Regn No: ____ _____

Name: _____

(To be written by the candidates)

8th NATIONAL CERTIFICATION EXAMINATION – May, 2009
FOR
ENERGY MANAGERS & ENERGY AUDITORS

PAPER – 1:	**General Aspects of Energy Management & Energy Audit**		
Date: 23.05.2009	Timings: 0930-1230 HRS	Duration: 3 HRS	Max. Marks: 150

General instructions:

- *Please check that this question paper contains **7** 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 — Marks: 50 x 1 = 50

(i) Answer all **50** questions
(ii) Each question carries **one** mark
(iii) Please hatch the appropriate oval in the OMR answer sheet with Black Pen or HB pencil, as per instructions

1.	India's proven oil reserves is about __% of total world reserves a) 0.1 b) 2 c) 0.4 d) 4
2.	The average operating Station Heat Rate (SHR) of a Thermal Power Plants is 3000 kCal/kWh; corresponding to this the station thermal efficiency in percentage is **a) 28.7%** b) 33.3% c) 40.1% d) 15.5%
3.	Which of the following may not be a suitable energy security option for India ? a) improving Energy Efficiency b) increasing Jatropha Cultivation c) increasing Renewable Energy use d) increasing oil fired thermal power stations
4.	The Sector which is not a Designated consumer as per the latest Gazette is a) Railways b) Iron & Steel c) Thermal Power plants d) Commercial Buildings
5.	As per Energy Conservation Act, 2001 appointment of BEE Certified Energy Manger is mandatory for a) **Designated Consumers** b) Urban Local Bodies c) All Captive Power Plants d) Electrical Distribution Licensees

6.	Which of the following could be a better index of Building Energy Performance? a) solar Heat Gain factor by wall and roof b) ratio of air-conditioned to total carpet area c) **kWh per unit area of the building per year(kWh /Sq. meter/year)** d) ratio of Captive generation to grid power consumed
7.	Calculate the amount of electricity required to heat 1 bucket (20 lit) of hot water from 30-50^{0}C a) 465 kWh b) 1 kWh c) 0.465 kWh d) 2 kWh
8.	Which of the following energy storage methods has the highest energy densities (kWh per kg)? **a) hydrogen** b) compressed air c) gasoline d) lead acid battery
9.	The rate of energy transfer is measured in a) Watts b) kCal/hr c) BTU/hr d) **all of the above**
10.	A three phase induction motor is drawing 15 Ampere at 440 Volts. If the operating power factor of the motor is 0.80 and the motor efficiency is 90%, then the power drawn by the motor is a) 9.14 kW b) 8.2 kW c) 10.16 kW d) 5.86 kW
11.	Nameplate kW or HP rating of a motor indicates a) input kW to the motor b) output kW of the motor c) minimum input kW to the motor d) maximum input kW to the motor
12.	Water flow in pipes is measured by a) pressure gauge b) infrared imaging c) ultrasonic meters d) anemometer
13.	The generally accepted energy performance parameter for thermal power plants would be a) heat rate (kCal/kWh) b) % aux. power consumption c) specific coal consumption d) all the above
14.	The type of energy possessed by the charged capacitor is a) kinetic energy b) electrostatic c) potential d) magnetic
15.	Matching energy usage to requirement means providing a) just theoretical energy needed b) just the design needs c) energy with minimum losses d) less than what is needed
16.	In general Specific Energy Consumption of a process plant for a given product mix and raw material mix a) increases with increasing capacity utilization **b) decreases with increasing capacity utilization** c) remain almost constant irrespective of capacity utilization d) has no relation with capacity utilization

