March 2023

POWER ENGINEERING

Time Allowed: 2.5 Hours *Full Marks: 60*

Answer to Question No. 1 of Group A is compulsory and to be answered first. This answer is to be made in separate loose script(s) provided for the purpose. Maximum time allowed is 30 minutes, after which the loose answer scripts will be collected and fresh answer scripts for answering theremaining part of the question will be provided. On early submission of answer scripts of Question No. 1, a student will get the remaining script earlier.

Answer any Five (05) Questions from Group B.

Group A

1. Choose the correct answer from the given alternatives (any twenty): 1x20

i) The thermodynamic cycle on which petrol engine works is –
(a) Otto cycle (b) Rankine cycle (c) Joule Cycle (d) Stirling cycle

ii) The compression ratio of petrol engine varies from –
(a) 6:1-12:1 (b) 16:1-20:1 (c) 20:1-26:1 (d) 25:1-30:1

iii) Supercharging _____ the power developed by the engine.
(a) decreases (b) increases (c) has no effect on (d) none of these

iv) Morse test is used to find the indicated power of a –
(a) single cylinder petrol engine (b) single cylinder diesel engine
(c) multi cylinder engine (d) none of these

v) The power actually developed by the engine cylinder of an IC engine is known as –
(a) brake power (b) indicated power (c) actual power (d) none of these

vi) The number of power strokes developed by atwo-stroke cycle engine is _____ as compared to that of afour-stroke cycle engine, having same engine speed-
(a) half (b) same (c) twice (d) four times

vii) In an I.C. engine, fuel used per hour is 10 kg and B.P. is 100 kW. Then brake specific fuel consumption of the engine will be –
(a) 10 kg/kW-hr (b) 1 kg/kW-hr (c) 0.1 kg/kW-hr (d) 0.01 kg/kW-hr

viii) Area of the actual indicator diagram of a four-stroke cycle engine is 10 cm^2, length of the diagram is 5 cm and scale of the indicator spring is 4 bar/cm of pencil travel. Then, actual M.E.P. will be-
(a) 2 bar (b) 4 bar (c) 5 bar (d) 8 bar

ix) For same peak pressure, peaktemperature and same heat rejection, the efficiency of Petrol engine is _____ Diesel engine.
(a) less than (b) equal to (c) greater than (d) less than or equal to

x) De-Laval turbine is a simple rotor_____turbine.
(a) impulse (b) reaction (c) axial flow reaction (d) mixed flow

xi) Curtis turbine is a _____.
(a) pressure compounded impulse turbine (b) velocity compounded impulseturbine
(c) pressure-velocity compounded impulseturbine (d) both (b) and (c)

xii) The purpose of governing of steam turbine is to-
(a) reduce the effective heat drop (b) reheat the steam and improve its quality
(c) completely balance against end thrust (d) maintain constant speed of the turbine

xiii) Critical pressure ratio for initially dry saturated steam is-
(a) 0.528 (b) 0.546 (c) 0.577 (d) 0.582

xiv) The velocity of steam leaving the nozzle(V) is given by-
(a) $V = 44.72Kh_d$ (b) $V = 44.72K\sqrt{h_d}$ (c) $V = 44.72\sqrt{Kh_d}$ (d) $V = 44.72h_d\sqrt{K}$
Where, K= Nozzle coefficient, h_d=Enthalpy drop during expansion.

xv) The flow of steam in convergent divergent nozzle is supersonic-
(a) at the entrance to the nozzle (b) at the throat of the nozzle
(c) at the convergent portion of the nozzle (d) at the divergent portion of the nozzle

xvi) Reheating in a gas turbine-
(a) increases the thermal efficiency (b) increases the compressor work
(c) increases the turbine work (d) decreases the thermal efficiency

xvii) Which of the following is NOT an air breathing engine-
(a) Turbojet engine (b) Turboprop engine (c) Rocket engine (d) Ramjet engine

xviii) A jet engine has-
(a) no propeller (b) propeller in front (c) propeller in back (d) propeller on the top

xix) Turboprop is preferred to turbojet because –
(a) it has high propulsive efficiency at high speeds (b) it can fly at supersonic speeds
(c) it can fly at high elevations (d) it has high power for take off

