

Regn No: _____

Name: _____

(To be written by the candidate)

**12th NATIONAL CERTIFICATION EXAMINATION
FOR
ENERGY MANAGERS & ENERGY AUDITORS – October, 2011**

PAPER – 1: General Aspects of Energy Management & Energy Audit

Date: 15.10.2011 Timings: 09:30-12:30 HRS Duration: 3 HRS Max. Marks: 150

Section – II: SHORT DESCRIPTIVE QUESTIONS

Marks: 8 x 5 = 40

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

S-1	List any five clip-on / portable instruments used in energy auditing.
Ans	Power analyser, flue gas analyser, non-contact flow meter, lux meter, thermocouples, hygrometer, psychrometer, anemometer, tachometer, stroboscope, infrared thermometer etc
S-2	The rating of a single phase electric geyser is 2300 Watts, at 230 Volt. Calculate: a) Rated current b) Resistance of the geyser in Ohms c) Actual power drawn when the measured supply voltage is 210 Volts
Ans	a) Rated Current of the Geyser, $I = P/V = 2300/230 = 10$ Ampere b) Resistance Value , $R = V/I = 230/10 = 23$ Ohms c) Actual Power drawn at 210 Volts = $(V/R)*V = (210/23)*210$ $= 1917$ Watt OR $(210/230)*(210/230)*2300 = 1917$ Watt

S-3	Calculate the net present value over a period of 3 years for a project with one investment of Rs 50,000 at the beginning of the first year and a second investment of Rs 30,000 at the beginning of the second year and fuel cost savings of Rs 40,000 each in the second and third year. The discount rate is 16%.
Ans	$\text{NPV} = -50,000 - \frac{30,000}{1.16} + \frac{40,000}{1.16^2} + \frac{40,000}{1.16^3}$ $= -50,000 - 25,862 + 29,727 + 25,626 = \underline{\text{- Rs. 20,509}}$
S-4	In a heat exchanger the inlet and outlet temperatures of the cooling water are 30°C and 36°C. The flow rate of cooling water is 400 litres/hr. The process fluid enters the heat exchanger at 60°C and leaves at 45°C. Find out the flow rate of the process fluid?(Cp of process fluid is 0.8 kCal/kg°C).
ANS	Heat transferred to cooling water = $m \text{ cp } \Delta t$ = $400 \times 1 \times (36-30)$ = 2400 kcal/hour Flow rate of process fluid = $2400 / (60-45) \times (0.8)$ = 200 kgs/hr
S-5	Briefly explain the differences between preliminary and detailed energy audit
ANS	Preliminary energy audit, which is also known as Walk-Through Audit and Diagnostic Audit, is a relatively quick exercise and uses existing, or easily obtained data. The scope of preliminary energy audit is to: ▪ Establish energy consumption in the organization (sources: energy bills and invoices) ▪ Obtain related data such as production for relating with energy consumption ▪ Estimate the scope for energy savings ▪ Identify the most likely and the easiest areas for attention (e.g. unnecessary lighting, higher temperature settings, leakage etc.) ▪ Identify immediate (especially no-/low-cost) improvements/ savings ▪ Set up a <i>baseline</i> or <i>reference point</i> for energy consumption ▪ Identify areas for more detailed study/measurement Detailed energy audit is a comprehensive audit and results in a detailed energy project implementation plan for a facility, since it accounts for the energy use of all major equipment. It considers the interactive effects of various projects and offers the most