17.	Which of the following will not motivate employees to conserve energy? a) training b) awareness c) enforcing targets d) incentives
18.	Which of the following best defines the role of an energy manager ? a) energy auditor and in charge of the finance department of the plant b) intermediate player between top management, energy and cost centers of the plant c) in charge of the captive power plant and mediator between plant and Electricity boards d) mediator between production manager and project manager
19.	Ten barrels of crude oil is equivalent to a) 1600 liters b) 2050 litres c) 2000 litres d) 10 liters
20.	If feed of 100 tonnes with 40% moisture, is dried to 20% moisture, the amount of water vapour evaporated would be a) 20 b) 28 c) 30 d) 40
21.	The force field analysis in energy action planning considers a) positive forces only b) negative forces only **c) both negative and positive forces** d) no forces
22.	An oil fired boiler operates at an excess air of 20%. If the stoichiometric air to fuel ratio is 14 and oil consumption is 200 kg per hour then the mass of flue gas leaving the boiler chimney in kg/ hour would be a) 3560 b) 3360 c) 3460 d) 3660
23.	Which of the following is false? a) 1 calorie = 4.187 kJ b) 1 calorie = 4.187J c) 1000 kWh = 1 MWh d) 860 kCal = 1 kWh
24.	The contract in which the ESCO provides financing and is paid an agreed fraction of actual savings as they are achieved is called a) traditional contract b) extended financing terms c) shared savings performance contract d) energy service contract
25.	Which of the following equation is used to calculate the future value of the cash flow? a) NPV $(1 - i)^n$ b) NPV + $(1 - i)^n$ **c) NPV $(1 + i)^n$** d) NPV/ $(1 + i)^n$
26.	The cost of installation of a variable speed drive in a plant is Rs 2 lakh. The annual savings are Rs 0.5 lakh. The maintenance cost is Rs. 5,000/year. The return on investment is a) 25% **b) 22.5%** c) 24% d) 27.5%
27.	A sensitivity analysis is an assessment of a) cash flows **b) risks due to assumptions** c) capital investment d) best financing source
28.	For an investment which has a fluctuating savings over its project life which of these analysis would be the best option a) Payback **b) NPV** c) ROI d) IRR

29.	ROI must always be ___ than interest rate a) lower **b) higher** c) equal d) no relation
30.	A sum of Rs 10,000 is deposited in a bank at the beginning of a year. The bank pays 10% interest annually. How much money is in the bank account at the end of the fifth year, if no money is withdrawn? **a) 16105** b) 15000 c) 15500 d) 16000
31.	A contract in which the costs are paid from all or part of the energy cost savings is called a) performance contract b) traditional contract c) extended technical guarantee contract **d) guaranteed savings performance** contract
32.	The annual electricity bill for a plant is Rs 10 lakhs and accounts for 38% of the total energy bill. Furthermore the total energy bill increases by 5% each year. How high is the plant's annual energy bill at the end of the third year? **a) Rs 30.46 lakhs** b) Rs 26.32 lakhs c) Rs 38.42 lakhs d) none of the above
33.	In Project Management the critical path in the network is a) the quickest path b) the shortest path c) the path from start to finish **d) the path where no activities have slack**
34.	The technique used for scheduling the tasks and tracking of the progress of energy management projects is called a) CPM **b) Gantt chart** c) CUSUM d) PERT
35.	If air consists of 77% by weight of nitrogen and 23% by weight of oxygen, the mean molecular weight of air is, a) 11.9 b) **28.92** c) 17.7 d) none of the above
36.	The calorific value of oil is 10000 kCal/ kg. Find out the coal equivalent to replace 1 kg of oil (Coal GCV = 16000 KJ/kg) assuming same efficiency a) 0.625 kg b) 2.6 kg c) 2 kg d) none of the above
37.	In a heat exchanger, inlet and outlet temperatures of cooling water are 28^{O}C & 33 ^{O}C. The cooling water circulation is 200 litres /hr. The process fluid enters the heat exchangers at 60 ^{O}C and leaves at 45 ^{O}C. Find out the flow rate of the process fluid? (Cp of process fluid =0.95) a) 70 b) 631 c) 63 d) 570
38.	Which of these is not a duty of an energy manager a) Report to BEE b) Provide support to accredited energy auditing firm c) Prepare a scheme for efficient use of energy d) Sign an energy policy
39.	Large scattering on production versus energy consumption trend line indicates **a) poor process control** b) many forced outages c) poor process monitoring d) none of the above

