B.E Power Engineering 3rd Year 2nd Semester Examination – 2022

Subject: Energy Conservation & Sustainability, Time: 3 Hrs. Full Marks: 100

	Answer the questions as per given instructions	Marks
[1]	**Answer *any five* from this question**	**[5×2=10]**
(a)	Define sustainability energy in view of energy conservation.	
(b)	Define smart green building.	
(c)	Define Environmental Management.	
(d)	What are the important steps of energy audit?	
(e)	Briefly define waste heat recovery scheme.	
(f)	State the basic objective of National Mission for Enhanced Efficiency (NMEE).	
(g)	What are the benefits of Continuous Emission Monitoring System (CEMS)?	
(h)	What do you mean by Macroclimate of a region?	
(i)	Define objective of Clean Development Mechanism (CDM).	
(j)	Define payback period in the aspect of energy audit.	
[2]	**Answer *any two* from this question**	**[10×2=20]**
(a)	Briefly explain Latent heat thermal storage with a neat sketch.	[8+2]
(b)	Briefly explain Fluidized Bed Combustion Boiler with a neat figure. State the advantages of this type.	[5+2+3]
(c)	Define purpose of external feed water treatment. Classify methods. Briefly explain any one method.	[3+2+5]
[3]	**Answer *any two* from this question**	**[10×2=20]**
(a)	Define energy audit. Briefly explain Electronics Ballast. Comment on the difference of it from the normal Ballast.	[3+4+3]
(b)	Briefly explain Maximum Demand Controller is used in any power plant. What is energy efficient Transformer?	[5+5]
(c)	Briefly state the benefits of green building. Briefly explain the source of materials & type of equipments are used in Green Building.	[4+6]
[4]	***Answer any two* from this question**	**[10×2=20]**
a)	State the principle of operation of Electrostatic Precipitator (ESP). Briefly explain dry & wet ESP.	[4+3+3]
b)	Briefly explain any two of the following: a) Flue Gas Desulphurization (FGD), b) Selective Catalytic Reduction (SCR), c) Continuous Emission Monitoring System (CEMS).	[5+5]
(c)	Classify the sources of air pollution. Define air pollution standards as per Clean Air Act. What are the mobile sources of pollution?	[2+4+4]
(d)	Briefly explain objective of ISO 14000 Environmental Management System Certification. What are the threats of Coastal zone & purpose of Coastal zone management?	[4+3+3]
[5]	**Answer *all* from this question**	**[15×2=30]**
(a)	A college has three engineering departments (Civil, Electrical & Mechanical) & their details of electrical appliances & respective loading durations are shown in Table 1&2. Energy cost is Rs.9/unit. Working is on the basis of 6 days in week. Draw Sankey diagram along with calculate 3rd year total costing for existing setup. Finally perform energy audit with calculation of saving in rupees per Annum with payback period calculation when replacing energy efficient devices. Also calculate Star rating of building (from EPI calculation). Use data from Table:1 (Loading topology department wise); Table:2 (Details of normal & energy efficient devices) & those are shown in next page.	[15]
(b)	Calculate the Green Building Index (GBI) of a specified building using the data provided in Table:3 & from that value conclude on the grading of the building. Assume: Gross floor area=203293m^2, service life=60Years Use following Equations: 1. GBI=(Building Hospitality Index, Q)×(Carbon Economic Index, E)/(Carbon Emission Index, C) 2. $C=\alpha\times(EC_E/EC_R)+\beta\times(OC_E/OC_R)$, where α, β are Weights of area=0.125, EC_E & EC_R=Embodied carbon emission in evaluated building & reference building in construction phase, OC_E & OC_R=Operational carbon emission in evaluated & reference building in operational & maintenance phase. 3. $Q=\sum_{i=1}^{5}(\frac{Si\times Wi}{DMi})\times\frac{1}{100}$, where Si= Score obtained in evaluated building in specific area i, DMi & Wi are allotted scores & weights for accessing carbon emission from that specific area. 4. $CE=\frac{\Delta RB}{\Delta IC}\times 100=(\frac{OER-OEE+GB}{ICE-ICR})\times 100$, where ΔRB, ΔIC are carbon emission reduction benefit & increased construction cost, OER & OEE are annual operational cost for reference building & evaluated building, ICE & ICR are initial construction cost of evaluated building & reference	[15]

	building, CB is carbon emission trading profit, CE is carbon economic efficiency, (E=1 if CE<4%); (E=0.05×CE+0.8 if 4%≤CE<8%); (E=1.2 if 8%≤CE)	