	accurate estimate of energy savings and cost. It includes detailed energy cost saving calculations and project implementation costs. One of the key elements in a detailed energy audit is the energy balance. This is based on an inventory of energy-using systems, assumptions of current operating conditions, measurements and calculations of energy use. Detailed energy auditing is carried out in three phases: a) Pre Audit Phase b) Audit Phase and c) Post Audit Phase.
S-6	A cotton mill dries 1200 kg of wet fabric in a drier from 54% initial moisture to 9% final moisture. How many kilograms of water are removed during drying operation?
ANS	Basis: 1200 kg/hr of wet fabric Dry fabric = $1200 \times 0.46 = 552 \text{ kg}$ Weight of final fabric = $552/0.91$ $= 606.6 \text{ kg}$ Water removed = $1200 - 606.6$ $= 593.4 \text{ kg}$
S-7	What is Demand Side Management (DSM)? Briefly list down the benefits of DSM with examples
ANS	Demand Side Management (DSM) means managing of the demand for power, by utilities / Distribution companies, among some or all its customers to meet current or future needs. DSM programs result in energy and / or demand reduction. DSM also enables end-users to better manage their load curve and thus improves the profitability. Potential energy saving through DSM is treated same as new additions on the supply side in MWs. DSM can reduce the capital needs for power capacity expansion. Examples:

	Replacement of inefficient pumps by star rated pumps under agricultural DSM Using time of the day tariff to shift the demand from peak to off peak hours Etc
S-8	Briefly compare NPV and IRR method of financial analysis.
ANS	Net Present Value The <i>net present value</i> method calculates the <i>present value</i> of all the yearly cash flows (i.e. capital costs and net savings) incurred or accrued throughout the life of a project and summates them. Costs are represented as negative value and savings as a positive value. The sum of all the present value is known as the <i>net present value</i> (NPV). The higher the <i>net present value</i>, the more attractive the proposed project. The net present value takes into account the time value of money and it considers the cash flow stream in entire project life. Internal Rate of Return Method By setting the net present value of an investment to zero (the minimum value that would make the investment worthwhile), the discount rate can be computed. The internal rate of return (IRR) of a project is the discount rate, which makes its net present value (NPV) equal to zero. It is the discount rate in the equation: $0 = - \frac{CF_0}{(1 + \kappa)^0} + \frac{CF_1}{(1 + \kappa)^1} + \dots + \frac{CF_n}{(1 + \kappa)^n} = \sum_{t=0}^n \frac{CF_t}{(1 + \kappa)^t}$ Where, CF_t = cash flow at the end of year “t” κ = discount rate n = life of the project.

----- End of Section - II -----

Section – III: LONG DESCRIPTIVE QUESTIONS

Marks: 6 x 10 = 60

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

L-1	Draw PERT Chart for the following for the task, duration and dependency given below Find out: i. critical Path ii. expected project duration <table><thead><tr><th>Task</th><th>Predecessors Tasks (Dependencies)</th><th>Expected Time as Calculated (Weeks)</th></tr></thead><tbody><tr><td>A</td><td>-</td><td>3</td></tr><tr><td>B</td><td>-</td><td>5</td></tr><tr><td>C</td><td>-</td><td>7</td></tr><tr><td>D</td><td>A</td><td>8</td></tr><tr><td>E</td><td>B</td><td>5</td></tr><tr><td>F</td><td>C</td><td>5</td></tr><tr><td>G</td><td>E</td><td>4</td></tr><tr><td>H</td><td>F</td><td>5</td></tr><tr><td>I</td><td>D</td><td>6</td></tr><tr><td>J</td><td>G - H</td><td>4</td></tr></tbody></table>	Task	Predecessors Tasks (Dependencies)	Expected Time as Calculated (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
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ANS	<pre>graph LR; A((A)) -- (3) --> D((D)); B((B)) -- (5) --> E((E)); C((C)) -- (7) --> F((F)); D -- (8) --> I((I)); E -- (5) --> G((G)); F -- (5) --> H((H)); G -- (4) --> J((J)); H -- (5) --> J; I -- (6) --> End(()); J -- (4) --> End; style End fill:none,stroke:none</pre> For drawing the network diagram 6 MARKS I. The critical path is through activities C, F, H, J II. The expected project duration is 21 weeks (7+5+5+4)																																	
L-2	A paper mill has two investment options for energy saving projects: Option : A Investment envisaged Rs.40 lakhs , annual return is Rs.8 lakhs, life of the project is 10 years, discount rate 10% .																																	