40.	In a cumulative sum chart, if the graph is horizontal, then a) nothing can be said b) energy consumption is reduced c) specific energy consumption is increasing **d) actual and calculated energy consumption are the same**
41.	Due to high oil prices, a firm goes for substitution of oil and with biomass in a boiler. The following scenario is most likely a) higher fuel cost b) better boiler efficiency **c) higher energy consumption** d) less smoke in the stack
42.	Which of the following Financial Analysis Techniques fails to consider the time value of money **a) Simple Payback Period (SPB)** b) Internal Rate of Return (IRR) c) Net Present Value (NPV) d) none of the above
43.	Assume project A has an IRR of 85% and NPV of Rs 15,000 and project B has an IRR of 25% and NPV of 200,000. Which project would you implement first if financing is available and project technical life is the same? **a) B** b) A c) cannot be decided d) question does not make sense
44.	The fixed energy consumption for the company is 1000 kWh. The slope in the energy – production chart is found to be 0.3. Find out the actual energy consumption if the company is to produced 80,000 Tons of product a) 25,000 b) 24,000 c) 26,000 d) 38,000
45.	Which of the following is not an environmental issue of global significance a) Ozone layer depletion b) Global Warning c) Loss of Biodiversity d) **Suspended particulate Matter**
46.	The commitment period for emission reductions of annex-I countries as per Kyoto protocol is a) since 2001 b) 2008 – 2012 c) there is none d) 2012 -2022
47.	The Global Warming Potential (GWP) of Nitrous Oxide gas is a) 1 b) 21 **c) 270** d) 100
48.	The national inventory of greenhouse gases in India indicates that about __ % of the total CO_2 emissions come from energy sector a) **55%** b) 15% c) 80% d) Negligible
49.	Ozone layer is found in the stratosphere between a) 5 to 10 km above the ground b) **10 to 50 km above the ground** c) 50 to 100 km above the ground d) 100 to 200 km above the ground
50.	In CDM terminology CER means a) Carbon Emission Reduction b) Clean Environment Rating c) Certified Emission Reduction d) Carbon Emission Rating

…… End of Section – I ……

Section - II: SHORT DESCRIPTIVE QUESTIONS Marks: 8 x 5 = 40

(i) Answer all **Eight** questions
(ii) Each question carries **Five** marks

S-1 Renovation and Modernization (R&M) of a 210 MW coal fired thermal power plant was carried out to enhance the operating efficiency from 27% to 31%. The specific coal consumption was 0.7 kg/kWh before R&M. For 8000 hours of operation per year, and assuming the coal quality remains the same, calculate

a) the coal savings per year and

b) the expected avoidance of CO_2 into the atmosphere in Tons/year if the emission factor is 1.53 kg CO_2/kg coal

ANS **Specific coal consumption of conventional power plant = 0.7 kg/kWh**
Specific coal consumption of power plant after R&M= 0.7 x (0.27/0.31)
= 0.6097 kg/kWh
Coal savings per annum = (0.7-0.6097) x 210 x 1000 x 8000
= 1,51,704 Tonnes per annum
CO2 avoidance = 1,51,704 x 1.53

= 232107 tonnes per annum

S-2	An energy meter connected to a 3 phase, 18.75 kWh pump shows 108 units consumption for six hours of operation. The load on the motor was steady. The consumer doubted the energy meter reading and electrical parameter such as current, voltage and power factor were measured. The measured values were 430 V line volts, 30.2 amps line current and 0.80 Power Factor. Find out if the energy meter reading is correct.
ANS	Energy consumption = $\sqrt{3}$ x 0.430 (kV) x 30.2(A) x 0.80(PF) x 6(hours) = 108 kWh The consumption shown by energy meter is correct

S-3 What is meant by the following terms ?

a) Normalising of data

b) Benchmarking

ANS **a) Normalising of data**

The energy use of facilities varies greatly, partly due to factors beyond the energy efficiency of the equipment and operations. These factors may include weather or certain operating characteristics. Normalizing is the process of removing the impact of various factors on energy use so that energy performance of facilities and operations can be compared.

a) Benchmarking

Comparison of energy performance to peers and competitors to establish a relative understanding of where our performance ranks.

