

KATHMANDU UNIVERSITY  
End Semester Examination  
March/April, 2017

Marks Scored:

Level : B.E  
Year : IV

Course : EPEG 410  
Semester : I

Exam Roll No. :

Time: 30 mins

F. M. : 10

Registration No.:

Date APR 10 2017

SECTION "A"

[20Q × 0.5 = 10 marks]

Choose the most appropriate answer for the following questions.

1. A flow in which each liquid particle has definite path and their paths do not cross each other is called ..... flow.  
a. uniform                      b. steady                      c. streamline                      d. turbulent
2. A large Reynolds number is an indication of ..... flow.  
a. laminar                      b. highly laminar                      c. turbulent                      d. highly turbulent
3. Cavitation is caused by .....  
a. high velocity                      b. high pressure                      c. low pressure                      d. low viscosity
4. Water at 25°C is flowing through a 1.0 km long G.I. pipe of 200 mm diameter at the rate of 0.07 m<sup>3</sup>/s. If value of Darcy friction factor for this pipe is 0.02 and density of water is 1000 kg/m<sup>3</sup>, the pumping power (in kW) required to maintain the flow is .....  
a. 1.8                      b. 17.4                      c. 20.5                      d. 41.0
5. A liquid flows downward through a tapped vertical portion of a pipe. At the entrance and exit of the pipe, the static pressures are equal. If for a vertical height 'h' the velocity becomes four times, then the ratio of 'h' to the velocity head at entrance will be .....  
a. 3                      b. 8                      c. 15                      d. 24
6. A 12 cm diameter straight pipe is laid at a uniform downgrade and flow rate is maintained such that velocity head in the pipe is 0.5 m. If the pressure in the pipe is observed to be uniform along the length when the down slope of the pipe is 1 in 10, the friction factor for the pipe will be .....  
a. 0.012                      b. 0.024                      c. 0.042                      d. 0.050
7. Kaplan turbine is .....  
a. A high head mixed flow turbine                      b. A low axial flow turbine  
c. An outward flow reaction turbine                      d. An impulse inward flow turbine
8. A Francis turbine is coupled to an alternator to generate electricity with a frequency of 50 Hz. If the alternator has 12 poles, then the turbine should be regulated to run at a constant speed of .....  
a. 250 rpm                      b. 500 rpm                      c. 600 rpm                      d. 1000 rpm

9. The speed ratio of a Pelton wheel operating under a head of 900 m is 0.45. The peripheral velocity of the turbine wheel is .....
- a. 28 m/s                      b. 96 m/s                      c. 42 m/s                      d. 60 m/s
10. In hydraulic power-generation systems, surge tanks are provided to prevent immediate damage to .....
- a. Draft tube                      b. Turbine                      c. Tail race                      d. Penstocks
11. Two pumps can operate independently at heads  $H_1$ ,  $H_2$  and discharge  $Q_1$ ,  $Q_2$ , respectively. If the pumps are connected in parallel, then the resulting discharge ( $Q$ ) and head ( $H$ ) are .....
- a.  $Q = Q_1 + Q_2$ ,  $H = H_1 + H_2$                       b.  $Q = Q_1 - Q_2$ ,  $H = H_1 - H_2$   
c.  $Q = Q_1 = Q_2$ ,  $H = H_1 = H_2$                       d.  $Q = Q_1 + Q_2$ ,  $H = H_1 = H_2$
12. STC for a solar photovoltaic module is .....
- a.  $1368\text{kW/m}^2$ , AM 1,  $25^\circ\text{C}$                       b.  $1368\text{kW/m}^2$ , AM 1.5,  $25^\circ\text{C}$   
c.  $1000\text{kW/m}^2$ , AM 1,  $25^\circ\text{C}$                       d.  $1000\text{kW/m}^2$ , AM 1.5,  $25^\circ\text{C}$
13. The rating of a lead acid battery is specified as 75Ah @C10, 2V. The battery discharging current will be .....
- a. 10A                      b. 7.5A                      c. 37.5A                      d. 3.75A
14. The optimum orientation for a panel located at latitude of 40 degrees is .....
- a. pointing south with its normal at an angle of 40 degrees to the horizontal  
b. pointing west with its normal at an angle of 40 degrees to the vertical  
c. pointing north with its normal at an angle of 40 degrees to the horizontal  
d. pointing south with its normal at an angle of 40 degrees to the vertical
15. The head of water to be pumped by a solar photovoltaic system can be measured using a .....
- a. pyranometer                      b. compass                      c. abney level                      d. conductivity meter
16. The quantity of fresh cow dung required for a  $6\text{m}^3$  biogas plant on hill is .....
- a. 24                      b. 30                      c. 36                      d. 45
17. The wind speed is measured using an instrument called .....
- a. Pyranometer                      b. Manometer                      c. Anemometer                      d. Wind vane
18. Sugar cane has been a source of alternative of .....
- a. diesel                      b. petrol                      c. kerosene                      d. lantern light
19. ....incorporates an electricity generating system based on pendulum connected to the generator.
- a. TAPCHAN                      b. Oscillating water column                      c. Binary cycle                      d. Salter duck
20. The type of generator employed in wind power plant is..... generator.
- a. synchronous                      b. induction                      c. permanent magnet                      d. brushless dc

