Applied Thermodynamics
Question Bank

Unit – 1

Q1. Deduce Maxwell equation and obtain the relation between various thermodynamic Properties.

Q2. Compare water tube and fire tube boiler

Q3. Explain constructional details, working for

(a) Fire tube boiler
(b) Water tube boiler
(c) Locomotive boiler

Q4. What are the essential for a boiler

Q5.List the various points on which the selection of boiler is based

Q5. Obtain the property relation for between various thermodynamic properties

Q6.Define the following terms

A. Volume expansivity
B. Isothermal and adiabatic compressibility
C. Joule Thomson coefficient

Unit 2

1. Explain the classification of boiler in details.
2. Explain the following in details with neat sketch and diagram:
    i. Water tube boiler
    ii. Fire tube boiler
    iii. Bab cock and will cock boiler
    iv. Locomotive boiler
    v. Lancashire boiler
3. Differentiate between water tube and fire tube boiler.
4. Describe with neat sketch water level indicator for the boiler.
5. Describe in brief:

i. Safety valve.
ii. Function of blow of cock.
iii. Economizer.
iv. ^{0}Super heater.
v. Air pre heater.

6. A coal fired boiler plant consumes 400kg of coal per hour. The boiler evaporates 32000kg of water at 44.5^0 C into superheated steam at a pressure of 12 bar and 274.5^0 C. If the calorific value of fuel is 32760 kj/kg of coal determine:
   i. Equivalent evaporation.
   ii. Thermal efficiency of the boiler.
7. Steam at 9 bar and 0.9 dry is supplied is an engine where it expands adiabatically to release pressure of 1.4 bar. Thereafter the pressure falls at constant volume to exhaust pressure of 0.3bar. Make calculation for:
   i. Steam consumption in Kg/kWh
   ii. Mean effective pressure
   iii. Thermal efficiency of the cycle
   iv. Heat to be removed in the condenser per unit mass of exhaust steam.
   v. Theoretical loss of work due to incomplete expansion.
8. A boiler evaporates 5 kg of water per kg of coal burnt on the fire grate in the combustion chamber. The temperature of feed water is 30^0 C and the steam is raised at 10 bar pressure. Calculate equivalent evaporation from and at 100^0 C per kg of coal as well as factor of evaporation if the steam produced is:
   i. 0.95 dry
   ii. Superheated to 250^0 C
9. Briefly discuss the working of condensing plant with neat sketch.
10. Discuss the classification of condenser on details
11. Explain in details:
   - Surface condenser
   - Jet condenser and its various types
   - Evaporative condenser
12. What is meant by boiler trails? Also explain the heat balance sheet on the boiler.
13. Discuss various methods to express the boiler performance.
14. What do you mean by formation reaction heat of reaction and standard enthalpy of formation?
15. Ethane is burned with 20%excess air. The combustion is complete is complete and is carried out at one atmospheric pressure. Find the air fuel ratio and dew point temperature of the combustion products.
16. Define Enthalpy of formation and enthalpy of combustion. Calculate the enthalpy of hydrogen at 60^0 C and 1 atm pressure. Assuming the specific heat of hydrogen as 14.5 kj/kg k

17. The following data were obtained in a boiler trail :
Mass and temperature of feed water =680 kg/hr and 20^0 C
Steam pressure ant its temperature =15 bar and 300^0 C
Coal used and its calorific value= 98kg/hr and 26500kj/kg
Flue gases formed and its temperature at chimney=18kg/kg of coal and 300^0 C
Ash and unburnt coal in ash pit =44kg/hr with 2200kj/kg calorific value
Mean specific heat of flue gases and feed water =1kj/kg K and 40187kj/kg K
Ambient temperature in the boiler room is 28^0

Determine

(a) Boiler efficiency
(b) Equivalent evaporation from and at 100^0 C
(c) Percentage heat un accounted for

18. Draw the heat balance sheet from the data given below which pertains to the trails made on a boiler generating 500kg/hr of steam at10.5 bar pressure and 0.97 dryness fraction.
Fuel used and its calorific value : 75kg/hr. and 31500 kj/kg
Moisture present in the fuel : 6%by mass
Mass of dry flue gases :10kg/kg of fuel
Temperature of flue gases :315^0 C
Specific heat of flue gases :2.1kj/kg k
Temperature of boiler room :38^0 C
Feed water temperature :50^0 C

