KATHMANDU UNIVERSITY
End Semester Examination
February/March, 2018

Marks Scored:

Level : B.E.
Year : IV

Course : EPEG 410
Semester: I

Exam Roll No:

Time: 30 mins

F.M : 10

Registration No.:

Date : MAR 15 2018

SECTION "A"
[20 Q.×0.5=10 marks]

Choose the most appropriate answer for the following questions.

1. The solar constant value as adopted value by world radiation center is ..... W/m^2.
   a. 1000 b. 4500 c. 1367 d. 5800

2. The diffused solar radiation is measured using an instrument called .....
   a. Pyranometer b. Manometer c. Anemometer d. pyrheliometer

3. The type of silicon material, in a mono crystalline silicon cell, facing the sun is .....
   a. p type b. n type c. p-n type d. p-i-n type

4. The cell voltage of a fully charged lead acid battery is approximately .....V.
   a. 1.685 b. 1.1 c. 2.1 d. 12.6

5. The HVR of a charge controller is the voltage level of a battery at which the ..... the battery.
   a. module is disconnected from b. module is reconnected to
   c. load is disconnected from d. load is reconnected to

6. The peak sun of a site is 4, the energy required by the load is 2000Wh, the derating factor is 0.9 and columbic efficiency is 0.95. The system voltage is assumed to be 24V. The size of solar module required for the load is .....A.
   a. 584.7 b. 24.3 c. 87.9 d. 78.9

7. To site a small wind turbine after a tree of height H, the hub height should be .....
   a. > H b. < H c. > 2H d. < 2H

8. For a room of size 3m × 3m, the illumination required is 200lux, the luminous flux produced by a lamp to be used is 1200 lumens, the coefficient of utilization is 0.8 and the maintenance factor is 0.7. The number of lamps required to illuminate the room as required is .....
   a. 2 b. 4 c. 1 d. 3

9. Resins from pine tree can be substitute to .....
   a. petrol b. diesel c. kerosene d. LPG

10. .....incorporates an electricity generating system based on compression of air.
    a. TAPCHAN b. Oscillating water column c. OTEC d. Salter duck

11. The concrete requirement for the construction of ..... dam is higher than other dam types.
a. arch b. buttress c. embankment d. gravity

12. The ..... turbine has the highest specific speed among the hydraulic turbines.
a. bulb b. Kaplan c. Pelton d. Francis

13. ..... is preferred over other materials specified below for penstock pipe in a MHP.
a. Concrete b. Wood c. ductile iron d. uPVC

14. The load requirement of 20 houses is 500W for 6 hours each. The load demand is fulfilled by a micro hydro power plant of 20kW. The load factor of the system will be ...
a. 0.25 b. 0.5 c. 0.125 d. 0.8

15. Water flows through a vertical contraction from a pipe of diameter d to another of diameter d/2. The flow velocity at the inlet to the contraction is 2m/s and pressure 200 kN/m2 if the height of the contraction measures 2m, the pressure at the exit of the contraction will be very nearly .....
a. 168 kN/m^2 b. 192 kN/m^2 c. 150 kN/m^2 d. 174 kN/m^2

16. The head loss in turbulent flow in pipe varies .....
a. directly as the velocity
b. inversely as the square of the velocity
c. inversely as the square of diameter
d. directly as the square of the velocity

17. A Pelton wheel with single jet rotates at 600 rpm. The velocity of the jet from the nozzle is 100m/s. If the ratio of the vane velocity to jet velocity is 0.44, the diameter of the Pelton wheel is .....
a. 0.7 m b. 1.4 m c. 2.1 m d. 2.8 m

18. A reaction turbine discharges 30 m^3/s of water under a head of 10 m with an overall efficiency of 92%. The power developed is .....
a. 2952 kW b. 2870 kW c. 2707 kW d. 2652 kW

19. Point A of head H_A is at a higher elevation than point B of head H_B. The head loss between these points is H_L. The flow will take place .....
a. always form A to B
b. from A to B if $H_A + H_L = H_B$
c. from B to A if $H_A + H_L = H_B$
d. from B to A if $H_B + H_L = H_A$

20. The imaginary line drawn in the fluid in such a way that the tangent to any point gives the direction of motion at the point is called .....
a. path line b. streak line c. filament line d. stream line

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SECTION "B"

Attempt any FIVE questions.
Assume necessary data if required

1. The daily load curve of a rural site is presented in Fig.1. If the solar radiation at the site is 5.5kwh/m^2/day and the average wind velocity is 10.5m/s, design a hybrid wind and photovoltaic system to meet the community load. Specify the size of the photovoltaic array, wind turbine, battery, charge controller and inverter, assuming all ac loads.