xx) Gas turbines are used in aircraft propulsion because-
(a) they are light (b) they are compact
(c) they have high power-to-weight ratio (d) all of the above

xxi) Pelton wheel is used in those places where:
(a) high head and low discharge are available (b) low head and high discharge are available
(c) high head and high discharge are available (d) low head and low discharge are available

xxii) In a reaction turbine, water at inlet possesses:
(a) only kinetic energy (b) only pressure energy
(c) both (a) and (b) (d) none of the above

xxiii) In a reaction turbine, draft tube is used:
(a) to transport water to the tail race without eddies (b) to convert K.E to pressure energy
(c) to ensure safety to the turbine (d) none of the above

xxiv) The overall efficiency of a Pelton wheel is 70%. If its mechanical efficiency is 85%,then its hydraulic efficiency will be –
(a) 87.4% (b) 82.4% (c) 72.3% (d) 62.5%

xxv) The specific speed of Kaplan turbine varies between-
(a) 1000-1200 rpm (b) 300-1000 rpm (c) 80-400 rpm (d) 10-70 rpm

Group B

2. a) What is knocking in I.C. engines?
b) An engine working on the Otto cycle has an air standard cycle efficiency of 56% and rejects heat 544kJ/kg of air. The pressure and temperature of air at the beginning of compression are 0.1 MPa and 60°C respectively. Compute: (i) the compression ratio of the engine, (ii) the work done per kg of air, (iii) the pressure and temperature at the end of compression, and (iv) the maximum pressure in the cycle. 2+6

3. a) Differentiate between Spark Ignition and Compression Ignition engines?
b) Draw and explain the actual valve timing diagram of a four-stroke petrol engine.
c) What is the function of a Carburettor in S.I. engine? 3+4+1

4. a) What are the purposes of lubrication in I. C. engines?
b) Following data were recorded during a trial on a 4-stroke diesel engine:
Number of Cylinder = 4, diameter of piston = 10 cm, stroke = 15 cm, indicated mean effective pressure = 0.67 MPa,speed = 2000 rpm, number of explosions = 980/minute, brake torque = 181.5 N-m, fuel consumption = 11.89 kg/hr, calorific value of fuel = 41800 kJ/kg, relative efficiency on brake power basis = 0.5.Calculate- (i) Mechanical efficiency, (ii) Brake thermal efficiency, (iii) Air standard efficiency, (iv) Brake specific fuel consumption. 2+6

5. a) Write down the classifications of steam turbine. Why compounding is done in steam turbines?
b) State the differences between impulse turbine and reaction turbine. 2+3+3

6. The velocity of steam, leaving the nozzles of an impulse turbine, is 1200m/sec, nozzle angle is 20°. The blade velocity is 250 m/s, blade friction factor is 0.9 and mass flow rate of 5000 kg/hr. Assuming symmetrical blading, calculate- (i) blade angles, (ii) driving force on the wheel, (iii) axial thrust on wheel, (iv) power developed by the turbine. 8

7. a) Draw the schematic flow diagrams of opencycle and closedcycle gas turbines and describe them.
b) Represent Brayton cycle on P-V and T-S diagrams and deduce its thermal efficiency. 4+4

8. a) Write down the working principle of a Pelton wheel after drawing a neat sketch of it.
b) Draw the schematic layout of a hydro-electric power plant and write a short note on it. 4+4

9. An inward flow reaction turbine has external & internal diameters as 1.0 m and 0.6 m respectively. The hydraulic efficiency of the turbine is 90% when the head on the turbine is 36 m. The velocity of flow at outlet is 2.5 m/s and discharge at outlet is radial. If the vane angle at outlet is 15° and width of the wheel is 100 mm at inlet and outlet, determine- i) The guide blade angle, (ii) speed of the turbine, (iii) vane angle of the runner at inlet, (iv) volume flow rate of turbine and (v) power developed. 8

10. a) What do you mean by specific speed of turbine?
b) A Pelton wheel operates under a head of 35m at a flow rate of 40.5 kilolitres/min. The buckets deflect the jet through an angle of 160° and the mean bucket speed is 13 m/s. Determine (i) the power developed at the runner and (ii) hydraulic efficiency of the turbine. 2+6