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 **8** 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.	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
2.	If a 2 KW immersion heater is used to heat 30litres of water at 30^{O}C, what would be the temperature of water after 15 minutes? Assume no losses in the system a) 87.3 ^{O}C **b) 44.3^{O}C** c) 71.3 ^{O}C d) none of the above
3.	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) iiii **d) iv**
4.	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**
5.	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**
6.	Energy is consumed by all sectors of the economy but at different proportions. Which sector in India is the largest consumer? a) Agriculture c). Commercial b) **Industrial** d). Domestic
7.	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
8.	Which of the following sector is not covered under PAT? a) Chlor-alkali c) Cement b) Aluminum d) **Commercial buildings**
9.	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**
10.	At Standard Atmospheric Pressure, specific enthalpy of saturated water, having temperature of 50^{o}C will be _____ kCal/kg. a) **1** b) 50 c) 100 d) none of the above
11.	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. a) 80 b) 120.5 c) **114.3** d) none of the above
12.	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**
13.	Which energy source releases the most climate-altering carbon pollution per kg? **a). Oil** b). Coal c). Rice husk d). Bagasse
14.	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
15.	Having a documented energy policy in industry

	a) Satisfies regulations b) **Reflects top management commitment** c) Indicates availability of energy audit skills d) None of the Above
16.	Red wood seconds is a measure of a) Density b) **Viscosity** c) Specific gravity d) Flash point
17.	Which amongst the following sources of electricity has the highest installed capacity in India ? a)Gas b) Nuclear c) Oil d) **Renewables**
18.	Energy Intensity is the ratio of a) **Fuel Consumption / GDP** b) GDP/Fuel Consumption c) GDP/ Energy Consumption d) Energy Consumption / GDP
19.	If Heat Rate of Power plant is 3000 kCal/kWh then efficiency of Power plant will be **a) 28.67%** b) 35% c) 41% d) None of the above
20.	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 medium to store _____ a. Electrical energy **b. Thermal energy** c. Kinetic energy d. Potential energy
21.	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. a) 8 b) 64 **c) 16** d) none of the above
22.	The producer gas is basically **a. CO, H_2 and CH_4** b. Only CH_4 c. CO and CH_4 d. Only CO and H_2
23.	The essential elements of monitoring and targeting system is a) Recording b) Reporting c) Controlling d) **All of the above**
24.	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**
25.	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
26.	If the reactive power drawn by a particular load is zero it means the load is operating at a) Lagging power factor b**) Unity power factor** c) Leading power factor d) none of the above
27.	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**
28.	Any management would like to invest in projects with a**)** Low IRR b) Low ROI c) Low NPV of future returns **d) none of the above**
29.	The kilowatt-hour is a unit of a) power **b) work** c) time d) force.
30.	Which among the following is a green house gas? a) Sulphur Dioxide b) Carbon Monoxide c) NO_2 **d) Methane**
31.	The internal rate of return is the discount rate for which the NPV is a. Positive **b. Zero** c. Negative d. Less than 1
32.	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. a) 0 b) 32 c) 14 **d) - 18**
33.	The quantity of heat required to raise the temperature of a given substance by 1 ^{o}C is known as: a) sensible heat b) specific heat **c) heat capacity** d) latent heat
34.	The Metric Tonne of Oil Equivalent (MTOE) value of 125 tonnes of coal having GCV of 4000 kcal/kg is a) 40 **b) 50** c) 100 d) 125
35.	A mass balance for energy conservation does not consider which of the following a. Steam b. water **c. Lubricating oil** d. Raw material
36.	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
37.	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
38.	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**
39.	In a cumulative sum chart if the graph is going up, it means **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
40.	Doppler effect principle is used in the following instrument a) lux meter **b) ultrasonic flow meter** c) infrared thermometer d) flue gas analyzer
41.	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. a) 216 kg b) 300 kg c) **1872 kg** d) none of the above
42.	Liquid fuel density is measured by an instrument called a) Tachometer b) hygrometer c) anemometer **d) none of the above**
43.	A comparison of the trapping of heat by CO_2 and CH_4 is that **a) CH_4 traps 21 times more heat in the atmosphere than does CO_2** 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
44.	Diagrammatic representation of input and output energy streams of an equipment or system is known as a) mollier diagram b) **sankey diagram** c) psychrometric chart d) balance diagram
45.	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**
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** b) 10.09 kW c) 10.97 kW d) None of the above
47.	Absolute pressure is a. Gauge pressure **b. Gauge pressure + Atmospheric pressure** c. Atmospheric pressure d. Gauge pressure - Atmospheric pressure
48.	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.

