Roll No: ----------

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination – May 2018

Program/course: M.Tech REE **Semester – II**
Subject: Small Hydro Power System **Max. Marks : 100**
Code : EPEC7018 **Duration : 3 Hrs**
No. of page/s: 4

Section A

All questions are mandatory: (Each question: 4 marks)

Q.no.	COs	Question
1.	CO1	Distinguish between small hydro, mini hydro and micro hydro.
2.	CO2	Readings taken with a float that is made to flow along a known length of 20m along a river with a smooth bed and sides; the width and depth of the river being 15m and 2m, respectively. Calculate the flow of the river if the time taken for the float to traverse 20m is 25 seconds. Assume the velocity correction factor as 0.85.
3.	CO3	Discuss different types of hydraulic turbines used in SHP.
4.	CO4	Discuss the potential of small hydro power in India.
5.	CO6	Discuss the environmental impacts of small hydro power plant.

Section B

All questions are mandatory: (Each question: 10 marks)

Q.no.	COs	Question
6.	CO1	Rain gauges are installed in twelve zones of Dhauliganga basin upto Tapovan which covers total area of 2962.10 sq.km The individual zone areas are given below:

Zones	Zone Areas (Sq.km)	Average Rainfall (mm)
Zone 1	5.33	1820
Zone 2	36.95	1800
Zone 3	73.39	1750
Zone 4	148.33	1720
Zone 5	249.76	1690
Zone 6	441.64	1675
Zone 7	705.92	1625
Zone 8	731.69	1580
Zone 9	397.94	1420

		Zone 10 | 132.27 | 1360 Zone 11 | 33.09 | 1260 Zone 12 | 5.78 | 1505 Calculate the average rainfall over the catchment by: a. Arithmetical average method [3M] b. Thiessen polygon method [7M]
7.	CO2	Explain different types of spillways with neat diagram
8.	CO3	Explain in detail about the speed and voltage regulation applied for SHP plants with the help of a case study.
9.	CO5	A closed cycle plant in Austria, with a gross head of 300m, has a headrace tunnel 4m dia and 700m long. The powerhouse discharges directly in the lower reservoir. The flow velocity is 6.5 m/s and the friction factor f = 0.018. If the overall efficiencies of pumping and generation are 88% and 90% respectively, estimate the plant efficiency.

Section C

All questions are mandatory: (Each question: 20 marks)

Q.no.	COs	Question
10.	CO4	In a regional power grid of a country the weekly load curve indicates the following: a. There is an energy shortage of 15 GWh per working day spread uniformly over 12 hours. b. There is a spare energy of 9 GWh per day spread over 3 hours uniformly. c. Demand is quite slack on Sundays so that enough energy can be spread for the pumps. Design wind and hydro based standalone - hybrid power system to satisfy above load curve. Month wise availability of renewable energy resources in the area is given below:

Sno	Month	Wind speed (m/s)	Discharge (cumec)
1	January	5.01	155
2	February	5.03	155
3	March	4.94	160
4	April	4.98	170
5	May	5.44	180
6	June	5.37	190
7	July	5.12	195
8	August	4.98	198
9	September	5.01	180
10	October	5.19	170
11	November	5.09	165
12	December	5.18	160

Assume the parameters wherever required.

11.	CO2	A storm gave the rainfall excess of 4 cm, 6 cm, and 5 cm at successive six-hour intervals. Workout a storm hydrograph form the six-hour storm when the unit hydro graph ordinates are given as below:

Time	***Six-hour UGO (cumec)***
0600	0
1200	150
1800	385
2400	500
0600	470
1200	390
1800	300
2400	215
0600	130
1200	80
1800	40
2400	15
0600	0

Assume a constant base flow of 15 cumec. Plot hydrograph and unit hydrograph.

(OR)

The average direct runoff calculated from hydrological studies is 930 m^3/s. From this 800 m^3/s is allowed to satisfy the agricultural need and the remaining is allowed into the hydropower channel. Calculate head loss due to friction and the desired effective thickness for the penstock of 6m diameter.

Given:

Gross head = 32.5m.
$L_{horizontal}$ = 44.37 m.
Roughness k = 0.18 mm.
The turbulent losses $K_{entrance}$ = 1, K_{bend1} = 0.38, K_{bend2} = 0.38, K_{valve} = 0.1
E = 100 x 10^9 N/m^2
S = 140 x 10^6 N/m^2
Pressure wave velocity = 1320 m/s.