5 The following data were recorded on a steam boiler:
Pressure and condition of steam at exit from boiler: 0.95MPA and 0.95 dry
Temperature of steam leaving the super heater =250^0 C
feed water supplied per hour: 7000 kg
Feed water temperature at entry to and exit from economizer: 250 C and 80^0 C
Quantity of coal burnt/hr and its calorific value: 750kg and 33915kj/kg
Determine the thermal efficiency of the plant.
Also calculate the heat absorbed by feed water in various components as a percentage of total heat.

Unit -3

1. Consider the same Rankine power cycle as we analyzed before. But this time we are going to superheat the steam in the boiler before allowing it to enter the turbine at 6 MPa. The steam exits from the turbine will be 100% saturated vapor as shown. After condensing, saturated liquid enters the pump at a pressure of 0.1 MPa. Determine

(a) the rate of heat transfer into the boiler per unit mass,
(b) the net power generation per unit mass.
(c) the thermal efficiency

2. A steam power plant operates between a boiler saturation temperature of 180oC and condenser temperature of 45oC. Dry saturated steam enters the turbine. Draw the T-s diagram, calculate the Rankine cycle efficiency and specific steam consumption (SSC).
3. Consider a coal-fired steam power plant that produces 300MW of electric power. The power plant operates on a simple ideal Rankine cycle with turbine inlet conditions of 5 MPa and 450o C and a condenser pressure of 25 kPa. The coal used has a heating value (energy released when the fuel is burned) of 29 300 kJ/kg. Assuming that 75% of this energy is transferred to the steam in the boiler and that the electric generator has an efficiency of 96%, determine:
   a) The overall plant efficiency (the ratio of net electric power output to the energy input as fuel)
   b) The required rate of coal supply
4. With neat sketch explain carnot vapour power cycle.
5. What are the four basic components of steam power plant
6. Describe the different operation of rankine cycle with its efficiency.
7. Discuss the effect of inlet pressure and temp of steam of rankine cycle.
8. How to inprove rankine cycle performance
9. Obtain th eefficiency of a rankine cycle with
   (a) Reheating
   (b) Regeneration
   (c) Combined reheat and regeneration
   (d) Cogeneration
   (e) Binary vapour power cycle.
10. A thermal power plant operates on a regenerative cycle with a single open feed water heater, as shown in the figure. For the state points shown, the specific enthalpies are: h1 = 2800 kJ/kg and h2 = 200 kJ/kg. The bleed to the feed water heater is 20% of the boiler steam generation rate. The specific enthalpy at state 3
11. What is the efficiency of an ideal regenerative Rankine cycle power plant using saturated steam at 327oC and pressure 135 bar at the inlet to the turbine, and condensing temperature of 27oC (corresponding saturation pressure of 3.6 kPa)?
12. *A Carnot cycle works on steam between the pressure limits of 7 MPa and 7 kPa. Determine thermal efficiency, turbine work and compression work per kg of steam.*

13.A steam power plant uses steam as working fluid and operates at a boiler pressure of 5 MPa, dry saturated and a condenser pressure of 5 kPa. Determine the cycle efficiency for (a) Carnot cycle (b) Rankine cycle. Also show the T-s representation for both the cycles.

13. *A steam turbine plant operates on Rankine cycle with steam entering turbine at 40 bar, 350ºC and leaving at 0.05 bar. Steam leaving turbine condenses to saturated liquid inside condenser. Feed pump pumps saturated liquid into boiler. Determine the net work per kg of steam and the*

cycle efficiency assuming all processes to be ideal. Also show cycle on T-s diagram. Also determine pump work per kg of steam considering linear variation of specific volume

14. *A steam power plant running on Rankine cycle has steam entering HP turbine at 20 MPa, 500ºC and leaving LP turbine at 90% dryness. Considering condenser pressure of 0.005 MPa and reheating occurring upto the temperature of 500ºC determine,*
    (a) the pressure at wich steam leaves HP turbine
    (b) the thermal efficiency

15. *In a steam turbine installation running on ideal Rankine cycle steam leaves the boiler at 10 MPa and 700ºC and leaves turbine at 0.005 MPa. For the 50 MW output of the plant and cooling water enteringand leaving condenser at 15ºC and 30ºC respectively determine*
(a) the mass flow rate of steam in kg/s
(b) the mass flow rate of condenser cooling water in kg/s .

