(b) Dry saturated steam at pressure of 6 bar flows through nozzles at the rate of 4.5 kg/sec and discharges at a pressure of 1.6 bar. The loss due to friction occurs only in the diverging portion of the nozzle and its magnitude is 12% of the total isentropic enthalpy drop. Assume the isentropic index of expansion $n = 1.135$, determine the cross sectional area at the throat and exit of the nozzles.

8. Derive an expression for force, work done, diagram efficiency, stage efficiency and axial thrust in case of steam turbines.

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[06 – 2209]

II/IV B.E. DEGREE EXAMINATION

Second Semester

Electrical and Electronics Engineering

THERMAL PRIME MOVERS

(Effective from the Admitted Batch of 2006–2007)

Time : Three hours | Maximum : 70 marks

First Question is compulsory.

Answer any FOUR from the remaining.

Assume suitable missing data wherever necessary.

All questions carry equal marks.

1. (a) Discuss the important points of difference between petrol and diesel engine.

(b) Explain the following terms relating to steam formation : (i) Sensible heat of water, (ii) Latent heat of steam.

(c) Explain the terms water space and steam space concerned to boilers.

(d) Various types of nozzles and their distinguishing features.

(e) Explain degree of reaction of steam turbine.

(f) Classification of gas turbines.

(g) First law of thermodynamics.

2. (a) Define a thermodynamic system. Differentiate between open system, closed system and an isolated system.

(b) Find the internal energy of 1 kg of steam at 20 bar when (i) it is superheated, its temperature being 400°C; (ii) it is wet, its dryness being 0.9. Assume superheated steam to behave as a perfect gas from the commencement of superheating and thus obeys Charle's law. Specific heat for steam = 2.3 kJ/kg K.

3. (a) State the differences between externally fired and internally fired boilers. (4)

(b) Give the construction and working of Babcock and Wilcox boilers. (10)

4. (a) Give a sketch of one cylinder internal combustion engine and label important parts. (4)

(b) Write short notes on the following: Brake power, Brake specific fuel consumption, Brake mean effective pressure, Mechanical efficiency, Brake thermal efficiency. (10)

(2) APR 12-17

5. Air consumption for a four stroke petrol engine is measured by means of a circular orifice of diameter 3.5 cm. The co-efficient of discharge for the orifice is 0.6 and the pressure across the orifice is 14 cm of water. The barometer reads 76 cm of Hg. Temperature of air in the room is 24°C. The piston displacement volume is 1800 cm^3. The compression ratio is 6.5. The fuel consumption if 0.13 kg/min of calorific value 44000 kJ/kg. The brake power developed at 2500 rpm is 28 kW. Determine (a) the air to fuel ratio, (b) the volumetric efficiency on the basis of air alone (c) the brake mean effective pressure (d) the relative efficiency on the brake thermal efficiency basis.

6. A gas turbine unit receives air at 1 bar, 300 K and compresses it adiabatically to 6.2 bar. The compressor efficiency is 88%. The fuel has a heating value of 44186 kJ/kg and the fuel-air ratio is 0.017 kg fuel/kg of air. The turbine internal efficiency is 90%. Calculate the work of turbine and compressor per kg of air compressed and thermal efficiency. For products of combustion $c_p = 1.147$ kJ/kgK, $\gamma = 1.33$.

7. (a) Derive an expression for maximum mass flow per unit area of flow through a convergent divergent nozzle when steam expands isentropically from rest.

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[06 – 2209]

II/IV B.E. DEGREE EXAMINATION.

Second Semester

Electrical and Electronics Engineering

THERMAL PRIME MOVERS

(Common with Dual Degree program in EEE)

(Effective from the admitted batch of 2006–2007)

Time : Three hours   Maximum : 70 marks

Question No. 1 is compulsory.

Answer any FOUR questions from the remaining.

All questions carry equal marks.

1. Explain the following in brief :
   (a) Describe thermodynamic process of perfect gases.
   (b) What is super saturated steam?
   (c) What is scavenging?
   (d) Describe the boiler draught.
   (e) What is compounding of the steam engine?
   (f) Differentiate between impulse and reaction turbine.
   (g) What are the methods to improve the thermal efficiency of gas turbines?

2. An ideal gas requires 1150 kJ/kg of heat to raise its temperature from 20 °C to 100 °C, when heated at constant pressure. When heat is supplied to the same gas at constant volume. The heat requirement is 825 kJ for the same temperature range, Determine the specific heat at constant pressure, specific heat at constant volume and the adiabatic exponent.

3. (a) Explain the working principle of Babcock Wilcox boiler with a neat sketch.

(b) Describe the function of air preheater with a sketch.

4. (a) Explain with a neat sketch, the sequence of events in the working of a two-stroke petrol engine.

(b) Describe the Morse test for determining the indicated power of a multi cylinder engine, state the assumptions made.