	Option : B Investment envisaged Rs.24 lakhs, annual return Rs.5 lakhs, life of the project is 8 years, discount rate is 10%. Calculate IRR of both the options and suggest which option the paper mill should select considering the risk is same for both the options.																					
ANS	Option A $-40 \times 10^5 = + \frac{8 \times 10^5}{(1 + X)^1} + \dots + \frac{8 \times 10^5}{(1 + X)^{10}}$ IRR = 15.10 % Option B $-24 \times 10^5 = + \frac{5 \times 10^5}{(1 + X)^1} + \dots + \frac{5 \times 10^5}{(1 + X)^8}$ IRR = 13 % Based on IRR, Option A has higher IRR and the mill may opt for option A																					
L-3	Use CUSUM technique and calculate energy savings for first 6 months of 2011 for those energy saving measures implemented by a plant prior to January,2011. The average production for the period Jan-Jun 2011 is 1000 MT/Month The plant data is given in the table below. <table><tr><th>2011-Month</th><th>Actual Specific Energy Consumption, kWh/MT</th><th>Predicted Specific Energy Consumption, kWh/MT</th></tr><tr><td>Jan</td><td>1203</td><td>1121</td></tr><tr><td>Feb</td><td>1187</td><td>1278</td></tr><tr><td>Mar</td><td>1401</td><td>1571</td></tr><tr><td>Apr</td><td>1450</td><td>1550</td></tr><tr><td>May</td><td>1324</td><td>1284</td></tr><tr><td>Jun</td><td>1233</td><td>1233</td></tr></table>	2011-Month	Actual Specific Energy Consumption, kWh/MT	Predicted Specific Energy Consumption, kWh/MT	Jan	1203	1121	Feb	1187	1278	Mar	1401	1571	Apr	1450	1550	May	1324	1284	Jun	1233	1233
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ANS	The table above gives values of Specific energy consumption monitored Vs predicted for each month. The variations are calculated and the Cumulative sum of differences is calculated from Jan-June-2011.																					

	<table><tr><th>2011- Month</th><th>Actual - SEC, kWh/MT</th><th>Predicted SEC- kWh/MT</th><th>Difference= Actual-Predicted</th><th>CUSUM</th></tr><tr><td>Jan</td><td>1203</td><td>1121</td><td>82</td><td>82</td></tr><tr><td>Feb</td><td>1187</td><td>1278</td><td>-91</td><td>-9</td></tr><tr><td>Mar</td><td>1401</td><td>1571</td><td>-170</td><td>-179</td></tr><tr><td>Apr</td><td>1450</td><td>1550</td><td>-100</td><td>-279</td></tr><tr><td>May</td><td>1324</td><td>1284</td><td>40</td><td>-239</td></tr><tr><td>Jun</td><td>1233</td><td>1233</td><td>0</td><td>-239</td></tr></table> = 239 kWh/MT x 1000 MT x 6 months Energy Savings for six months = -239,000 kWh	2011- Month	Actual - SEC, kWh/MT	Predicted SEC- kWh/MT	Difference= Actual-Predicted	CUSUM	Jan	1203	1121	82	82	Feb	1187	1278	-91	-9	Mar	1401	1571	-170	-179	Apr	1450	1550	-100	-279	May	1324	1284	40	-239	Jun	1233	1233	0	-239
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L-4	In a textile plant the average monthly energy consumption is 7,00,000 kWh of purchased electricity from grid, 40 kL of furnace oil (specific gravity=0.92) for thermic fluid heater, 60 tonne of coal for steam boiler, and 10 kL of HSD (sp.gravity= 0.885) for material handling equipment. Given data: (1 kWh = 860 kcal, GCV of coal= 3450 kCal/kg, GCV of furnace oil= 10,000 kCal/kg, GCV of HSD= 10,500 kCal/kg, 1kg oil equivalent = 10,000 kCal) a) Calculate the energy consumption in terms of Metric Tonne of Oil Equivalent (MTOE) for the plant. b) Calculate the percentage share of energy sources used based on consumption in MTOE basis. c) Comment whether this textile plant qualifies as a notified designated consumer under the Energy Conservation Act?																																			
ANS	a) $(40000 \times 0.92 \times 10000) + (60000 \times 3450) + (7,00,000 \times 860) + (10,000 \times 0.885 \times 10,500)$ $\text{MTOE} = \frac{(36.8 \times 10^7) + (20.7 \times 10^7) + (60.2 \times 10^7) + (9.2925 \times 10^7)}{10^7}$ = 127 Metric Tonnes of Oil Equivalent per month b) Electricity %= 47.4, Furnace oil%=29.0 , Coal % =16.3, HSD% =7.3 c) Annual energy consumption of the textile plant = 127 x 12 = 1524 MTOE which is less than 3000 MTOE cut off limit as notified under the EC act. Therefore this textile plant is not a designated consumer for the present energy consumption levels.																																			