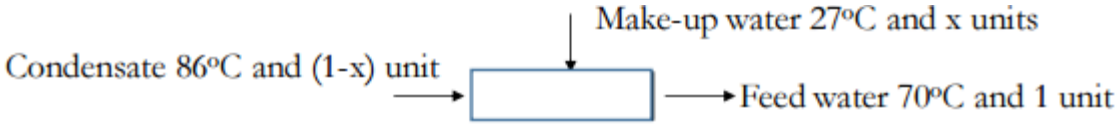
	a) 300 kg b) 350 kg c) 400 kg d) none of the above
49.	What is the expected power output in watts from a wind turbine with 6m diameter rotor, a coefficient of performance 0.45, generator efficiency 0.8,a gear box efficiency 0.90 and wind speed of 11m/sec a. 4875 watts b. 1100 watts **c. 7312 watts** d. 73.12 kW
50.	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**

…… End of Section – I ……

Section – II: SHORT DESCRIPTIVE QUESTIONS

S-1	**Give relationship between Absolute and Gauge pressures. Give 4 different units used in pressure measurement**.
Ans	*Absolute pressure* is zero-referenced against a perfect vacuum, so it is equal to *gauge pressure* plus *atmospheric pressure*. *Gauge pressure* is zero-referenced against ambient *air pressure*, so it is equal to *absolute pressure* minus *atmospheric pressure*. (Negative signs are usually omitted) Absolute Pressure = Prevailing Atmospheric Pressure + Gauge Pressure (***NOTE: also please refer guide book-1 pg-70***) The four units of pressure measurement are: i) Pascal ii) kg / cm^2 iii) Atmospheric iv) mm of mercury v) Meters of water column vi) Pounds / $inch^2$
S- 2	**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 costs Rs 1800/tonne. Calculate the annual cost savings at 300 days of operation, assuming the boiler efficiency remains same at 72% for coal and agro residue as fuel.**
Ans	Useful energy to generate steam by 6 tonnes of coal per day = 6000 x 3300 x 0.72 = 14256000 kcal/day

	To deliver 14256000kcal/day , daily amount of rice husk required = 14256000 =6387 kg/day 3100 x 0.72 Daily saving = 6000 x 4200 - 6387 x 1800 1000 1000 = 25200-11497 = Rs 13703/- Annual saving=13703 x 300 =Rs 41,10,900/-
S – 3	**Explain how an ESCO model works?**
	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. The ESCO will usually offer the following performance contract options. • Fixed fee • Shared Savings • Guaranteed savings
S-4	**The annual fuel cost of boiler operation in a plant is Rs.10 Lakhs. The boiler with 65% efficiency is now replaced by a new one with 78% efficiency. What is the annual cost savings**?
	Existing efficiency =65% Proposed efficiency=78% Annual fuel cost =Rs. 10 Lakhs Annual cost savings = annual fuel cost *(1-(Eff_O/Eff_N)) = 10 x ((1-(0.65/0.78)) =Rs. 1,66,667 per annum
S-5	**A tank containing 600 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 2108.1 kJ/kg. The tank is well insulated and heat losses are negligible.** **Determine the steam flow rate in kg/hr.**
	Q = 600 kg x 2 kJ/kg^{O}C x (40-10)^{O}C/(1200) = 30 kJ/sec Therefore mass of steam = 30 kJ/sec x3600 / 2108 .1 kJ/kg = 51.23 kg/h
S – 6	**Feed water is provided to a boiler at 70^{o}C from the feed water tank. The temperature of condensate water returning to the tank is 86^{o}C, while the**