S-4 What are the three flexible mechanisms available under Kyoto protocol for achieving GHG reduction targets. Explain briefly the mechanism applicable to India.

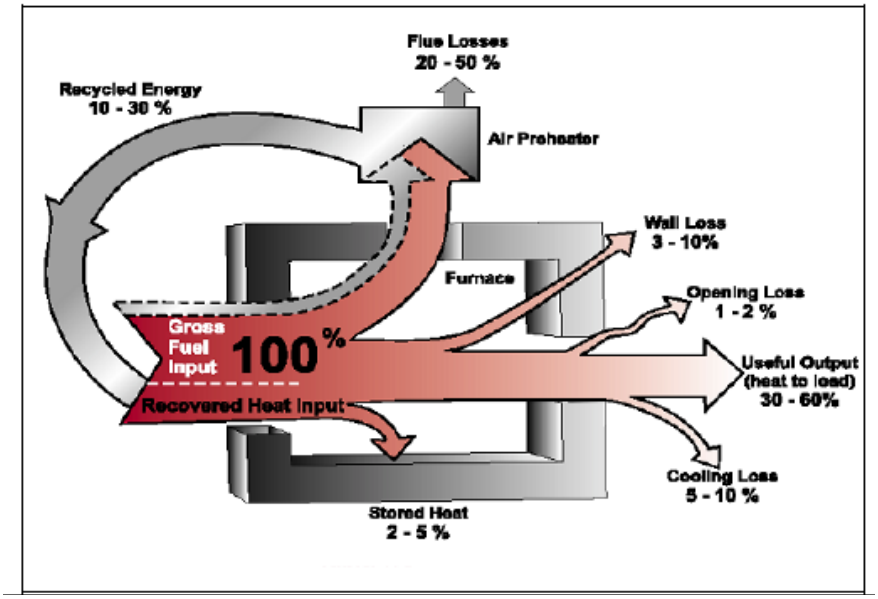
ANS
1. Joint implementation
2. Emissions trading
3. Clean Development Mechanism (CDM)

CDM is applicable to India. It is a mechanism by which the developed countries finance/fund projects intended to reduce GHG emissions in return for emission reduction credits. This will help them to achieve the emission reduction targets. Alternatively the emission reductions achieved by developing countries can also be purchased,

S-5 What is a Sankey diagram and what are its uses ? Explain with an example.

ANS The Sankey diagram is a very useful tool to proportionally represent an entire input and output energy flow in any energy equipment or system such as boilers, fired heaters, furnaces etc. after carrying out an energy balance calculation, This diagram represents visually various outputs and losses so that energy managers can focus on finding improvements in prioritized manner.

Example:



S-6	**In a compressed air Dryer, electrical heater is used for regeneration of silica gel. The present Electrical energy consumption is 100 kWh/day. The management intends to replace the electrical heater by steam coil. a) How much steam is need per day? b) Calculate cost savings/year. Cost of power is Rs.4/kwh and cost of steam is Rs. 600/ton (Assuming only latent heat of steam used. Latent heat of steam is 540 kcal/ kg. Efficiency of steam heating is 70%, operating days = 300)**
ANS	Latent heat of steam = 540 kcal/kg a) Amount of steam required = 100 * 860/(540*0.7) = 227.5 kg/day b) Cost of power = 100 * 4 = Rs.400/day Cost of steam = 0.2275 * 600 = Rs. 136.5/day Annual cost savings = (400 – 136.5) * 300 = Rs. 79050/-

S-7 Explain Time of Day (TOD) Tariff and how it is beneficial for the power system and consumers?

ANS

i. **In Time of the Day Tariff (TOD) structure incentives for power drawl during off-peak hours and disincentives for power drawl during peak hours are built in.**

ii. **Many electrical utilities like to have flat demand curve to achieve high plant efficiency.**

iii. **ToD tariff encourage user to draw more power during off-peak hours (say during 11pm to 5 am, night time) and less power during peak hours. Energy meter will record peak and off-peak consumption and normal period separately.**

iv. **TOD tariff gives opportunity for the user to reduce their billing, as off peak hour tariff is quite low in comparison to peak hour tariff.**

v. **This also helps the power system to minimize in line congestion, in turn higher line losses and peak load incident and utilities power procurement charges by reduced demand**

S-8 Calculate the net present value over a period of 3 years for a project with the following data. The discount rate is 15%.

