B.E Power Engineering 3rd Year 2nd Semester Examination – 2023
Subject: Energy Conservation & Sustainability, Time: 3 Hrs. Full Marks: 100

	Subject: Energy Conservation & Sustainability, Time: 3 Hrs. Full Marks: 1	
	Answer the questions as per given instructions	Marks
[1]	Answer any five from this question [CO1]	[5×2=10]
(a)	Define energy conservation.	
(b)	Briefly state objectives of Indian Green Building Council (IGBC).	
(c)	Briefly define the major areas of ISO 14000 EMS (Environmental Management System) certification.	
(d)	What do you mean by preliminary energy audit?	
(e)	What are the factors effecting waste heat recovery feasibility?	
(f)	Name different types of dust collecting equipments.	
(g)	Briefly state the benefits of soft starter over the normal starter for induction motor operation.	
(h)	What are the methods of disposal for high level radioactive waste?	
(i)	Define Latent Heat Thermal Storage.	
(j)	What are the three spheres of Sustainability?	
[2]	Answer any two from this question [CO2]	[10×2=20]
(a)	Why do we need thermal energy storage? Classify different methods of thermal energy storage.	[5+5]
(b)	Classify Waste Heat Recovery System (WHRS) on the basis of type of equipment. Briefly explain any one type waste heat recovery equipment with a neat sketch.	[4+6]
(c)	What is Pulverized fuel boiler? Briefly state the advantages & disadvantages.	[5+5]
[3]	Answer any two from this question [CO3]	[10×2=20]
(a)	State the steps of energy audit. What are the difference between normal & energy efficient motor?	[5+5]
(b)	Briefly explain energy efficient lighting control.	[10]
(c)	Briefly state the benefits of green building. Briefly explain the source of materials & type of equipments are	[4+6]
	used in Green Building.	
[4]	Answer any two from this question [CO4]	[10×2=20]
a)	State the principle of operation of Flue Gas Desulphurization (FGD). State the benefits of this system.	[6+4]
b)	Briefly explain Selective Catalytic Reduction (SCR). Name different components of SCR.	[8+2]
(c)	Classify nuclear waste. Briefly explain the disposal process of any one type nuclear waste.	[2+8]
(d)	Briefly explain the objective of Perform Achieve & Trade scheme (PAT). What are the elements of PAT?	[6+4]
[5]	Answer all from this question [CO5]	[15×2=30]
(a)	A college has three departments (Physics, Chemistry & Mathematics) & 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 3 rd 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=253595m², service life=60Years Use following Equations: 1. GBI=(Building Hospitality Index, Q)×(Carbon Economic Index, E)/(Carbon Emission Index, C) 2. C=α×(EC_E/EC_R)+β×(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=∑_{i=1}⁵ (Si×Wi)/DMi) × 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=ΔRB/ΔIC × 100 = (OER-OEE+CB)/ICE-ICR) × 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]

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(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	Volume=	Tube	Cooling	Fan	Computer	Pump	Air condition
	Level	Area	Light	requirement	(Conventio	(150W)	(0.5h.p)	1.5 Ton 3 star
		×height	(36W)		nal)			1926W
	(lumen/m ²)		[No./hrs	_	(60W)	[No./hrs		
			loading]	(Watt/m³)	[No./hrs	loading]	[No./hrs	[No./hrs
		$(m^2)\times m$			loading]		loading]	loading]
Physics	120	500×3	45/8	24	100/8	55/8	2/1	15/8
Chemistry	120	600×3	50/8	24	125/8	65/8	2/1	18/8
Mathematics	120	400×3	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	Replacement cost/fitting	Illumination (Lumen/m²)	Power rating	Life (hr.)	Cooling Capacity	Co- efficient of	Maintenan
	(Rs.)	(Rs.)	(=======,	(Watt)	()	(Watt)	Utilization	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/m²) & required cooling level in watt/m³ respectively
- A & V are effective area to be illuminated in m² or effective volume to be cooled in m³ 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/m²/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 Embodied &	Building hospitality index	Wi	DMi	Si		nomic Index I unit area in US	•
		operational Carbon Emissions/unit	parameters				Parameters	Evaluated Building	Reference Building

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GBI≥4	Green 1st	area (Kg/m²) EC _E =455.5	Ecology	31	32	22.5	Initial construction cost	ICE=358.2	ICR=268.4
3≤GBI<4	Green 2nd	EC _R =678.5	Health	30	45	33.0	Annual operational cost	OEE=6.6	OER=11.1
2.5≤GBI<3	Green 3 rd	OC _E =1180	Function	23	33	27.0	Annual carbon emission trading profit	CB=0.6	CB=0.0
2≤GBI<2.5	Green 4th	OC _R =2655.6	Energy Efficiency	36	36	26.0			
GBI<2	Out of Grade		Resource Efficiency	32	27	30.05			