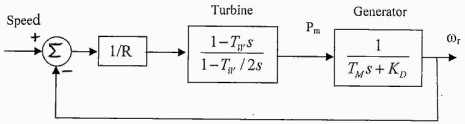
Form A: Paper-setting Blank Ref. No. EX/PG/PE/T/129B/2019

M. E. Power Engineering 1st Yr 2nd Sem. Examination, 2019

Subject: Hydro Turbine

Time: Three hours Full marks: 100

**Answer any 5 question**

| No. of questions | | |
|---|---|---|
| 1. | What do mean by governing of hydraulic turbine?<br>For a stand-alone hydraulic turbine plant the block diagram is shown below. If $T_w = 2.0$s, $T_M = 10$s and $K_D = 0$, determine (i) the lowest value of the droop R for which the speed governing is stable and (ii) the value of R for which the speed control action is critically damped. Symbols have their own meanings.<br>  <br> | 4+16 |
| 2. | Derive the "classical" transfer function of a hydraulic turbine (variation of turbine output power change in response to gate opening) for an ideal lossless turbine. Sate all the assumptions. | 20 |
| 3. | What should be the guide line for modeling hydraulic turbines?<br>For a run-of-river plant the discharge data available throughout the year related to the release from all outlets of a dam is given below. The performance testing of the SHP getting water from the dam at 100%, 80% and 60% of rated load gives efficiency of 79.3%, 76.6% and 71.7%. The SHP has two Francis Type machines each consumes 8.5cumnec water at 100% load. Calculate the weighted efficiency of the plant. | 10+10 |

| Month | Discharge (cumec) |
|---|---|
| January | 6.22 |
| February | 30.866 |
| March | 31.004 |
| April | 37.776 |
| May | 10.995 |
| June | 5.594 |
| July | 51.796 |
| August | 68.679 |
| September | 162.766 |
| October | 74.044 |
| November | 6.906 |
| December | 0 |

4. What do mean by economical diameter of a penstock? 4+16
A hydro-electric station is using 10 $m^3/s$ of water through a penstock which has a friction factor of 0.016. The maximum normal pressure in the penstock is 40 $kgf/cm^2$ and a water hammer overpressure is 10% over the normal pressure is anticipated. The cost of the penstock material is Rs.15000/- per tonne including the erection cost. The safe stress of the material of the penstock is $3000kg/cm^2$. The life of the project is 50 years and the rate of interest is 8% of the loaned money amount. It is proposed to sell the energy at the rate of Rs.2.75/- per kWh. What should be the optimum diameter of the penstock, given the operation, maintenances and repair costs are 6%. Assume the turbine efficiency to be 90% and the annual load factor as 0.6. Also consider capital recovery factor for 50 years as 0.0725.

5. Given below are the monthly rainfall P and the corresponding runoff R values covering a period of 18 months for a catchment. Develop a correlation equation between R and P 15+5

| Month | P | R | Month | P | R |
|---|---|---|---|---|---|
| 1 | 5 | 0.5 | 10 | 30 | 8.0 |
| 2 | 35 | 10.0 | 11 | 10 | 2.3 |
| 3 | 40 | 13.8 | 12 | 8 | 1.6 |
| 4 | 30 | 8.2 | 13 | 2 | 0.0 |
| 5 | 15 | 3.1 | 14 | 22 | 6.5 |
| 6 | 10 | 3.2 | 15 | 30 | 9.4 |
| 7 | 5 | 0.1 | 16 | 25 | 7.6 |
| 8 | 31 | 12.0 | 17 | 8 | 1.5 |
| 9 | 36 | 16.0 | 18 | 6 | 0.5 |

What are different methods for the classification hydro power plants?

6. What is meant by hydrological cycle? How can the parameters of the cycle be written in an equation form? 3+2+15
A square catchment area of 25 sq unit has five rain gauges installed. With respect to a Cartesian co-ordinate system the corner points of the area are (0,0), (0,5), (5,5) and (5,0) unit. The co-ordinates of the rain gauge stations are (1,1), (3,-1), (4.5,1.5), (3.5,3.5), (0.5,4) unit and the corresponding rainfall values are 6.5cm, 8.3cm, 12.7cm, 11.8cm and 5.0cm respectively. Calculate the average rainfall over the catchment area by (i) Arithmetical average method and (ii) Theissen polygon method.

7. A Kaplan turbine develops 8000HP under a head of 5m. The speed ratio and flow ratio are 2.0 and 0.6 respectively and the boss diameter of the runner is 35% of the external diameter of the runner. Calculate the diameter of the runner, speed of the runner and specific speed of the runner. Consider the overall efficiency of the turbine is 90%. 14+3+3
Why anchor blocks are used for long penstocks?
What do you mean by dead storage and live storage of a dam?