B.E Power Engineering 3rd Year 1st Semester Supplementary Examination – 2024
Subject: Non-conventional Power Generation

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

CO	Each question must be answered as per given instructions	Marks
[1]	**Answer *any ten* from this module**	**[20]**
(a)	Define green & brown energy	10×2
(b)	Define: Extra-terrestrial radiation.	
(c)	Define: solar declination angle.	
(d)	What is concentration ratio of solar collector?	
(e)	Define Tip-speed ratio of wind turbine.	
(f)	What is Yaw control of wind turbine?	
(g)	Classify thin film solar cell.	
(h)	Define: Fermentation process.	
(i)	What is Faraday current in MHD generation system?	
(j)	Classify Fuel cell.	
(k)	Define Phase velocity of ocean wave.	
(l)	Define the expression of tidal energy.	
(m)	Define heliostat?	
(n)	Classify geothermal region.	
(o)	What is solar pond?	
[2]	**Answer *any one* from this module**	**[10]**
(a)	Deduce the extractable wind power from any in wind turbine.	[8+2]
(b)	Briefly explain with a neat sketch of power tower type solar thermal power generation scheme.	[8+2]
[3]	**Answer *any two* from this module**	**[20]**
(a)	Briefly explain Proton Exchange Membrane type fuel cell with a neat sketch.	[8+2]
(b)	Derive the generated voltage equation of Magneto Hydrodynamic Generation (MHD) with a neat sketch.	[2+8]
(c)	Classify energy storage methodology & briefly explain any one type.	[2+8]
[4]	***Answer any two* from this module**	**[20]**
a)	Derive the expression of total wave energy is carried forward per unit width across wave front of water surface of natural ocean wave resource.	[10]
b)	Derive useful heat content per square Kilometer of dry rock granite & then time constant of useful heat extraction using water flow & useful heat extraction rate.	[4+3+3]
(c)	Briefly explain the major components of Tidal power plant. State the advantages & disadvantages of Tidal energy.	[8+2]
[5]	**Answer *any three* from this module**	**[30]**
(a)	A propeller type wind turbine has the following data: speed of free wind at a height of 18 m is 18m/s, air density is 1.25 kg/m^3, surface roughness (α) is 0.17, height of tower is 80 m, diameter of rotor is 60 m, wind velocity at turbine reduces by 22%, generator efficiency is 72%. a) Find total available wind power, b) power extracted by the turbine, c) electrical power generated, d) axial thrust on turbine, e)maximum axial thrust on turbine.	[10]
(b)	Design a 24 volt **solar photo voltaic energy system** by calculating the capacity of inverter, size of battery bank & size of solar photo voltaic array & sub-array. **Assume**: Total connected load is 15 KW & total system loading (energy) is 150kWhr/Day. **For inverter design-** Diversity factor of 85%, overall load Power factor is 0.80 & 100% standby mode. **For battery bank design- Assume:** 75% maximum occupancy, 7% inverter & 3% wiring loss, 4½ non sunny days, maximum depth of discharge (for longer life) is 73% & 2 Volt in each cell. **For module design- Assume:** battery energy efficiency 75%, module rating as nominal voltage is 12V, 35 Wp (Watt-peak) with full sun for 5 hours daily on average & 7½% loss in wiring in between array & battery along with battery regulator. In solar photo voltaic system design assume an array consists of a number of modules those are connected in series to form panels & a number of panels are connected in parallel to form sub-arrays.	[10]
(c)	Calculate the following of a dry rock granite to a depth of 7 Km. Take the Geothermal temperature gradient is at 30°K/Km, minimum useful temperature is 150°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 1.5 m^3/sec/km^2, iii) Useful heat extraction rate at initially & after 10 years. Assume water density 1000 kg/m^3& specific heat capacity 4200 J/kg/°K.	[10]

(d)	A single basin type Tidal power plant has a basin area of 3.5 km^2. The tide has an average range of 17 meter. Power is generated only during the Ebb cycle. The turbine stops operating when the head on it falls below 2.5m. Calculate the average power generated by the plant in single empting process of the basin if the turbine generation efficiency is 0.8. 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, 50 days slurry retention time in digester & maximum 85% of digester volume can be occupied by slurry).	[10]