Ref. No. EX/PE/T/323/2017

BACHELOR OF POWER ENGG. 3RD YEAR, 2ND SEM. EXAMINATION, 2017

SUBJECT: NON-CONVENTIONAL POWER GENERATION **Time: Three Hours** **Full Marks 100**

Answer any FIVE questions

Question No.		Marks
1. a)	For any solar thermal collector assume the following data: optical efficiency (γ)=0.8, incident solar radiation(q_{in})=800W/m^2, ambient temperature(T_a)=27^{0}C, heat loss co-efficient (U)=25 W/m^{2}K, collector efficiency factor(F')=1, receiver effective temperature (T)=80^{0}C, thermodynamic 1st law efficiency $\varepsilon_I=\varepsilon_2(1-T_a/T)$, & 2nd law efficiency ε_2=0.80, where receiver thermal output $Q_{out}=F'[\gamma.A_{in}.q_{in} - UA_{rec}(T-T_a)]$; $\gamma=[U.A_{rec}(T_{max}-T_a)/A_{in}.q_{in}]$; a) Find the stagnation temperature (T_{max}) & collector efficiency (ε_c) if concentration ratio ($CR=A_{in}/A_{rec}$) is 15; b) Find optimal temperature of receiver ($T=T_{opt}$) at which overall efficiency($\varepsilon=\varepsilon_c\varepsilon_I$) is maximum along with maximum efficiency(ε_{max}) for CR=15.	**8**
b)	State the advantages of thin film type solar cell over the crystalline silicon wafer.	**4**
c)	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 20 KW & total system loading (energy) is 200 kWhr/Day. **For inverter design:** Diversity factor of 75%, overall load Power factor is 0.7 & 100% standby mode. **For battery bank design assume:** 80% maximum occupancy, 8% inverter & 2% wiring loss, 5½ non sunny days, maximum depth of discharge (for longer life) is 75% & 2 Volt in each cell. **For module design:** battery energy efficiency 85%, module rating as nominal voltage is 12V, 35 Wp (Watt-peak) with full sun for 6 hours daily on average & 6½% 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.	**8**
2.a)	Derive the equation of available wind power can be extracted from natural resource. Define Betz limit. Show the response of power coefficient (Cp) with variation of interference factor (a) for wind turbine & mention the condition of maximum Cp value.	**8+2+2**
b)	A propeller type wind turbine has the following data: speed of free wind at a height of 14 m is 16m/s, air density is 1.25 kg/m^3, surface roughness (α) is 0.16, height of tower is 80 m, diameter of rotor is 60 m, wind velocity at turbine reduces by 25%, generator efficiency is 75%. 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.	**8**
3.a)	Mention the name of suitable working fluid is used in Ocean Thermal Power Plant (OTPP) along with its essential characteristics. Briefly explain power generation scheme in Ocean Thermal Power Plant (OTPP) with a neat figure.	**1+2+8**

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b)	What are major challenges have to be faced in OTPP installation? Briefly explain hydrogen economy system regarding OTPP.	6+3
4.a)	Derive the expression of total wave power per unit width across wave front can be carried forward for natural ocean wave resource. Define group velocity & phase velocity of natural ocean wave.	8+2+2
b)	Calculate the following for deep Atlantic Ocean wave having wave length 50 m & amplitude 1 m, water density 1025 kg/m^3 :- i) Phase velocity, ii) Group velocity. iii) Total energy per unit area of wave surface, iv) Power develops per unit width across wave front.	8
5.a)	Classify electrical power generation schemes using geothermal power & briefly explain any one scheme with a neat figure. Classify geothermal region in respect the temperature gradient mentioning the gradient value.	2+8+2
b)	Calculate the following of a dry rock granite to a depth of 6 Km. Take the Geothermal temperature gradient is at 35^{o}K/Km, minimum useful temperature is 150^{o}K above the surface temperature T_o, rock density(ρ_r)=2800 kg/m^3, Specific heat capacity(C_r) =900 J/kg/^{o}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/^{0}K.	8
6.a)	Briefly explain the constructional features with principle of operation of Proton Exchange Membrane (PEM) fuel cell with a neat figure. Comment on efficiency of fuel cell.	8+2
b)	Briefly explaining operating principle of Magneto Hydrodynamic (MHD) power generator & then derive the voltage equation.	5+5
7.a)	State the major advantages of biomass energy. Briefly explain Municipal Solid Waste to energy incineration plant with figure.	4+8
b)	Calculate the volume of a cow dung based biogas plant required for cooking needs for a family of ten adults & lighting needs with five 100 CP (Candle Power) lamps for five hours daily. Also calculate the required number of cows to feed the plant. (Assume biogas required for cooking: 0.227m^3/person/day, gas required for each 100CP lamp: 0.126m^3/hr., cow dung production rate: 10kg/cow/day, cow dung having 18% solid mass content, biogas yield of 0.34m^3/kg of dry mass, slurry density: 1090kg/m^3).	8
8.	Briefly state the name of different energy storage methods with their examples. Briefly explain different major energy storage methods.	4+16