B.E Power Engineering 3rd Year 1st Semester Examination – 2025
Subject: Non-conventional Power Generation

Time: Three hours **Full Marks: 100**

	Each question must be answered as per given instructions	Marks
[1]	**Answer *any ten* from this module**	**[20]**
(a)	Briefly state the basic need for shifting our energy use from conventional to renewable.	10×2
(b)	Comment on most feasible renewable energy for India.	
(c)	Define: solar zenith angle.	
(d)	Define: terrestrial solar radiation.	
(e)	Which one is point focusing & line focusing scheme among the solar thermal power generation schemes?	
(f)	Define Perturbation factor of wind turbine.	
(g)	Define yaw control of wind turbine.	
(h)	State the efficiency level of crystalline silicon & thin film type solar cell.	
(i)	Define: Pyrolysis process.	
(j)	What is cause of skewing & splitting of electrode in MHD generation system?	
(k)	Comment on Fuel cell whether it is more advantageous than Battery.	
(l)	Define Ebb cycle of Tidal energy.	
(m)	Define Plate tectonic theory to establish Geothermal energy.	
(n)	State the relation between group velocity & phase velocity of Ocean wave.	
(o)	Classify solar pond with a brief definition.	
[2]	**Answer *any one* from this module**	**[10]**
(a)	Deduce the expression of Torque is developed in wind turbine & then establish the relationship between Torque coefficient & Power coefficient.	[4+6]
(b)	Briefly explain with a neat sketch of integrated parabolic trough collector system for large scale solar thermal power generation scheme.	[8+2]
[3]	**Answer *any two* from this module**	**[20]**
(a)	Briefly explain Proton Exchange Membrane fuel cell with a neat sketch.	[8+2]
(b)	Classify different methods of Biomass to Biogas conversion technique. Briefly state any one method with a neat sketch.	[2+6+2]
(c)	Briefly state the principle of Superconducting Magnetic Energy storage system with a neat sketch. Comment on it's application.	[6+2+2]
[4]	***Answer any two* from this module**	**[20]**
a)	Derive the expression of total wave energy is carried forward per unit area of water surface of natural ocean wave resource.	[10]
b)	Classify Geothermal power generation scheme. Briefly state any one type with a neat sketch.	[2+6+2]
(c)	Briefly explain Ocean thermal power generation scheme with a neat sketch. What are the challenges have to be faced for extracting Ocean thermal energy?	[5+2+3]
[5]	**Answer *any three* from this module**	**[30]**
(a)	Following data were measured for a Horizontal Axis Wind Turbine: Speed (u_0) of wind at 1 ATM & 25^{0}C is 18m/sec, diameter (2R) of rotor is 85m and speed of rotor (ω) is 45 r.p.m. Calculate the torque produce at the shaft for the maximum output for the turbine. [Assume 1 ATM=1.01325×10^5 Pacal, Specific gas constant of dry air =287.058J/Kg/^{0}K , Tip speed ratio, $\lambda=R\omega/u_0$, Max. Power coefficient ($C_{p\,max.}$)=0.593]	[10]
(b)	Calculate following parameters for Kolkata (Latitude(φ) 22.50^{0}N & Longitude(ψ) 88.37^{0}E) at 1:30 P.M, on 14th December, 2024, if the solar module surface is oriented(γ) 40^0 West of South & tilted(β) at 30^0 to the horizontal: i) angle of incidence (θ) of beam radiation on solar module, ii) Extraterrestrial Normal Radiation (E.N.R) (G_{on}), iii) Extraterrestrial Horizontal Radiation (E.H.R) (G_o), iv)Global Radiation (G.R) on solar module (G_T); v) Module Power generation (M.P). [Assume hour angle $\omega=(15^0h^{-1})$ (T_{solar}-12h), where T_{solar} = local solar time & declination $\delta=\delta_0\text{Sin}[360^0(284+n)/N]$, where $\delta_0=23.45^0$ & n is the day & N is number of days in year & $\cos\theta$ = (A-B)sin δ+{C sin ω+(D+E)cos ω}cos δ, where A=sin φ.cos β, B=cos φ .sin β. cos γ, C=sin β. sin γ, D=cos φ.cos β, E=sin φ.sin β.cos γ ; Zenith Angle (Z.A)=θ_z where $\cos\theta_z$ = cos φ.cos ω cos γ+ sin φ.sin δ; $R_b=\cos\theta/\cos\theta_z$; Global Horizontal Radiation (G.H.R) in Kolkata (G)=4.92kWhr./m^2/day (i.e. 0.205 kW/m^2) ; E.N.R (G_{on})=1.367{1+0.033cos(360^0×n/365)}in kW/m^2; E.H.R(G_o)= $G_{on}.\cos\theta_z$; Diffused Radiation(D.R) in Kolkata(G_d)= 1.558 kWhr./m^2/day (i.e. 0.0649 kW/m^2); Beam Radiation (B.R) (G_b)=(G- G_d) ; Anisotropy Index(A.I) (A_i)=G_b/G_o; Horizontal Brightening Factor (H.B.F)(f)= $\sqrt{G_b/G}$; Module Power generation(M.P)=D.F× Module Power Rating × G_T ; Global Radiation (G.R) in module surface	[10]

	$(G_T)=(G_b+G_d.A_i).R_b+G_d(1-A_i).\{0.5+\cos(\beta/2)\}.(1+f.\sin(\beta/2)^3$ in kW/m^2; Derating factor (D.F)=0.8, Module Power Rating=35 Watt-peak]	
(c)	Calculate the following of a dry rock granite to a depth of 7.5 Km. Take the Geothermal temperature gradient is at 40°K/Km, minimum useful temperature is 160°K above the surface temperature T_o, rock density(ρ_r)=2700 kg/m^3, Specific heat capacity(C_r) =750 J/kg/°K. i) Useful heat content per square kilometer, ii) Time constant of heat extraction using water flow at a rate of 1.2 m^3/sec/km^2, iii) Useful heat extraction rate at initially & after 15 years. Assume water density 1000 kg/m^3& specific heat capacity 4200 J/kg/^{0}K.	[10]
(d)	A single basin type Tidal power plant has a basin area of 4.5 km^2. The tide has an average range of 18 meter. Power is generated only during the Ebb cycle. The turbine stops operating when the head on it falls below 3m. Calculate the average power generated by the plant in single empting process of the basin if the turbine generation efficiency is 0.75. Estimate the annual average energy generation of the plant. Assume sea water density is 1025kg/m^3 & Ebb cycle duration is 12hr. 25 min.	[10]
(e)	Calculate the volume of a cow dung based biogas plant required for cooking needs for a family of ten adults & lighting needs with eight 100 CP (Candle Power) lamps for eight hours daily. Also calculate the required number of cows to feed the plant. (Assume biogas is required for cooking: 0.227m^3/person/day, gas required for each 100CP lamp: 0.126m^3/hr., cow dung production rate: 8kg/cow/day, cow dung having 16% solid mass content, biogas yield of 0.34m^3/kg of dry mass, slurry density: 1090kg/m^3, heating value of biogas is 25MJ/m^3, slurry contains equal quantity of water & cow dung, 45 days slurry retention time in digester & maximum 80% of digester volume can be occupied by slurry).	[10]