Draw the velocity triangle and find :

(i) blade angle at inlet,

(ii) tangential force on ring of moving blades and

(iii) power developed in a stage.

(c) Discuss any one method of steam turbine governing with suitable diagram.

5. Attempt any *two* out of the following : **(10×2=20)**

(a) A simple gas turbine admits air at atmospheric pressure (1.013 bar) and 15°C and compresses air in the compressor upto 16 bar. Then the air enters the combustion chamber and is heated to a maximum temperature of 1350°C, further it enters the turbine and expands to atmospheric pressure. The isentropic efficiency of compressor and turbine is 0.87, combustion efficiency 0.98, drop of pressure through the combustion chamber is 0.3 bar. Specific heat at constant pressure for both air and gases 1.005 kJ/kg K. Ratio of specific heats 1.4. Determine the flow of air and gases for a net power of 200 MW developed.

(b) Answer the following :

(i) With the help of neat sketch explain the working of turbo prop engine.

(ii) Discuss the basic theory and operation of rocket engine.

(c) Discuss the effect of regenerator on the performance of gas turbine cycle. When regenerator becomes superfluous ?

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(Following Paper ID and Roll No. to be filled in your Answer Book)

PAPER ID : 3989 **Roll No.**

B. Tech.

(SEM. IV) THEORY EXAMINATION 2011-12

APPLIED THERMODYNAMICS

Time : 3 Hours *Total Marks : 100*

Note : (1) Attempt *all* questions.

(2) All questions carry equal marks.

(3) Be precise in your answer.

(4) Use of steam tables and Mollier chart is permitted.

(5) Assume any relevant data suitably, if missing.

1. Attempt any *two* out of the following : **(10×2=20)**

(a) Explain the following :

(i) Coefficient of volume expansion,

(ii) Isothermal compressibility,

(iii) Joule Thomson coefficient and

(iv) Inversion curve.

(b) The volumetric composition of the 'dry' products of combustion of an unknown hydrocarbon fuel C_xH_y gives : CO_2 12.1%, O_2 3.8%, CO 0.9% and N_2 83.2%. Determine :

(i) Chemical composition of fuel,

(ii) The air fuel ratio, and

(iii) Percentage of excess air used.

(c) What is meant by heat of reaction ? When is it positive and when negative ? In what way it differs from enthalpy of formation ?

2. Attempt any *two* out of the following : **(10×2=20)**

(a) Answer the following :

(i) Make comparison between fire-tube and water-tube boiler.

(ii) Discuss the effect of air leakage in condenser on the performance of thermal power plant.

(b) What do you understand by balanced draught ? Draw the variation of pressure in different components in the path of flue gases (from air inlet into boiler to the chimney inlet in case of balanced draught).

A chimney of 33 m height is used to create a draught of 19.2 mm of water column. The temperature of the flue gases in the chimney is 369°C. Estimate the quantity of air used for each kilogram of fuel burnt in a boiler having above chimney. Take the temperature of ambient as 29.7°C.

(c) The following observations were obtained during a test on a boiler :

Steam produced per kg of coal fired	9.21 kg
Steam pressure	12 bar
Dryness fraction of steam leaving the drum	0.96
Temperature of steam leaving superheater	240°C
Mean specific heat of superheated steam	2.09 kJ/kg K
Calorific value of fuel	33900 kJ/kg
Temperature of feed water entering the economiser	25°C
Temperature of feed water leaving the economiser	81°C

Calculate :

(i) Percentage of heat absorbed in economiser, boiler drum and super heater.

(ii) Overall efficiency of the boiler.

3. Attempt any *two* out of the following : **(10×2=20)**

(a) Derive an expression for mean effective pressure of a steam engine considering the effect of clearance and compression. What do you mean by 'missing quantity' ? How it can be minimized ?

(b) A steam turbine utilises convergent nozzles where expansion of steam is isentropic. The steam is at 6 bar and 260°C at inlet to these nozzles. Total area of nozzles at exit is 30 cm^2. The pressure at exit is 4 bar. Find the condition of steam at exit and mass flow rate. Neglect velocity of approach.

(c) Answer the following :

(i) Derive the expression for critical pressure ratio in flow through steam nozzles.

(ii) Discuss supersaturated flow in nozzles.

4. Attempt any *two* out of the following : **(10×2=20)**

(a) Why is an open feed water heater is used in steam plant ? What is it called ? In a regenerative Rankine cycle, steam enters in turbine at 120 bar and 550°C and leaves at 0.05 bar. Steam is bled from turbine at 20 bar pressure for heating in open feed water heater. Find the thermal efficiency of the cycle. Assume isentropic expansion in turbine.

(b) The following data belong to a stage of Parson's steam turbine consisting of one ring of fixed blades and one ring of moving blades :

Average diameter of blade ring	70 cm
Speed	3000 rpm
Steam velocity at exit from blades	160 m/s
Blade outlet angle	20°
Steam flow through blades	7 kg/s