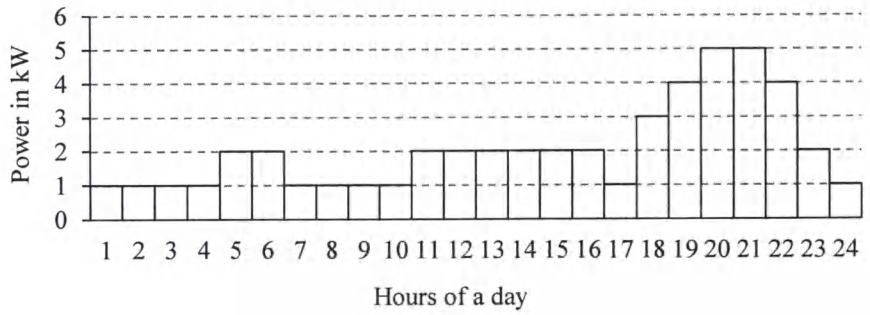

Fig.1: Daily load curve of a rural community

Draw the schematic diagram for the installation of the components of the system. [8]

2.a. Describe the difference between an ON-OFF charge controller and a PWM charge controller. [2]

b. Discuss the impact of tracking system for daily clear sky insolation on a solar PV module. [2]

c. A community of ten families is to be electrified by a biogas power plant. The expected electrical load of a family is as presented in table-1 below. Determine the size of a biogas generator to meet the expected load. Also determine the cattle requirement for the plant and the volume of the biogas digester to be used. [4]

Table-1 Electrical load of family of the community

Load	Power (W)	Quantity	Operating hours
Lamp	10	3	6
Mobile charger	5	2	4
TV (color)	160	1	4

3.a. Explain the terms ICS, briquettes and gassifier used for solid biomass applications. [3]

b. Explain how wave energy can be used for electricity generation. [2]

c. A Pelton wheel is to be designed for the following specifications:
Shaft power: 9510kW; Head: 320m; Speed: 780 rpm;
Overall efficiency: 75%; Speed ratio: 0.43; C_v: 0.98;
Jet diameter: not to exceed 1/6th of the wheel diameter
Determine the followings:
(i) The wheel diameter (ii) Diameter of the jet (iii) the number of jets required [3]

4.a. Draw the power curve of a wind turbine and explain the terms cut in speed, rated speed and cut out speed with respect to the curve. [2]

b. Which is the type of battery used between shallow cycle and deep cycle for solar photovoltaic systems? Explain your answer. [2]

c. Two reservoirs are connected by a pipeline consisting of two pipes, one of 10cm diameter and length 5m, and the other of 22.5cm diameter and 14m length. The difference of water levels in the two reservoirs is 5m. Determine all the head losses, and the rate of flow. Draw the energy gradient line and hydraulic gradient line. Consider f = 0.04. [4]

5.a. Describe the different types of non-rigid dams used for hydropower schemes. [2]

b. What is specific speed of a hydraulic turbine? How are turbines classified according to specific speed? [2]

c. The following data pertain to an inward flow reaction turbine:

Net head	= 86.4m
Speed of runner	= 650 rpm
Shaft power available	= 397kW
Ratio of wheel width to wheel diameter at inlet	= 0.1
Ratio of outer diameter to inner diameter	= 0.5
Flow ratio	= 0.17
Hydraulic efficiency	= 95%
Overall efficiency	= 85%
Flow velocity	= constant
Discharge	= radial

Neglecting the blockage by the blades, find the dimensions and blade angles of the turbine [4]

6.a. Explain the working principle of centrifugal pump with a suitable diagram showing the pump parts. [2]

b. Describe the use of AVR and ELC for a micro hydro power plant. [2]

c. For a particular site of a river, the mean monthly discharges for 12 months are presented in table-2 below. Draw the hydrograph for the given discharges and find the average monthly flow. Also draw the flow duration curve for the site. Determine the power available at mean flow of water if the available head is 90m, and the overall efficiency of generation is 82%. [4]