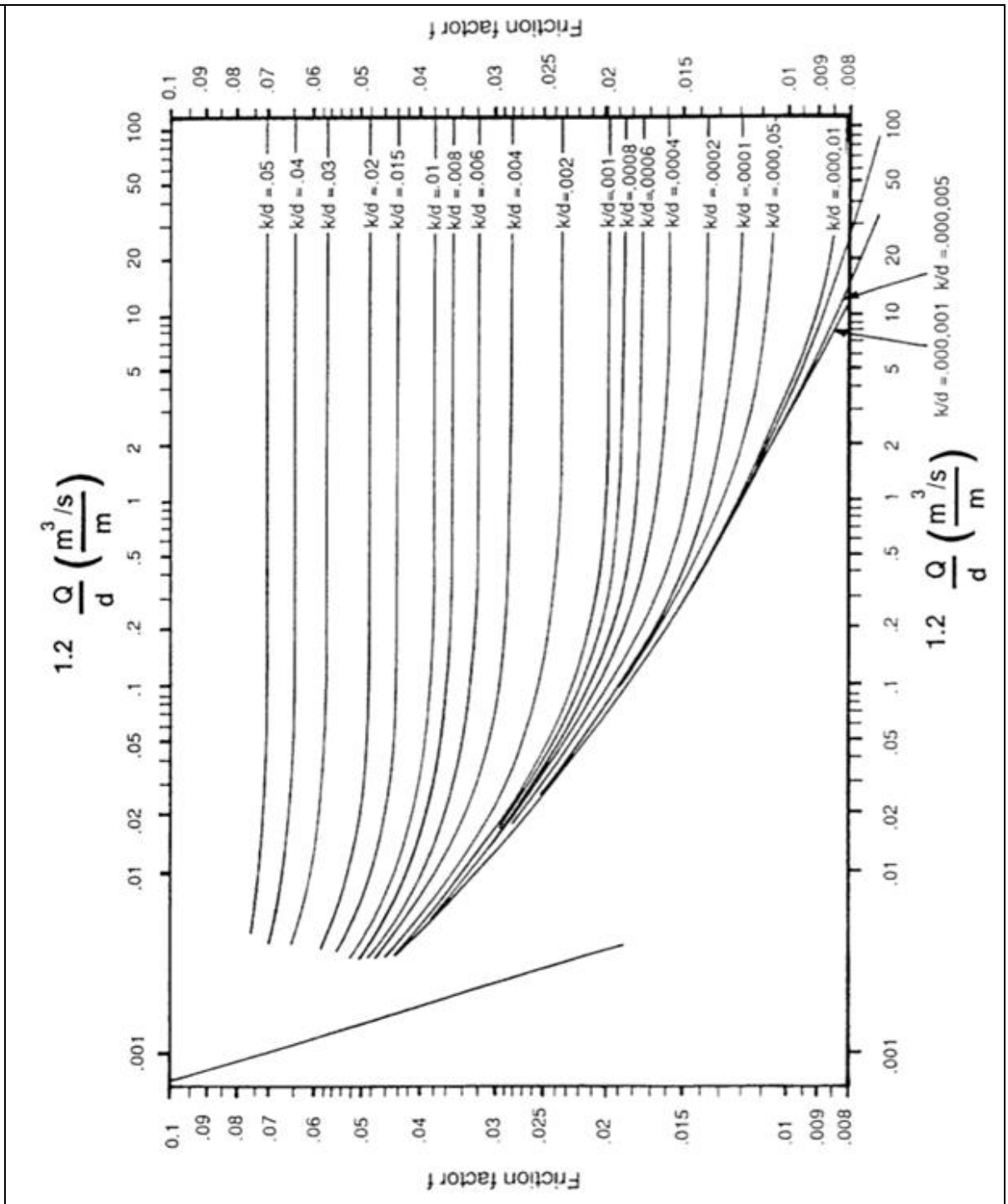

Figure 1 Moody Chart

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Section A

All questions are mandatory: (Each question: 4 marks)

Q.no.	COs	Question
1.	CO1	Discuss the opportunities and threats of small hydropower in India.
2.	CO2	If the angle measured by the Abney level are 34º, 28º, 32º and the distance between the posts are 30m, 35m and 40m respectively. Calculate the total head.
3.	CO3	Briefly explain the term *Voltage regulation* and comment on the same with respect to different types of transmission lines.
4.	CO4	Discuss the various financial indicators of SHP considered by the investors.
5.	CO5	a. Explain the significance of *specific speed* for turbines and pumps. [2M] b. If the system has a head of 100m and if 850kW turbine is coupled to a generator of 1500rpm. Calculate specific speed. [3M]

