Name: **Enrolment No:**	UPES

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, December 2018

Course: Steam, Gas and Hydraulic Turbine **(**MREQ 702**)** **Semester: I**
Programme: M Tech RE
Time: 03 hrs. **Max. Marks: 100**
Instructions: Attempt all questions. Take appropriate data if missing

SECTION A

S. No.		Marks	CO
Q 1	Discuss the impulse momentum principle w.r.t to a turbine	**5**	**CO4**
2	Investigate various losses in turbine blades in an axial flow gas turbine	**5**	**CO3**
3	Explain the can type combustion chamber in gas turbine	**5**	**CO2**
4	Derive the relation of velocity of pressure pulse in a compressible fluid	**5**	**CO1**
	SECTION B		
5	Discuss the working of combined steam and gas turbine plant with help of flow diagram and T-S diagram.	**10**	**CO3**
6	A Pelton Wheel is to be designed for the following specifications: a. Shaft Power =12000 kW b. Head of water=400 rpm c. Speed= 800 rpm. d. Overall efficiency=90% e. Jet diameter not to exceed one sixth of wheel diameter. Determine the following a. The diameter of wheel. b. The number of jets required. c. Diameter of jet. Or A 137 mm diameter jet of water issuing from a nozzle impinges on buckets of a Pelton wheel and jet is deflected by 165 ˚ by the buckets. The head available at the nozzle is 400 m . Assuming C_v=0.97 and speed ratio= 0.46 and reduction in relative velocity while passing through buckets as 15 % a) Find the force exerted by the jet on buckets in tangential direction b) The power developed, and Hydraulic efficiency	**10**	**CO4**

7	The velocity of steam leaving the nozzle of an impulse turbine is 900 m/s and the nozzle angle is 20°.The blade velocity is 300m/s and blade friction factor is 0.7.Calculate for a mass flow rate of 1 kg/s and symmetric blading a) Blade inlet angle b)the driving force on wheel c) axial thrust d) diagram power e)diagram efficiency	**10**	**CO1**
8	a) Differentiate b/w the axial and radial flow gas turbines. b) Explain types of cooling of turbine blades in gas turbines	**10**	**CO3**
	SECTION-C		
Q 9	A Gas turbine plant with an exhaust heat exchanger has following data: Turbine and Compressor Pressure ratio = 10 Minimum Cycle Temperature = 300 K Maximum Cycle Temperature = 1050 K Flow rate through turbine and compressor = 10 kg/s Effectiveness of heat Exchanger = 0.8 Compressor and turbine efficiency= 85% Mass flow rate of fuel can be ignored and properties of Gas and air are about same. Determine: a) Power Developed b) Thermal efficiency of plant. c) Efficiency of ideal joule cycle with perfect heat exchange. **OR** A gas turbine plant consists of two compressors of equal pressure ratio with intercooling to minimum cycle temperature at inlet to the second compression stage followed by single stage turbine. Isentropic efficiency of compressor and turbine are η_c=85% for both stages, η_t=¿90% and the minimum and maximum temperature of cycle is 300 K and 1050 K and pressure ratio is 7 and air enters the turbine at 1 bar. Find the specific output of the above cycle and cycle efficiency.(given C_p=¿ 1 kJ/kg.K and ϒ=1.4 for both air and gas	**20**	**CO2**
10	a) Analyze Velocity and Pressure compounding w.r.t to impulse steam turbine. b) Discuss the components of Kaplan turbine along with diagram. Draw inlet and outlet velocity triangle and analyze work done and efficiency calculations for the same.	**10+ 10**	**CO1/4**

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SECTION A

S. No.		Marks	CO
Q 1	Define cavitation and suggest methods to avoid it in hydraulic turbines	**5**	**CO4**
2	Explain the combustion phenomenon in gas turbines.	**5**	**CO2**
3	Differentiate b/w axial and radial flow gas turbines.	**5**	**CO3**
4	Describe the functions of draft tube w.r.t to reaction turbine..	**5**	**CO4**
Q 5	Discuss a) Critical pressure ratio and b) Choked flow w.r.t convergent –divergent nozzle of steam turbine	**10**	**CO1**
6	A Francis turbine with an overall efficiency of 75% is required to produce 148.25 kW power.it is working under a head of 7.72 m. The peripheral velocity =0.26√2gh and the radial velocity of flow at inlet is 0.96√2gh.the wheel runs at 150 rpm and the hydraulic losses in the turbine are 22% of the available energy. assuming radial discharge, determine i. The guide blade angle. ii. The wheel vane angle at inlet. iii. Diameter of the wheel at inlet iv. Width of wheel at inlet	**10**	**CO4**
7	Prove that the overall efficiency of combined gas and steam cycle plant is given by(abbreviations : gt-gas turbine, st-steam turbine.) $\eta_o = \eta_{¿} + \eta_{st} - \eta_{¿} * \eta_{st}$ ¿ A combined gas and steam plant develops 10 MW at the gas turbine shaft with an efficiency of 20%. A steam turbine power plant ($\eta_{st} = 32\,\%$) is operated through the WHRB which receives the turbine exhaust. calculate a. Output of steam turbine plant b. Thermal efficiency of combined cycle plant. c. Overall heat rate.	**10**	**CO3**

8	Discuss the types of turbine blade cooling w.r.t axial flow gas turbine. also explain the various losses in turbine blades.	**10**	**CO3**
Q 9	Explain the effects of following methods on efficiency of gas turbine with the help of T-S diagram and flow diagram. a) Effect of intercooling. b) Effect of regeneration. c) Effect of reheating Or A closed cycle regenerative gas turbine operating with air as the working medium. Assume the following data: inlet air pressure and temperature to the compressor is 1.4 bar and 310 K. The maximum temperature of cycle is 1050 ˚K. Pressure at outlet of compressor is 5 bar. Effectiveness of regenerator is 100 ‰net output is 3000 W. Assuming the compression and expansion to be isentropic ($C_p = 1.005 \frac{KJ}{Kg.k}$, $\Upsilon = 1.4$). calculate A) Thermal efficiency. B) Mass flow rate of air per minute	**20**	**CO2**
10	In a stage of an impulse steam turbine the mean diameter of blade ring is 800 mm and speed of rotation is 3000 rpm. The direction of final absolute velocity of steam is axial. The inlet and exit angles of blades are 30°.assuming blade friction factor of 0.85 and steam flow rate of 1 kg/s. Determine a) The nozzle angle b) the absolute velocity of steam leaving the nozzle c) the enthalpy drop in the stage d) the tangential thrust & axial thrust e) blading work and blading efficiency.	**20**	**CO1**