L-5	Write short notes on any two • National Mission for Enhanced Energy Efficiency • ISO 50001 • Distinction between energy conservation and energy efficiency
ANS	National Mission for Enhanced Energy Efficiency It is one of the eight national missions under National Action Plan on Climate Change (NAPCC). To enhance energy efficiency four new initiatives will be put in place. These are: • 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. • Accelerating the shift to energy efficient appliances in designated sectors through innovative measures to make the products more affordable. • Creation of mechanisms that would help finance the demand side management programmes in all sectors by capturing future energy savings. • Developing fiscal instruments to promote energy efficiency. ISO 50001 The future ISO 50001 standard for energy management was recently approved as a Draft International Standard (DIS). ISO 50001 is expected to be published as an International Standard by early 2011. ISO 50001 will establish a framework for industrial plants, commercial facilities or entire organizations to manage energy. Targeting broad applicability across national economic sectors, it is estimated that the standard could influence up to 60% of the world's energy use. The document is based on the common elements found in all of ISO's management system standards, assuring a high level of compatibility with ISO 9001 (quality management) and ISO 14001 (environmental management). ISO 50001 will provide the following benefits: Distinction between energy conservation and energy efficiency Energy Conservation and Energy Efficiency are separate, but related concepts. Energy conservation is achieved when growth of energy consumption is reduced in physical terms. Energy Conservation can, therefore, be the result of several processes or developments, such as productivity increase or technological progress. On the other hand Energy efficiency is achieved when energy intensity in a specific product, process or area of production or consumption is reduced without affecting output, consumption or comfort levels. Promotion of energy efficiency will contribute to energy conservation and is therefore an integral part of energy conservation promotional policies.

L-6	An evaporator is to be fed with 10,000 kg/hr of a solution having 1 % solids. The feed is at 38°C. It is to be concentrated to 2% solids. Steam is entering at a total enthalpy of 640 kCal/kg and the condensate leaves at 100°C. Enthalpies of feed are 38.1 kcal/kg, product solution is 100.8 kCal/kg and that of the vapour is 640 kCal/kg. Find the mass of vapour formed per hour and the mass of steam used per hour.
ANS	Mass of vapour Feed = 10,000 kg/hr @ 1 % solids Solids = $10,000 \times 1/100$ = 100 kg/hr $\text{Mass}_{\text{out}} \times 2/100 = 100$ $\text{Mass}_{\text{out}} = 10,000/2 = 5000 \text{ kg/hr}$ Vapour formed = $10,000 - 5000$ = 5000 kg/hr Thick liquor = 5000 kg/hr Steam consumption: Enthalpy of feed = $10,000 \times 38.1 = 38.1 \times 10^4 \text{ kCal}$ Enthalpy of the thick liquor = $100.8 \times 5000 = 5,04,000 \text{ kCal}$ Enthalpy of the vapour = $640 \times 5000 = 32,00,000 \text{ kCal}$ Heat Balance Heat input by steam + heat in feed = heat out in vapour + Heat out in thick liquor $[M \times (640-100) + 38.1 \times 10,000] = (32,00,000 + 5,04,000)$ $M \times 540 = 33,23,000$ Mass of steam required = $33,23,000/540$ = 6153.7 kg/hr

----- End of Section - III -----