Table:1 Loading topology department wise (Ref. Q.5.a)

Department	Illumination Level (lumen/m^2)	Volume= Area ×height (m^2)×m	Tube Light (36W) [No./hrs loading]	Cooling requirement (Watt/m^3)	Fan (Conventional) (60W) [No./hrs loading]	Computer (150W) [No./hrs loading]	Pump (0.5h.p) [No./hrs loading]	Air condition 1.5 Ton 3 star 1926W [No./hrs loading]
Civil	175	800×3	75/8	24	200/8	75/8	2/1	15/8
Electrical	175	900×3	50/8	24	185/8	65/8	2/1	18/8
Mechanical	175	750×3	65/8	24	195/8	85/8	2/1	19/8

Table:2 Details of normal & energy efficient devices (Ref. Q.5.a)

Device	Investment Cost/fitting (Rs.)	Replacement cost/fitting (Rs.)	Illumination (Lumen/m^2)	Power rating (Watt)	Life (hr.)	Cooling Capacity (Watt)	Co-efficient of Utilization	Maintenance Factor
Tube light	200	50	2100	36	4000	------	0.6	1
LED	500	Nil	1800	18	50000	--------	0.6	1
Fan (Conventionally controlled)	400	75	----------	60	80000	--------	0.6	1
Fan (Automatic control)(reduce 3hrs operating time than conventional)	600	75	----------	60	70000	----------	0.6	1
A.C (3 star)	25000	1000	--------	1926	70000	4200	0.6	1
A.C(5 star)	35000	1000	-------	1677	70000	4200	0.6	1

Assume:

1. $N=(E \times A)/(O \times CU \times MF)$ & $M=(C \times V)/(CC \times CU \times MF)$

Where, N & M are No. of Light fitting & Split A.C are needed respectively
E & C are required illumination level in Lux (lumen/m^2) & required cooling level in watt/m^3 respectively
A & V are effective area to be illuminated in m^2 or effective volume to be cooled in m^3 respectively
O & CC are luminous flux produces per lamp in lumen & cooling capacity per A.C in watt respectively
CU & MF are Coefficient of utilization & maintenance factor respectively

2. **Energy Performance Index (EPI) = Energy consumption/area of building/year (in kWhr/m^2/year)**

Where EPI= 80-70 building rating: 1star; 70-60: 2 star; 60-50: 3 star, 50-40: 4 star; below 40: 5 star

3. 1st yr annual costing=investment charge+ 1st yr energy charge; 2nd yr total costing=previous year costing+ 2nd yr energy charge; 3rd yr total costing=previous years' total costing +3rd yr energy charge+ replacement of fitting charge

Table: 3 Details of Green building parameters (Ref. Q.5.b)

GBI Range	Grade		Embodied & operational Carbon Emissions/unit area (Kg/m^2)		Building hospitality index parameters	Wi	DMi	Si		Carbon Economics Index (Cost /unit area in USD/m^2)		
										Parameters	Evaluated Building	Reference Building

GBI≥4	Green 1st	EC_E=565.7	Ecology	34	35	25.5	Initial construction cost	ICE=258.2	ICR=258.7
3≤GBI<4	Green 2nd	EC_R=698.5	Health	31	48	34.0	Annual operational cost	OEE=7.6	OER=12.1
2.5≤GBI<3	Green 3rd	OC_E=1280	Function	24	35	28.0	Annual carbon emission trading profit	CB=0.7	CB=0.0
2≤GBI<2.5	Green 4th	OC_R=2555.6	Energy Efficiency	37	37	28.0			
GBI<2	Out of Grade		Resource Efficiency	30	28	31.05			