	temperature of makeup water is 27°C. Determine the amount of condensate water that can be recovered?
	 • Performing a mass & heat balance yields, • (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%
S – 7	**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 170°C Consider drying to take place at atmospheric pressure where the latent heat of water is 540 Kcal/Kg.**
	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 170 ^{O}C = 170 kcal/kg Quantity of steam required = (200 X 540)/(660 – 170) = 220.4 kg/hr
S – 8	**The average monthly electricity consumption in an Aluminium producing unit is 12.35 lac 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 720 kL of HSD (sp. gr. 0.88), determine if the unit qualifies as a Designated Consumer under the EC Act?**
	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) = 1274.52 Mtoe _(i) Annual Furnace oil consumption = 5760 kL Equivalent heat energy = (5760 x 1000 x 9660)/(1 x 10^7) = 5564.16 Mtoe _(ii) Annual HSD consumption = 720 kL Equivalent heat energy = (720 x 1000 x 9410)/(1 x 10^7) = 677.52 Mtoe _(iii) Total annual energy consumption = 1274.52 + 5564.16 + 677.52 = 7516.2 Mtoe To be a designated consumer, the minimum annual energy consumption (in aluminium sector)

	should be 7500 Mtoe. As the plant exceeds this threshold limit, it qualifies to be a designated consumer.

……. End of Section – II ……..…..

Section – III: LONG DESCRIPTIVE QUESTIONS

L - 1	**The integrated paper plant has produced 119366 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 50 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.**
Ans	Reference year production = 119366 MT Reference year specific energy consumption = 53 GJ/tonne of product Assessment year production = 124141 MT Assessment year specific energy consumption = 50 GJ/tonne of product $Production\ Factor\ = \frac{Assessment\ year's\ production}{Reference\ year's\ production}$ production factor = (124141 / 119366) = 1.04 $Reference\ year's\ energy\ consumption, GJ$ $= Reference\ year's\ specific\ energy\ consumption, \frac{GJ}{MT}\ X\ Reference\ year'sProduction, MT$ = 53 x 119366 = 6326398 GJ $Assessment\ year's\ energy\ consumption, GJ$ $= Assessment\ year's\ specific\ energy\ consumption, \frac{GJ}{MT}\ X\ Assessment\ year'sProduction, MT$ =50 x 124141 = 6207050 GJ $Reference\ year's\ equivalent\ energy\ use, GJ$ $= Reference\ year's\ energy\ consumption, GJ\ X\ Production\ factor$ = 6326398 GJ x 1.04 =6579454 GJ $Plant\ Energy\ performance, \%$ $= \frac{Reference\ year's\ equivalent - Assessment\ years\ energy}{Reference\ year's\ equivalent\ energy}\ x\ 100$ = ((6579454 - 6207050) / 6579454)x 100 = 5.66% $Plant\ Energy\ performance, \% \ = 5.66$ Inference : plant energy performance is positive and hence the plant is achieving energy savings.
L – 2	**a) 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.

1) **Supply voltage= 408V**
2) **Current drawn= 30A**
3) **PF=0.83**

Find out the following at motor operating conditions.

1) **Power input in kW**
2) **% motor loading**

b) List five energy saving measures in your home

Ans

a) 1) Power input = 1.732*408*30*0.83
= 17.60 kW

2) % motor loading = [17.60/(20/0.88)]*100
= [(17.60/22.73)]*100
= 77.43%

b)

- 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^{o}C-23^{o}C instead of 16^{o}C
- Placing the fridge so that the rear (condenser coils) are located where there is proper air flow.

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 18%. 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	1,00,000	6,00,000		2,50,000
6		6,00,000		2,00,000
7		6,00,000		1,16,650

	8		3,80,300		

Ans

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.

a) NPV of Project A @ 18% = (-1750000 / $(1+0.18)^0$) + (4,00,000 / $(1+0.18)^1$) +(4,00,000 / $(1+0.18)^2$) +(4,00,000 / $(1+0.18)^3$)+ (4,00,000 / $(1+0.18)^4$) +((6,00,000-100000) / $(1+0.18)^5$)+ (6,00,000 / $(1+0.18)^6$) +(6,00,000 / $(1+0.18)^7$)+ (3,80,300 / $(1+0.18)^8$) = 57,367

b) NPV of Project B @ 18% = (-1200000 / $(1+0.18)^0$) + (4,50,000 / $(1+0.18)^1$) +(4,00,000 / $(1+0.18)^2$) +(3,50,000 / $(1+0.18)^3$)+ (3,00,000 / $(1+0.18)^4$) +(2,50,000 / $(1+0.18)^5$)+ (2,00,000 / $(1+0.18)^6$) +(1,16,650 / $(1+0.18)^7$) = 57370

Since both the projects are having the same NPV at 18%, 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.