5. The compression ratio of an Otto cycle is and the suction temperature and pressure are 300 K and 100 kPa respectively, heat supplied in the constant volume process is 540 kJ/kg. The air flow rate is 100 kg/h. Assume $\gamma = 1.4$ and $C_v = 0.71$ kJ/kg K and determine

(a) the power output

(b) the mean effective pressure and

(c) the efficiency.

6. (a) What is steady flow energy equation as applied to steam nozzles? Explain its use in the calculation of steam velocity at the exit of a nozzle.

(b) Steam is supplied to a nozzle at 3.5 bar an 0.96 dry. The steam enters the nozzle at 240 m/s. The pressure drops to 0.8 bar. Determine the velocity and dryness fraction of the steam when it leaves the nozzle.

7. (a) Derive the equation for maximum efficiency of an Reaction turbine.

(b) Explain Pressure Velocity Compounding of an Impulse turbine.

8. A gas turbine plant with a pressure ratio of 1:5 takes in air at 15° C. The maximum temperature is 600° C and develops 2200 kW. The turbine and compressor efficiencies are equal to 0.85. Assume $C_p = 1$ kJ/kg K and $C_v = 0.714$ kJ/kg K, Determine :

(a) actual overall efficiency of the turbine and

(b) mass of the air circulated by the turbine.

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7. (a) With a neat sketch the working principle of a four stroke diesel engines. (7)

(b) In a ideal brayton cycle air from the atmosphere at 1 atm, 300 k is compressed to 6 atm and the maximum cycle temperature is limited to 1100 k by using large air-fuel ratio. If the heat supply is 100 mw, find (i) the thermal efficiency of the cycle (ii) work ratio, (iii) power output, (iv) energy flow rate of the exhaust gas leaving the turbine. (7)

8. (a) Derive the expression of optimum pressure ratio for maximum net work output in an ideal Brayton cycle. (7)

(b) An air standard diesel engine has compression ratio of 18, the heat transferred to the working fluid per cycle is 1800 kJ/kg. At the beginning of compression stroke, the pressure is 1 bar and the temperature is 300 K. Calculate (i) Thermal efficiency (ii) Mean effective pressure. (7)

[06 –2209]

II/IV B.E. DEGREE EXAMINATION.

Second Semester

Electrical and Electronics Engineering

THERMAL PRIME MOVERS

(Common with M.S.E.E.E.)

(Effective from the admitted batch of 2006–2007)

Time : Three hours Maximum : 70 marks

Question No. 1 is compulsory.

Answer any other FOUR questions from the remaining.

All questions carry equal marks.

1. Explain : $(14 \times 1 = 14)$

(a) Internal energy is a property.

(b) Carnot Cycle.

(c) Entropy.

(d) Throttling.

(e) Dryness fraction.

(f) Draw the otto cycle on a p – v diagram.

(g) Define compression ratio.

(h) Define point function.

(i) What is fine tube boiler?

(j) What is pre-ignition?

(k) List the functions of injector.

(l) State the necessities for cooling of an engine.

(m) Classify the boilers.

(n) Define work ratio.

2. (a) Derive an expression for work done and heat transferred during adiabatic expansion. (7)

(b) A mass of 0.05kg of carbon dioxide (mol. weight 44), occupying a volume of 0.03 m^3 at 1.025 bar, is compressed reversibly until the pressure is 6.15 bar. Calculate final temperature, the work done on the CO_2, the heat flow to or from the cylinder walls, (i) When the process is according to law $pv^{1.4}$ = constant (ii) when the process is isothermal. (iii) When the process takes place in a perfectly thermally insulated cylinder. Assume CO_2 to be a perfect gas, and take $\gamma = 1.3$. (7)

3. (a) What are the various methods of finding dryness fraction and at least one method in detail? (7)

(b) A rigid container is filled with steam at 7 bar and 200° C. At what temperature and pressure will the steam starts condense when the container is cooled? To what temperature and pressure must the container be cooled to condense 50 % of the steam mass? (7)

4. (a) Explain how steam boilers are classified. (7)

(b) Explain with a neat diagram, the construction and working of a Babcock and Wilcox Water tube boiler. (7)

5. The blade speed of a single ring of an impulse turbine is 300 m/s and the nozzle angle is 20°. The isentropic heat drop is 473 kJ/kg and the nozzle efficiency is 0.85. Given that the blade velocity coefficient is 0.7 and the blades are symmetrical, draw the velocity diagrams and calculate for a mass flow of 1 kg/s : (a) Axial thrust on the blading (b) Steam consumption per B.P. hour if the mechanical efficiency is 90 per cent (c) Blade efficiency, stage efficiency and maximum blade efficiency. (14)

6. (a) Differentiate between impulse and reaction turbine. (7)

(b) In an isentropic flow through nozzle, air flows at the rate of 600 kg/hr. At inlet to the nozzle, pressure is 2 MPa and temperature is 127 degree celsius. The exit pressure is 0.5 MPa. Initial air velocity is 300 m/s determine (i) Exit velocity of air (ii) Inlet and exit area of nozzle. (7)