Year	Investment (Rs)	Savings (Rs)
0	1,20,000	
1	50,000	75,000
2		75,000
3		75,000

ANS

$NPV = -120,000 + (75000-50000)/(1+0.15) + 75000/(1+0.15)^2 + 75000/(1+0.15)^3$

= -120,000 + 21,739 + 56,710 + 49, 313

= Rs. 7762

…… End of Section – II ……

Section – III: LONG DESCRIPTIVE QUESTIONS

Marks: 6 x 10 = 60

(i) Answer all **Five** questions
(ii) Each question carries **Ten** marks

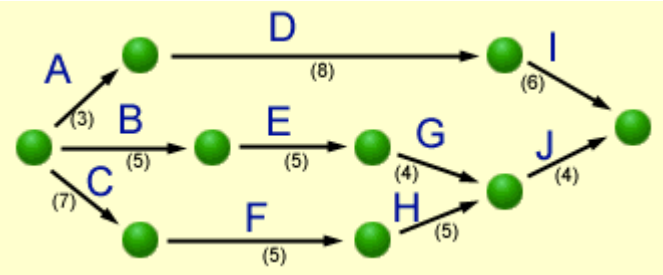
L-1

a) Draw PERT Chart for the following for the task, duration and dependency given below.

b) Find out:
   i. Critical Path
   ii. expected project duration

Task	Predecessors Tasks (Dependencies)	Time (Weeks)
A	**-**	**3**
B	**-**	**5**
C	**-**	**7**
D	**A**	**8**
E	**B**	**5**
F	**C**	**5**
G	**E**	**4**
H	**F**	**5**
I	**D**	**6**
J	**G - H**	**4**

ANS

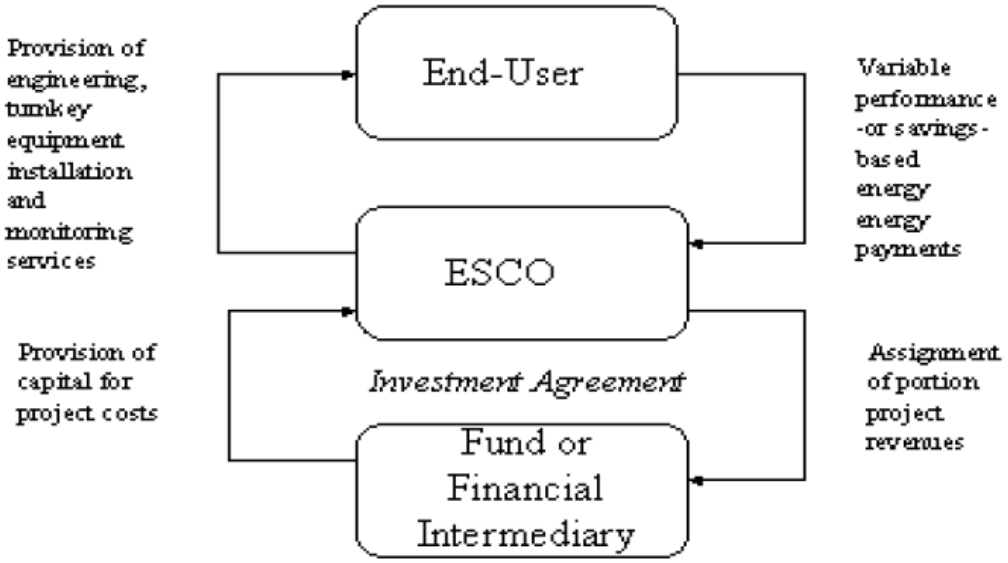


- **The critical path is through activities C, F, H, J**

- **The expected project duration is 21 weeks (7+5+5+4)**

L-2	a) Explain the functioning of an ESCO in performance contracting. b) Name two macro and micro factors considered in the sensitivity analysis of major energy saving projects.
Ans	a)