Section B

All questions are mandatory: (Each question: 10 marks)

Q.no.	COs	Question
6.	CO1	a. The rainfall data for a catchment is given below: **Time period in hours** | 0-2 | 2-4 | 4-6 | 6-8 | 8-10 | 10-12 | 12-14 | 14-16 **Rainfall in cm** | 5.5 | 3.5 | 10.0 | 5.0 | 3.0 | 0.0 | 8.0 | 3.5 Draw the rainfall hyetograph. If the Φ- index is 2.5 cm/h, calculate the runoff. [5M] b. The infiltration capacity curve for a catchment having the initial infiltration capacity of 2.0 cm/h, which assumes almost a constant value of 0.5 cm/h after 9 hours of rainfall. Estimate the total infiltration, if the Horton's constant, k, is equal to 4 per day. [5M]
7.	CO2	Explain different types of silt basin for small hydropower system based on its design.

8.	CO4	a. A 12kW micro hydro project for grain milling is proposed. It has a start up cost of Rs. 2000000. The discount rate is 20%. An energy survey relating to the project established that the grain milling operation will bring in annual earnings of Rs. 700000. The operating and maintenance cost are expected to be 14000 per year. What will be the income of the project, if the cost and earning are imagined as spread out over 12 years? [5M] b. Discuss briefly on cash flow analysis related to small hydro power system. [5M]
9.	CO5 CO6	a. A 100 MW reversible pump-turbine has to work under a head of 400m. Choose a suitable specific speed and running speed for the machine. Note: Assume the efficiency of machine as 88%. [5M] b. Explain the environmental impacts of hydro power plant with a capacity less than 25MW. [5M]

Section C

All questions are mandatory: (Each question: 20 marks)

<table>
<tr><th>Q.no.</th><th>COs</th><th>Question</th></tr>
<tr><td>10.</td><td>CO4</td><td>In a regional power grid of a country the weekly load curve indicates the following:
a. There is an energy shortage of 15 GWh per working day spread uniformly over 12 hours.
b. There is a spare energy of 9 GWh per day spread over 3 hours uniformly.
c. Demand is quite slack on Sundays so that enough energy can be spread for the pumps.

Design wind and pumped storage plant based standalone - hybrid power system to satisfy above load curve.

Month wise availability of renewable energy resources in the area is given below:

<table>
<tr><th>Sno</th><th>Month</th><th>Wind speed (m/s)</th></tr>
<tr><td>1</td><td>January</td><td>5.01</td></tr>
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			9	September	5.01
			10	October	5.19
			11	November	5.09
			12	December	5.18

<u>Topology</u>

There is a large reservoir on a big river to serve as lower pool. A suitable site is available 1.25 km away with a high hill 300 m higher than the lower pool for developing the above reservoir.
Assume the parameters wherever required.

11. CO2

The average direct runoff calculated from hydrological studies allowed into the hydropower channel is 0.52 m^3/s.

Given:
Gross head = 284m.
$L_{horizontal}$ = 1800 m.
Roughness k = 0.18 mm.
The turbulent losses $K_{entrance}$ = 1, K_{bend1} = 0.38, K_{bend2} = 0.38, K_{valve} = 0.1
E = 100 x 10^9 N/m^2
S = 140 x 10^6 N/m^2

Select the best penstock diameter and its thickness among the following:

1. Penstock diameter (d) = 0.45m; thickness = 0.165 * d
2. Penstock diameter (d) = 0.35m; thickness = 0.165 * d
3. Penstock diameter (d) = 0.30m; thickness = 0.165 * d

(OR)

The stream flows due to three successive storms of 3.5, 4.5 and 2.5 cm of 6 hours duration each on a basin are given below. The area of the basin is 45.4 km2. Assuming a constant base flow of 10 cumec, and an average storm loss of 0.25 cm/hr, derive the ordinates of 6-hour unit hydro graph for the basin.

Time (hr)	0	3	6	9	12	15	18	21	24	27	30	33	36	39
Stream flow (cumec)	10	14	18	32	46	54	58	49	36	25	17	12	11	10

Plot hydrograph and unit hydrograph.