Table-2 Monthly discharges available for a river

Month	Discharge (m^3/s)	Month	Discharge (m^3/s)
January	100	July	1000
February	225	August	1200
March	300	September	900
April	600	October	600
May	750	November	400
June	800	December	200

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Formulae for reference:

$Q=A_1V_1=A_2V_2$; $f=\frac{0.0791}{Re^{1/4}}$; $\mathrm{Re}=\frac{\rho VD}{\mu}=\frac{VD}{\nu}$; $\mathrm{h_i}=\frac{0.5V_1^2}{2g}$; $\mathrm{h_f}=\frac{4fLV^2}{D\times 2g}$; $h_{e=}\frac{(V_1-V_2)^2}{2g}$; $h_{0=}\frac{V^2}{2g}$; $u=K_u\sqrt{2gH}$; $\mathrm{V_1}=\mathrm{C_v}\sqrt{2gH}$; B = 3.5d; L = 2.5d; T = d; $Z=15+\frac{D}{2d}$; $V_{w2}=u_2-V_{r2}cos\varphi$; $F=\rho Q(V_{w1}-V_{w2})$; $u=\frac{\pi DN}{60}$; $V_1Sin\alpha=V_{f1}$; $V_1Cos\alpha=V_{w1}$; $V_{r1}=\sqrt{(V_{w1}-u_1)^2+V_{f1}^2}$; $tan\alpha=\frac{V_{f1}}{u_1}$; $tan\theta=\frac{V_{f1}}{V_{w1}-u_1}$; $tan\varphi=\frac{V_{f2}}{u_2}$; $\pi D_1B_1V_{f1}=\pi D_2B_2V_{f2}$; $\mathrm{Q}=\pi\mathrm{D_1B_1V_{f1}}$; $H=\frac{1}{g}(V_{w1}u_1)+\frac{V_2^2}{2g}$; $P=\rho Q\times V_{w1}u_1$; $n_H=\frac{V_{w1}u_1}{gH}$; $n_H=\frac{2(V_1-u)(1+K\cos\emptyset)u}{V_1^2}$; $P=\eta wQH$; $N_s=\frac{N\sqrt{P}}{H^{3/4}}$

Tables for reference:

Table A: Specifications of different sizes of PV module

Module type		PV-150	PV-110	PV-065	PV-045	PV-030
Electrical parameters						
Rated power	[W_p]	150	110	65	50	30
Rated current	[A]	8.8	6.6	4.0	3.0	1.8
Rated voltage	[V]	16.7	16.7	16.3	16.7	16.7
Short circuit current	[A]	9.8	7.5	4.6	3.3	2.05
Open circuit voltage	[V]	21.0	20.7	20.5	21.5	21.6

Table B: Specifications of different sizes of lead-acid batteries

Battery type		B-50	B-75	B-100	B-150	B-200
Rated voltage	[V]	12	12	12	12	12
Capacity 20hr	[Ah]	50	75	100	150	200
Capacity 5hr	[Ah]	40	60	80	120	160

Table C: Bio-gas plant design considerations

Design Parameters of a Biogas Plant		
S.N.	Parameters	Value
1	1kWh electrical energy	0.56m^3 of biogas
2	1Kg of fresh cow dung	40 liters of biogas
3	Digestion temperature	20-35
4	Retention time (HRT)	30 days
5	Biogas energy content	6kWh/m^3
6	One cow yield	10 kg dung/day
7	One ox yield	12 kg dung/day
8	One buffalo yield	15 kg dung/day
9	One pig yield	2 kg dung/day
10	Gas production per kg dung for all	0.04 m^3
11	Gas requirement for cooking	0.25 m^3/person
12	Gas requirement for lighting one lamp	0.125 m^3/hour

Table D : Wind turbine specifications

Parameters	**Specifications**
Rotor Diameter	2.4 m
Number of Blades	3
Design Tip Speed Ratio	6
Cut in Wind Speed	3 m/s
Rated Wind Speed	9 m/s
Controlling Mechanism	Hinged Tail Vane System
Tower Height	12 m
Rated Power Output	400 Watt