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.
In performance contracting, an end-user (such as an industry, institution, or utility), seeking to improve its energy efficiency, contracts with ESCO for energy efficiency services and financing. An agreed portion of the savings is shared with the ESCO. The ESCO gets back the invested money plus profit over a period of time



b)

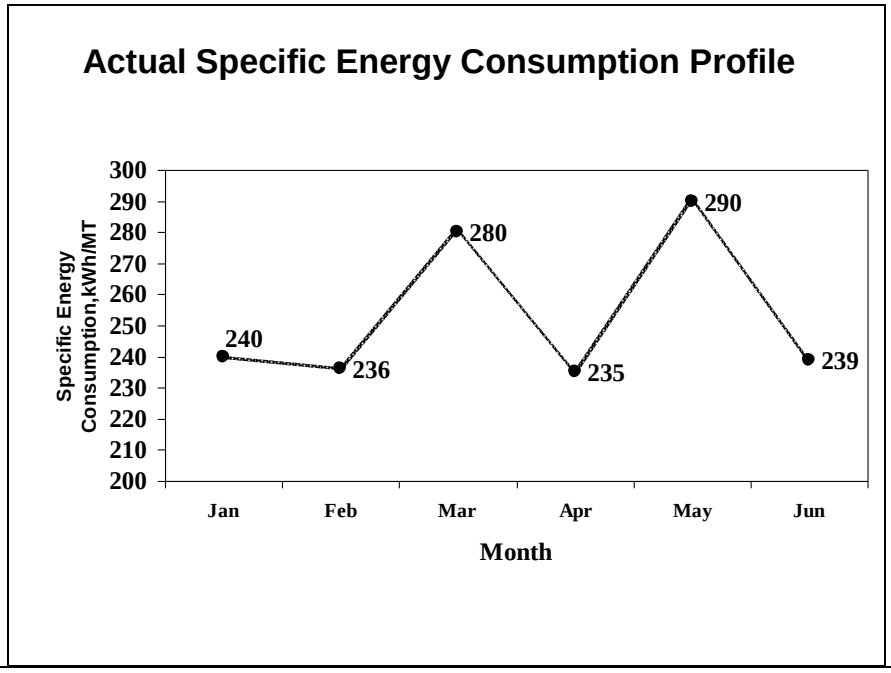
Micro factors

- Operating expenses (various expenses items)
- Capital structure
- Costs of debt, equity
- Changing of the forms of finance e.g. leasing
- Changing the project duration

Macro factors Macro economic variables are the variable that affects the operation of the industry of which the firm operates. They cannot be changed by the firm's management. Macro economic variables, which affect projects, include among others:
- Changes in interest rates
- Changes in the tax rates

	• Changes in the accounting standards e.g. methods of calculating depreciation • Changes in depreciation rates • Extension of various government subsidized projects e.g. rural electrification • General employment trends e.g. if the government changes the salary scales • Imposition of regulations on environmental and safety issues in the industry • Energy Price change • Technology changes

L-3	Energy saving measures was implemented in a process plant prior to Jan-2008. Use CUSUM technique and calculate energy savings for 6 months period of 2008. The company produced consistently 2000 T/month in each of the six months. Refer the graph given in table below. The predicted Specific energy consumption for 2000 MT production is 260 kWh/MT. It may be noted that retrofits were not functioning during March & May 2008.



