B.E Power Engineering 3rd Year 2nd Semester Examination – 2024

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 [CO1]**	**[5×2=10]**
(a)	Define energy sustainability.	
(b)	Briefly define carbon trading potential.	
(c)	Briefly state the objectives of LEED(Leadership in Energy & Environmental Design.	
(d)	What do you mean by energy audit?	
(e)	Classify waste heat recovery system on the basis of type of equipments?	
(f)	Briefly state the factors effecting ESP performances.	
(g)	Briefly state the difference between standard motor & energy efficient motor.	
(h)	What Photochemical Smog?	
(i)	Classify the Thermal Energy Storage.	
(j)	Define CDM (Clean Development Mechanism)?	
[2]	**Answer *any two* from this question [CO2]**	**[10×2=20]**
(a)	Briefly explain Latent heat of thermal storage with a neat figure.	[5+5]
(b)	Briefly state the challenge of recovering low temperature waste heat. Briefly explain any one kind of corresponding equipment.	[4+6]
(c)	What is Waste heat boiler? Briefly state the advantages & disadvantages with a neat figure.	[5+3+2]
[3]	**Answer *any two* from this question [CO3]**	**[10×2=20]**
(a)	State the steps of energy audit. Briefly explain energy efficient lighting control?	[5+5]
(b)	What are the types of occupancy sensors? Briefly explain control techniques.	[10]
(c)	Briefly state the benefits of green building. Briefly state the type of equipments those are used in Green Building with a neat schematic diagram.	[4+6]
[4]	***Answer any two* from this question [CO4]**	**[10×2=20]**
a)	Define CEMS (Continuous Emission Monitoring System). Mention the components of CEMS. Briefly state the benefits.	[2+4+4]
b)	State the objectives of External water treatment. With classification briefly explain any one process.	[2+2+6]
(c)	What are the threats of Coastal zone & it's ecosystem? State the purposes of Coastal zone management.	[5+5]
(d)	Briefly explain the objective of National Missions on Energy Efficiency (NMEE). What are the missions of NMEE?	[6+4]
[5]	**Answer *all* from this question [CO5]**	**[15×2=30]**
(a)	A college has three departments (Electrical, Mechanical & Civil Engg.) & their details of electrical appliances & respective loading durations are shown in **Table 1&2**. Energy cost is Rs.8/unit. Working is on the basis of 5 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=153595m^2, service life=50Years 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. $CE=\frac{\Delta RB}{\Delta IC}\times 100=(\frac{OER-OEE+CB}{ICE-ICR})\times 100$,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 building, CB is carbon emission trading profit, CE is carbon economic efficiency,	[15]

[Turn over

	(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]
Electrical	150	400×3	45/8	24	100/8	55/8	2/1	15/8
Mechanical	150	500×3	50/8	24	125/8	65/8	2/1	18/8
Civil	150	600×3	35/8	24	95/8	45/8	2/1	12/8

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	250	50	2100	36	4000	------	0.6	1
LED	550	Nil	1800	18	50000	--------	0.6	1
Fan (Conventionally controlled)	450	75	----------	60	80000	--------	0.6	1
Fan (Automatic control)(reduce 3hrs operating time than conventional)	650	75	----------	60	70000	----------	0.6	1
A.C (3 star)	24000	1000	--------	1926	70000	4200	0.6	1
A.C(5 star)	34000	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		**Carbon Emission Index parameters**		**Building hospitality index parameters**	Wi	DMi	Si		**Carbon Economic Index Parameters** (Cost /unit area in USD/m^2)		
			Embodied & operational Carbon Emissions/unit							Parameters	Evaluated Building	Reference Building

		area (Kg/m^2)								
GBI≥4	Green 1st	EC_E=450.5	Ecology	21	32	22.5	Initial construction cost	ICE=360.2	ICR=250.4
3≤GBI<4	Green 2nd	EC_R=670.5	Health	20	45	33.0	Annual operational cost	OEE=5.6	OER=10.1
2.5≤GBI<3	Green 3rd	OC_E=1170	Function	33	33	27.0	Annual carbon emission trading profit	CB=0.7	CB=0.0
2≤GBI<2.5	Green 4th	OC_R=2650.6	Energy Efficiency	26	36	26.0			
GBI<2	Out of Grade		Resource Efficiency	22	27	30.05			