# VEERMATA JIJABAI TECHNOLOGICAL INSTITUTE

[Central Technological Institute, Maharashtra State]

**Matunga, Mumbai-400 019**

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| SEMESTER EXAMINATION | *May 2012* | DATE OF EXAM | *May 11, 2012* |
| SEMESTER & PROGRAM | *Sem. IV S.Y.B.Tech. (Mechanical)* | TIME | *13.30 – 16.30 Hrs* |
| TIME ALLOWED | *3 Hrs.* | MARKS | *100* |
| COURSE (Course Code) : | *ME 0207* | | |

Instructions
1. Attempt any **FIVE** questions.
2. All questions carry equal marks.
3. Figures to the right indicate full marks.
4. Assume suitable data, if required.

Q.1. A. Compare the pressure compounding and velocity compounding in case of impulse turbines. 6

B. Compare the water tube boilers with fire tube boilers. 6

C. The following observations were made during the test for finding the calorific value of a gaseous fuel with the help of Boys Gas Calorimeter : 8

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| Gas burnt | = 60 lit. |
| Gas Pressure | = 4 cm of water above atm. |
| Barometer reading | = 750 mm of Hg. |
| Temp. of gas | = 30 °C. |
| Water circulated through the calorimeter | = 20 kg. |
| Temp. rise for water | = 10 °C. |
| Condensate collected during the test | = 60 gms. |

Find the HCV and LCV of the fuel at NTP.

Q.2. A. A single – cylinder double – acting reciprocating air compressor compresses 26 kg / min of air from a suction pressure of 0.96 bar and temperature of 26 °C to a discharge pressure of 5.5 bar. The clearance volume is such that the maximum pressure in the cylinder at the end of compression stroke cannot exceed 13 bar. Calculate the clearance volume and the ideal power, if the compressor runs at 400 rpm. Assume $n = 1.3$ for both compression and expansion. 8

B. Explain with suitable sketches the working of La'Mont boiler. 6

C. Explain with a suitable sketch the construction of combined velocity diagram for inlet and outlet steam in case of a simple impulse turbine. 6

Q.3. A. Starting with the steady flow energy equation for a nozzle, derive the expression for the outlet velocity of steam through a nozzle, neglecting velocity of approach. 6

B. Calculate the heat absorbed by the feed water in various components as a percentage of total heat absorbed for the following data of a boiler : 8

Steam pressure = 12 bar
Dryness fraction of the steam leaving the boiler = 0.96.
Temperature of the steam leaving the superheater = 240 °C.
Quantity of coal fired = 760 kg / hr.
Quantity of feed water supplied = 7000 kg / hr.
C.V. of coal = 33874 kJ / kg of coal.
Feed water temperature entering the economiser = 25 °C.
Feed water temperature leaving the economiser = 80 °C.
Sp. Heat of the superheated steam = 2.09 kJ / kg.K
Hence, calculate the thermal efficiency of the boiler.

C. Explain with suitable sketches, the working of a Bomb Calorimeter. 6

PTO.

Q.4. A. Derive the expression for ideal intermediate pressure in case of a two – stage reciprocating compressor with perfect intercooling. 6

B. With suitable sketches, deduce the expression for thermodynamic analysis of ideal Brayton cycle for efficiency. 6

C. The following particulars relate to a two – row velocity compounded impulse turbine : 8

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| Steam velocity at nozzle outlet | = 650 m / sec. |
| Blade velocity | = 125 m / sec. |
| Nozzle outlet angle | = 16°. |
| Outlet angle of first row of moving blade | = 18°. |
| Outlet angle of fixed guide blades | = 22°. |
| Outlet angle of second row of moving blade | = 36°. |
| Steam flow rate | = 2.5 kg / sec. |

The ratio of relative velocity at outlet to that at inlet is 0.84 for all blades.
Determine for each row of moving blades the following :

i) Velocity of whirl.
ii) Tangential thrust on the blades.
iii) Power developed.
iv) Overall efficiency.

Q.5. A. Explain the concept of boiler heat balance. 6

B. In a gas turbine plant, the air at 1 bar, 15 °C is compressed to 8 bar with compression efficiency of 87 %. The air is heated in the regenerator and the combustion chamber till its temperature is raised to 1500 K, and during the process, the pressure drops by 0.14 bar. The air is then expanded in the turbine and passes to regenerator which has 75 % effectiveness and yields the exhaust at a pressure 0.14 bar higher than the atmospheric. If the isentropic efficiency of the turbine is 88 %, determine the thermal efficiency of the plant. 8

C. Explain the concept of complete combustion. Hence, discuss the significance of stoichiometric air : fuel ratio. Extend the same analogy to discuss rich and lean combustion. Write the expression for complete combustion of hydrocarbon fuels and apply the same for octane ( $n = 8$ ). 6

Q.6. A. Explain with suitable schematic representation the working of rotating vane type rotary compressor. 6

B. Starting with the expression of discharge of mass through the steam nozzle, derive the expression for the critical pressure ratio in the nozzle. Hence mention the values of the same for saturated and superheated steam. 6

C. Dry and saturated steam enters a nozzle at 2 bar and with negligible velocity. The mass flow rate is 0.03 kg / sec. The discharge pressure is 1 bar and the expansion is isentropic. Find the throat pressure, quality of the steam at the throat, throat area and exit area. 8

Q.7. A. Compare the liquid fuels with solid fuels. 6

B. Saturated steam is generated at a pressure of 8 bar in a Lancashire boiler of 21 $m^3$ capacity. Two – third of the drum volume is occupied by water, having density of 896.86 kg / $m^3$. The remaining volume is occupied y the steam. Due to some reason, the explosion of the boiler takes place. Find the energy released due to explosion. 8

C. Compare the impulse turbines with the reaction turbines. 6

Q.8. A. Explain with suitable sketches the basic approaches employed in a gas turbine towards the improvement in the efficiency. 10

B. Calculate the throat and exit areas for a convergent – divergent air nozzle if the air at 9 bar, 200 °C expands isentropically in the nozzle into a space at 1.1 bar at the rate of 5 kg / sec. Assume negligible inlet velocity. Redesign the nozzle if the isentropic efficiency for the expansion through the nozzle is 90 %. 10