ANS	

2008-Month	Actual - SEC, kWh/MT	Predicted SEC- kWh/MT	Difference= Actual- Predicted	CUSUM
Jan	240	260	- 20	-20
Feb	236	260	- 24	-44
Mar	280	260	+ 20	-24

	Apr	235	260	- 25	-49
	May	290	260	+ 30	-19
	Jun	239	260	- 21	-40

= 40 kWh/MT x 2000 MT
Energy Savings for six months = 80000 kWh

L-4	a) Draw an energy balance for the DG set with following data. A Diesel Generator trial gives Set 3.2 kWh per Liter of diesel. The cooling water loss and exhaust flue gas loss as percentage of fuel input are 31% and 35% respectively. Assume calorific value of diesel as 10200 kCal/kg. The Specific gravity of Diesel is 0.85. Calculate unaccounted loss as percentage of input energy. b) Explain the following terms in heat transfer with examples. i) Conduction ii) Convection
ANS	**a) Power Output = 3.2 kWh x 860 kCal/kWh = 2752 kCal** **Power Output as % of fuel input = (2752/(0.85x10200)x100 ~ 31.74%** **Losses as % of fuel input:** **Cooling Water Loss = 31%** **Exhaust Flue Gas Loss = 35%** **Therefore, unaccounted Loss = 100-(31.74+31+35) = 2.26%** b) i) **Conduction** The conduction of heat takes place, when two bodies are in contact with one another. If one body is at a higher temperature than the other, the motion of the molecules in the hotter body will vibrate the molecules at the point of contact in the cooler body and consequently result in increase in temperature. ii) **Convection** The transfer of heat by convection involves the movement of a fluid such as a gas or liquid from the hot to the cold portion. There are two types of convection: natural and forced. In case of natural convection, the fluid in contact with or adjacent to a high temperature body is heated by conduction. As it is heated, it expands, becomes less dense and consequently rises. This begins a fluid motion process in which a circulating current of fluid moves past the heated body, continuously transferring heat away from it. In the case of forced convection, the movement of the fluid is forced by a fan, pump or other external means. A centralized hot air heating system is a good example of forced convection.

L-5	Production rate from a paper machine is 340 tonnes per day (TPD). Inlet and outlet dryness to paper machine is 40% and 95% respectively. Evaporated moisture temperature is 80 °C. To evaporate moisture, the steam is supplied at 3 kg /cm^2. Latent heat of steam at 3 kg /cm^2 is 517 kCal/kg. Assume 24 hours/day operation. i) Estimate the quantity of moisture to be evaporated ii) Input steam quantity required for evaporation (per hour) Note: Consider enthalpy of evaporated moisture as 632 kcal/kg
ANS	Production rate from a paper machine = 340 TPD = 14.16 TPH (tonnes per hour) Inlet dryness to paper machine = 40% Outlet dryness from paper machine = 95% i) Estimation of moisture to be evaporated: Paper weight in final product = 14.16 x 0.95 = 13.45 TPH Weight of moisture after dryer = 0.708 TPH Paper weight before dryer on dry basis = 13.45 TPH Weight of moisture before dryer = ((13.45 x 100)/40) – 13.45 = 20.175 TPH Evaporated moisture quantity : 20.175 - 0.708 = 19.467 TPH ii) Input steam quantity required for evaporation Evaporated moisture temperature = 80 °C Enthalpy of evaporated moisture = 632 kCal/kg Heat available in moisture (sensible & latent) = 632 x 19467 = 12303144 kCal /h For evaporation minimum equivalent heat available should be supplied from steam Latent Heat available in supply steam (at 3 kg/cm^2) = 517 kCal/kg Quantity of steam required = 12303144/ 517 = 23797 kg = 23.8 MT/hour

L-6	An agency is implementing Energy efficiency measures in municipal water pumping under ESCO route. The investment is Rs. 6 crores. Present annual bill is Rs. 4 Crores. The expected savings are 20%. (Cost of power = Rs.4/kwh, Annual maintenance cost -10% of investment) The expected CDM revenues would be Rs. 50 Lakhs/year. Calculate IRR for this project after including the CDM benefit
ANS	

year	outflow	inflow		Net flow
	Rs. Lakhs	Savings	CDM	
0	-600		0	-600
1	-60	80	50	70
2	-60	80	50	70
3	-60	80	50	70
4	-60	80	50	70
5	-60	80	50	70
6	-60	80	50	70
7	-60	80	50	70
8	-60	80	50	70
9	-60	80	50	70
10	-60	80	50	70
	IRR			3%

…… End of Section – III ……