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 / $(1+0.2)^4$) +((6,00,000-100000) / $(1+0.2)^5$)+ (6,00,000 / $(1+0.2)^6$) +(6,00,000 / $(1+0.2)^7$)+ (3,80,300 / $(1+0.2)^8$) = (-) 56734

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

As the NPV of project B at 20% is higher than that of Project A, Project B is recommended.

L – 4

The energy consumption pattern in a steel re rolling mill over 8 month period is provided in the table below;

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

Estimate,

i) Fixed energy consumption in the Mill.

ii) Expected coal consumption for a production of 600 Tons/month.

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)

$$Cn + m\sum x = \sum y$$
$$c\sum x + m\sum x^2 = \sum xy$$

n	x	y	x^2	xy
1	488	422	238144	205936
2	553	412	305809	227836
3	455	411	207025	187005
4	325	363	105625	117975
5	488	438	238144	213744
6	585	426	342225	2 9 10
7	455	414	20702	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;

$$y = 0.23x + 316$$

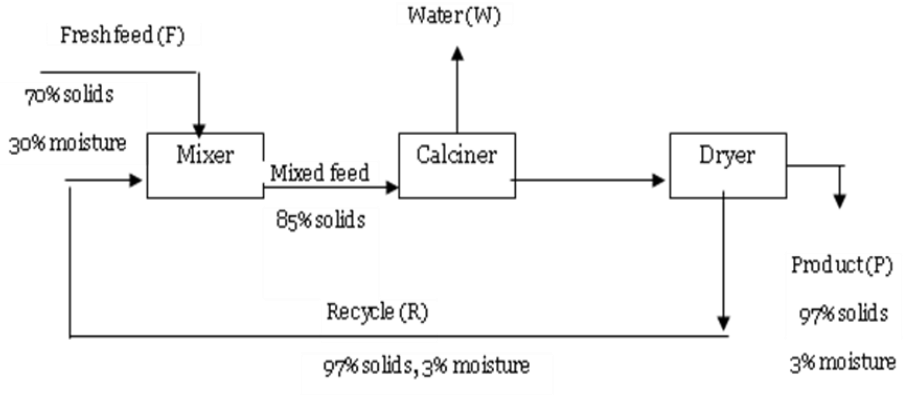
i) The fixed energy consumption in the Mill = 316 Tons of coal/month

ii) The expected coal consumption for a production of 600 Tons,

$= 0.23 \times 600 + 316 = 454$ 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. 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). 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.
L- 6	**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 30% moisture (w/w) with recycle stream of dried material having 3% moisture (w/w). The dryer operation is shown in fig below. What fraction of the dried product must be recycled?** 
	Let F indicate quantity of feed

	R indicate quantity of recycle P indicate quantity of product **Based on solid content at Mixer** 0.7F + 0.97R = 0.85 (F + R) Hence R =1.25 F ……..(1) **Based on solid content at Drier** 0.85 (F + R) = 0.97 (P + R) 0.85 (F + 1.25F) = 0.97 P + (0.97 x 1.25 F) 1.91 F = 0.97 P + 1.21F 0.7 F = 0.97 P Hence F = 1.386 P ……(2) Substituting (2) in (1) for obtaining Recycle quantity in terms of Product R = (1.25 x 1.386 P) = 1.7325 P ……..(3) Product plus Recycle is P + R = (P + 1.7325 P) = P(1 + 1.7325) = 2.7325 P ……...(4) R (as a fraction of dried product) = {(1.7325 P) / (2.7325 P)} x (100) = 63.4%

……. End of Section – III ……