**Note: - Pl. start your question paper from next page**

| Name:<br>Enrolment No: | UPES |
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# UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

## Online End Semester Examination, May. 2021

**Programme Name: B. Tech (Mechanical Engineering)** **Semester : VIII**
**Course Name : Steam & Gas turbines** **Time : 03 hrs**
**Course Code : MEPD 4004P** **Max. Marks: 100**
**Nos. of page(s) :2**
**Instructions: Attempt all questions**

## SECTION A

1. **Each question carries 5 marks.**

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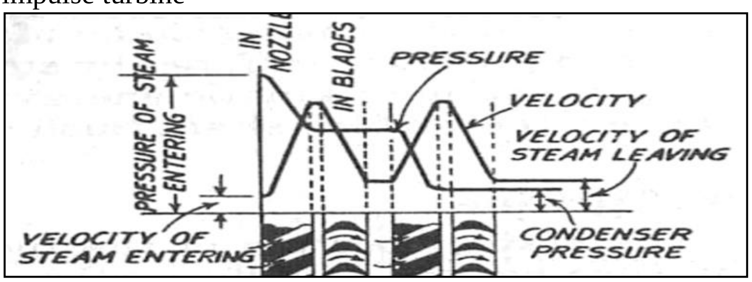
| Q1. | a. Describe work and heat interaction between system and surroundings<br>b. If 50 J of energy is added to a system that does no external work, by how much will the internal energy of that system be raised? | | **CO1** |
| Q2. | i). The given **Fig. 1** represents pressure and velocity variation for a<br>a.) Reaction Turbine b.) Velocity compounded impulse turbine<br>c.) Pressure –Velocity compounded turbine d.) Pressure compounded impulse turbine<br><br>. **Fig. 1.**<br>ii). The purpose of governing in steam turbines is to<br>a.) reduce the effective heat drop b.) reheat the steam and improve its quality<br>c.) completely balance against end thrust d.) maintain the speed of the turbine<br><br>iii) Symmetrical blading is used in a turbine when its degree of reaction is<br>a.) 25% b.) 50% c.) 75% d.) 100%<br><br>iv). In Jet type condenser<br>a.) cooling water passes through the tubes and the seam surrounds them.<br>b.) steam passes through the tubes and cooling water surrounds them. | | **CO1** |

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| | c.) steam and cooling water mix. d.) steam and cooling water do not mix.<br><br>v). The blades of a reaction turbine are<br>a.) Aerofoil type & asymmetrical b.) Flat type & asymmetrical<br>c.) Aerofoil type & symmetrical d.) Flat type & symmetrical | | |
| Q3. | Describe super heating, reheating and regenerative feed water heating. | | **CO1** |
| Q4. | Explain barometric condenser | | **CO1** |
| Q5. | Explain flying bomb of propulsion system | | **CO1** |
| Q6. | Explain the effects of super saturation and its phenomenon. | | **CO1** |

**SECTION B**

**All question carries 10 marks**

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| Q1. | A steam generator comprises a boiler, a super heater, an economiser at $140^{0}$ C and leaves as saturated liquid. Air is preheated from a temperature of $25^{0}$ C to 250 $^{0}$ C. Steam leaves the boiler drum at 60 bar, 0.98 dry and leaves the super heater at 450 $^{0}$ C. When using coal with a calorific value of 25.2 MJ/kg, the rate of evaporation is 8.5 kg steam per kg coal and the air fuel ratio is 15:1 by mass. Neglecting heat losses and pressure drops, estimate the heat transfer per kg of fuel in each component and the efficiency of the steam generator. What are the percentages of the total heat absorption taking place in the economiser, boiler and the super heater, respectively? Assume Cp of air and water as 1.005 and 4.2kJ/kg K; respectively.. | | **CO2** |
| Q2. | The nozzles of the impulse stage of a turbine receive steam at 17 bar and $320^{0}$'C and discharge it at I.1 bar. The nozzle efficiency is 93% and the nozzle angle is 19°. The blade speed is that required for maximum efficiency and the entry of steam to the blades is without shock. The blade exit angle is 4° less than the blade inlet angle. The blade velocity coefficient is 0.93 and the steam flow rote is 1390 kg/h.<br>Calculate (a) the diagram power, and (b) the stage efficiency. | | **CO2** |
| Q3. | Derive the condition for maximum efficiency of a Reaction turbine is<br>$\boldsymbol{\acute{\eta}_{max} = 2 \cos^2 \alpha / 1 + \cos^2 \alpha}$ | | **CO2** |
| Q4. | Air is drawn in a gas turbine unit at $17^{0}$C and 1.02bar, pressure ratio is 8:1 the compressor is driven by the H.P turbine, and L.P turbine drives a separate power shaft. The isentropic efficiency of compressor and the H.P and L.P turbines are 0.85, 0.85 and 0.85 respectively. If the maximum cycle temperature is $690^{0}$C, calculate:<br>The pressure and the temperature of gases entering the power turbine, The net power developed by the unit per kg/s mass flow, The work ratio, Thermal efficiency of the unit, For compression $C_{pa}$=1.008kJ/kg k and ɣ=1.41<br>For combustion and expansion process $C_p$ = 1.18kJ/kg k and ɣ=1.444 | | **CO3** |

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| Q5. | Explain governing of a steam turbine and Describe any two method of governing for turbines.<br><br>**OR**<br>Explain the different losses in turbines. | | **CO3** |
| | **SECTION C**<br>**Each Question carries 20 Marks.** | | |
| Q1. | A gas turbine employs a heat exchanger with a thermal ratio of 75%. The turbine operates between the pressure of 1.02 bar and 4.07 bar and ambient temperature is $20^0$ C. Isentropic efficiencies of compressor and turbine are 85% and 85% respectively. The pressure drop on each side of the heat exchanger is 0.06 bar and in the combustion chamber 0.16 bar. Assume combustion efficiency to be unity and calorific value of the fuel to be 41800 kJ/kg.<br>Calculate the increase in efficiency due to heat exchanger over that for simple cycle. Assume $C_P$ is constant throughout and is equal to be 1.024 kJ/kg K, and assume $\gamma$ = 1.41.<br>For simple cycle the air – fuel ratio is 93:1, and for the heat exchange cycle the turbine entry temperature is the same for a simple cycle.<br>OR<br><br>i. At a stage of a reaction turbine, the rotor diameter is 1.5 m speed ratio 0.8. If the blade outlet angle is $20^0$ and the rotor speed 3500 r.p.m., find the blade inlet angle and diagram efficiency.<br>Also find the percentage increase in diagram efficiency and rotor speed. if the turbine is designed to run at the best theoretical speed. (15 M)<br><br>ii. Explain working procedure of athodyd jet with schematic diagram. (5 M) | | **CO3** |