200000 / (1+0.2)^0) + (4,50,000 / (1+0.2)^1) + (4,00,000 / (1+0.2)^2) + (3,50,000 / (1+0.2)^3) + (3,00,000 / (1+0.2)^4) + (2,50,000 / (1+0.2)^5) + (2,00,000 / (1+0.2)^6) + (1,16,650 / (1+0.2)^7) = 3.86$</p> <p>As the NPV of project B at 20% is higher than that of Project A, Project B is recommended.</p>
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L – 4	<p>The energy consumption pattern in a steel re rolling mill over 8 month period is provided in the table below;</p> <table border="1" style="margin-left: auto; margin-right: auto; border-collapse: collapse; text-align: center;"> <thead> <tr> <th style="padding: 5px;">Month</th> <th style="padding: 5px;">Production (Tons)</th> <th style="padding: 5px;">Coal Consumption (Tons)</th> </tr> </thead> <tbody> <tr><td style="padding: 5px;">1</td><td style="padding: 5px;">488</td><td style="padding: 5px;">422</td></tr> <tr><td style="padding: 5px;">2</td><td style="padding: 5px;">553</td><td style="padding: 5px;">412</td></tr> <tr><td style="padding: 5px;">3</td><td style="padding: 5px;">455</td><td style="padding: 5px;">411</td></tr> <tr><td style="padding: 5px;">4</td><td style="padding: 5px;">325</td><td style="padding: 5px;">363</td></tr> <tr><td style="padding: 5px;">5</td><td style="padding: 5px;">488</td><td style="padding: 5px;">438</td></tr> <tr><td style="padding: 5px;">6</td><td style="padding: 5px;">585</td><td style="padding: 5px;">426</td></tr> <tr><td style="padding: 5px;">7</td><td style="padding: 5px;">455</td><td style="padding: 5px;">414</td></tr> <tr><td style="padding: 5px;">8</td><td style="padding: 5px;">419</td><td style="padding: 5px;">396</td></tr> </tbody> </table> <p style="margin-left: 20px;">Estimate,</p> <p style="margin-left: 20px;">i) Fixed energy consumption in the Mill.</p> <p style="margin-left: 20px;">ii) Expected coal consumption for a production of 500 Tons/month.</p>	Month	Production (Tons)	Coal Consumption (Tons)	1	488	422	2	553	412	3	455	411	4	325	363	5	488	438	6	585	426	7	455	414	8	419	396
Month	Production (Tons)	Coal Consumption (Tons)																										
1	488	422																										
2	553	412																										
3	455	411																										
4	325	363																										
5	488	438																										
6	585	426																										
7	455	414																										
8	419	396																										

Ans	To establish the relationship between Production & Coal consumption, it is necessary to derive the best-fit line. for which the following normal equation are used (see page 218 of book 1)
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$Cn + m\sum x = \sum y$ $c\sum x + m\sum x^2 = \sum xy$				
n	x	y	x ²	xy
1	488	422	238144	205936
2	553	412	305809	227836
3	455	411	207025	187005
4	325	36	105 5	11 975
5	488	438	238144	213744
6	585	426	342225	249210
7	455	414	207025	188370
8	419	396	175561	165924
Total	3768	3282	1819558	1556000

Therefore, the normal equations become;

$8c + 3768m = 3282$ i

$3768c + 1819558m = 1556000$ ii

$c = (3282 - 3768m) / 8$

Substituting in Eq. ii,

$m = 0.23$ and

$c = 316$

The best-fit straight line equation is;

$y = 0.23x + 316$

i) The fixed energy consumption in the Mill = 316 Tons of coal/month

ii) The expected coal consumption for a production of 500 Tons,

$= 0.23 \times 500 + 316 = 431$ Tons

L - 5 Explain PAT Scheme and its potential impact?

Ans **Perform, Achieve and Trade (PAT) Scheme** is a market based mechanism to enhance cost effectiveness of improvements in energy efficiency in energy-intensive large industries and facilities, through certification of energy savings that could be traded.

The key goal of PAT scheme is to mandate specific energy efficiency improvements for the most energy intensive industries. The scheme builds on the large variation in energy intensities of different units in almost every sector. The scheme envisages improvements in the energy intensity of each unit covered by it. The energy intensity reduction target mandated for each unit is dependent on its operating efficiency: the specific energy consumption reduction target is less for those who are more efficient, and is higher for the less-efficient units.

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	<p>Further, the scheme incentivizes units to exceed their specified SEC improvement targets. To facilitate this, the scheme provides the option for industries who achieve superior savings to receive energy savings certificates for this excess savings, and to trade the additional certified energy savings certificates with other designated consumers(energy intensive industries notified as Designated Consumers under the Energy Conservation Act and included under PAT Scheme) who can utilize these certificates to comply with their specific energy consumption reduction targets. Energy Savings Certificates (ESCerts) so issued will be tradable at Power Exchanges. The scheme also allows units which gain ESCerts to bank them for the next cycle of PAT, following the cycle in which they have been issued. The number of ESCerts which would be issued would depend on the quantum of energy saved over and above the target energy savings in the assessment year (for 1stCycle of PAT, assessment year is 2014-15).</p> <p>After completion of baseline audits, targets varying from unit to unit ranging from about 3 to 7% have been set and need to be accomplished by 2014-15 and after which new cycle with new targets will be proposed. Failing to achieve the specific energy consumption targets in the time frame would attract penalty for the non-compliance under Section 26 (1A) of the Energy Conservation Act, 2001 (amended in 2010). For ensuring the compliance with the set targets, system of verification and check-verification will be carried out by empanelment criteria of accredited energy auditors.</p>
L-6	<p>In a particular drying operation, it is necessary to hold the moisture content of feed to a calciner to 15% (W/W) to prevent lumping and sticking. This is accomplishing by mixing the feed having 35% moisture (w/w) with recycle steam of dried material having 5% moisture (w/w). The dryer operation is shown in fig below. What fraction of the dried product must be recycled?</p> <div style="margin-top: 10px;"> <p>Fresh Feed (F) : 65% solids & 35% Moisture</p> </div>
	<p>Let F indicate quantity of feed R indicate quantity of recycle P indicate quantity of product Based on solid content at Mixer</p>

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$$0.65F + 0.95R = 0.85 (F + R)$$
$$\text{Hence } R = 2F \dots\dots\dots(1)$$

Based on solid content at Drier

$$0.85 (F + R) = 0.95 (P + R)$$
$$0.85 (F + 2F) = 0.95 P + (0.95 \times 2 F)$$
$$2.55 F = 0.95 P + 1.9 F$$
$$0.65 F = 0.95 P$$
$$\text{Hence } F = 1.46 P \dots\dots\dots(2)$$

Substituting (2) in (1) for obtaining Recycle quantity in terms of Product

$$R = (2.0 \times 1.46 P) = 2.92 P \dots\dots\dots(3)$$

Product plus Recycle is

$$P + R = (P + 2.92 P) = P(1 + 2.92) = 3.92 P \dots\dots(4)$$

$$R \text{ (as a fraction of dried product)} = \{(2.92 P) / (3.92 P)\} \times (100)$$
$$= 74.49\%$$