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SECTION "B"

Attempt *ANY FIVE* questions. Assume necessary data if required

1. a. A Pelton wheel running at 480 r.p.m. and operating under an available head of 420m is required to develop 4800 kW. There are two equal jets and bucket deflection angle is  $165^\circ$ . The overall efficiency is 85% when the water is discharged from the wheel in a direction parallel to the axis of rotation. The co-efficient of velocity of nozzle = 0.97 and the blade speed ratio = 0.46. The relative velocity of water at exit from the bucket is 0.86 times the relative velocity at inlet. Calculate the followings: (i) cross-sectional area of each jet, (ii) bucket pitch circle diameter and (iii) hydraulic efficiency of the turbine. [4]  
b. Explain the working principle of a centrifugal pump. [2]  
c. Describe the selection requirement for the type of a dam for a site. [2]
2. a. Explain how speed is controlled for Francis runner at a hydropower plant. [2]  
b. A horizontal pipeline 60 m long is connected to a water tank at one end and discharges freely into the atmosphere at the other end. For the first 30m of its length from the tank the pipe is 200mm diameter and its diameter is suddenly enlarged to 400mm. The height of water level in the tank is 10m above the center pipe. Determine all the head losses, and the rate of flow. Also draw the hydraulic gradient and energy gradient lines. Take co-efficient of friction,  $f = 0.01$  for both sections of the pipe. [4]  
c. Explain cavitation and mention few measures to be taken to prevent cavitation in turbines. [2]
3. a. In an inward flow reaction turbine the head on the turbine is 32m. The external and internal diameters are 1.44 m and 0.72 m respectively. The velocity of flow through the runner is constant and equal to 3m/s. The guide blade angle is  $10^\circ$  and the runner vanes are rigid at inlet. If the discharge at outlet is radial, determine: (i) the speed of the turbine, (ii) the vane angle at outlet of the runner, and (iii) hydraulic efficiency of the runner. [4]  
b. Draw the overall layout of a micro-hydro-power plant and mention all the components used for the plant. [2]  
c. A 6 m long pipe is inclined at an angle of  $20^\circ$  with the horizontal. The smaller section of the pipe which is at lower level is of 100mm diameter and the larger section of the pipe is of 300mm diameter. If the pipe is uniformly tapering and the velocity of water at the smaller section is 1.8m/s, determine the difference of pressure between the two sections. [2]
4. a. Explain how geothermal energy can be used to generate electricity. [2]  
b. A telecommunication company needs to replace its existing diesel generator set by a hybrid solar-wind power system for their telecom-towers at a rural community. The average power required for the unit is 10kW. The unit consists of 2kW air-conditioning unit, three SMPS units each of 2.5kW, lighting and other loads of 0.5kW. The SMPS unit supplies power to two BTS (about 30A each), 2 battery bank (about 40A each at max. charge) and miscellaneous load (about 10A). Design a photovoltaic, wind and battery based hybrid power supply for the unit. Estimate the size of all the components required and draw the installation diagram showing all the components of the hybrid systems with the connected loads. [6]

5. a. Explain active stall, passive stall and pitch control for wind turbines? [2]  
 b. Describe any two methods of head measurement for a micro-hydro power plant. [2]  
 c. At a particular site of a river, the mean monthly discharge for 12 months is as tabulated 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%. Take each month of 30 days. [4]

Month	Discharge (m <sup>3</sup> /s)	Month	Discharge (m <sup>3</sup> /s)
January	500	July	1250
February	400	August	1500
March	300	September	1200
April	250	October	1000
May	100	November	750
June	750	December	750

6. a. A small village community consists of 50 families, each consisting of 5 persons. The village survey report found the 75 cows, 80 oxen, 30 buffaloes and 10 pigs in the village. A bio-gas plant is to be designed for the community depending on the availability of dung from the cattle. The gas from the plant is to be used for cooking and lighting 2 lamps for each family of the village. Determine the feasibility of the bio-gas plant and the size of the plant required for this purpose. Refer the table-3 for design parameters of a bio-gas plant. Draw the basic layout of the different components of the bio-gas plant. [4]  
 b. Explain the principle of operation of a concentrated solar cell and multi-junction solar cell. [2]  
 c. Explain the terms shulpation, discharge rate, memory effect, and depth of discharge for a battery. [2]

**Formulae for reference:**

$$Q=A_1V_1=A_2V_2; f = \frac{0.0791}{Re^{1/4}}; Re = \frac{\rho VD}{\mu} = \frac{VD}{\nu}; h_i = \frac{0.5V_1^2}{2g}; h_f = \frac{4fLV^2}{D \times 2g}; h_e = \frac{(v_1-v_2)^2}{2g}; h_0 = \frac{v^2}{2g}; u = K_u \sqrt{2gH};$$

$$V_1 = C_v \sqrt{2gH}; B = 3.5d; L = 2.5d; T = d; Z = 15 + \frac{D}{2d}; V_{w2} = u_2 - V_{r2} \cos \phi; F = \rho Q (V_{w1} - V_{w2});$$

$$u = \frac{\pi DN}{60}; V_1 \sin \alpha = V_{f1}; V_1 \cos \alpha = V_{w1}; V_{r1} = \sqrt{(V_{w1} - u_1)^2 + V_{f1}^2}; \tan \alpha = \frac{V_{f1}}{u_1}; \tan \theta = \frac{V_{f1}}{V_{w1} - u_1};$$

$$\tan \phi = \frac{V_{f2}}{u_2}; \pi D_1 B_1 V_{f1} = \pi D_2 B_2 V_{f2}; Q = \pi D_1 B_1 V_{f1}; H = \frac{1}{g} (V_{w1} u_1) + \frac{V_2^2}{2g}; P = \rho Q \times V_{w1} u_1; n_H = \frac{V_{w1} u_1}{gH};$$

$$n_H = \frac{2(V_1 - u)(1 + K \cos \theta) u}{V_1^2}; P = \eta_w QH; N_s = \frac{N \sqrt{P}}{H^{3/4}}$$

**Tables for reference:**

**Table 1: Specifications of different sizes of PV module**

Module type	PV-150	PV-110	PV-065	PV-045	PV-030
<b>Electrical parameters</b>					
Rated power [W <sub>p</sub> ]	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 2: 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 3: Bio-gas plant design considerations**

Design Parameters of a Biogas Plant		
S.N.	Parameters	Value
1	C/N ratio	20-30
2	pH	6-7
3	Digestion temperature	20-35
4	Retention time (HRT)	30 days
5	Biogas energy content	6kWh/m <sup>3</sup>
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 <sup>3</sup>
11	Gas requirement for cooking	0.25 m <sup>3</sup> /person
12	Gas requirement for lighting one lamp	0.125 m <sup>3</sup> /hour