15. *A reheat cycle has steam generated at 50 bar, 500ºC for being sent to high pressure turbine and expanded upto 5 bar before supplied to low pressure turbine. Steam enters at 5 bar, 400ºC into low pressure turbine after being reheated in boiler. Steam finally enters condenser at 0.05 bar and subsequently feed water is sent to boiler. Determine cycle efficiency, specific steam consumption and work ratio.*
16. *In a steam power plant the high pressure turbine is fed with steam at 60 bar, 450ºC and enters low pressure turbine at 3 bar with a portion of steam bled out for feed heating at this intermediate pressure. Steam finally leaves low pressure turbine at 0.05 bar for inlet to condenser. Closed feed heater raises the condensate temperature to 115ºC. Bled steam leaving closed feed heater is passed through trap to mix with condensate leaving condenser. Consider actual alternator output to be 30 MW, boiler efficiency as 90% and alternator efficiency of 98%. Determine,*
    (a) the mass of steam bled for feed heating,
    (b) the capacity of boiler in kg/hr.
    (c) the overall thermal efficiency of plant
    Also give layout and T-s diagram

17. What do you understand by ideal regenerative cycle? Why is it not possible in practice? Also give actual regenerative cycle
18. Compare performance of regenerative cycle with simple Rankine cycle
19. Discuss advantages of binary vapour cycles over single vapour cycle
20. A steam engine working on Rankine cycle operates between 1.96 MPa, 250ºC and 13.7 kPa. If engine consumes steam at the rate of 0.086 kg per second, determine Rankine cycle efficiency, neglecting
    pump work. Also, find Rankine cycle efficiency considering pump work.
21. In a steam power plant working on boiler pressure of 80 bar and condenser pressure of 0.075 bar determine cycle efficiency considering it to work on Carnot cycle.
22. A reheat cycle operates between 80 bar and 0.075 bar. Temperature of steam entering turbine is 600ºC
    and first stage of expansion is carried out till the steam becomes dry saturated. Subsequently steam is

reheated upto the initial temperature at inlet. Neglecting pump work determine efficiency and specific
steam consumption in kg/hp·hr. [42.5%, 141 kg/hp-hr]

23. A steam turbine installation of 60 MW capacity has steam entering turbine at 7 MPa, 500ºC with steam bleeding at 2 MPa and 0.2 MPa for feed heating. Remaining steam at 2 MPa is reheated upto 480ºC. Steam finally leaves turbine at 36 mm Hg (absolute). Give layout, mass fraction of steam bled out perkg of steam generated, cycle efficiency and mass flow rate of steam entering turbine.

Unit -4

1. **Steam enters the rotor of a reaction turbine with an absolute velocity of 236 m/s and the relative velocity of 132 m/s. It leaves the rotor with a relative velocity of 232 m/s absolute velocity of 126 m/s. The specific work output is**
2. In a reaction turbine, the enthalpy drop in the fixed blade ring is 50 kJ per Kg and the enthaply drop in the moving blade ring is 25 kJ per Kg. The degree of reaction of the turbine is
3. Classify steam engines.
4. Give a neat sketch of simple steam engine and explain its working.
5. Describe with sketches any five different parts of steam engines.
6. Why is it necessary to provide guides for a cross-head?
7. Describe the function of crank.
8. What is the eccentric? Explain its utility?
9. Describe the working of D-slide valve.
10. Describe hypothetical and actual indicator diagrams for a simple steam engine.
11. What are factors responsible for actual indicator diagram differing from hypothetical diagram?
12. Describe significance of diagram factor.
13. What do you understand by missing quantity of steam?
14. Why the cylinder of steam engine is generally steam jacketed?
15. What do you understand by compound steam engines?
16. Describe various types of compounding in steam engines and their relative merits and demerits.
17. Show the hypothetical and actual P-V diagram for compound steam engine having HP and LP cylinders.
18. Discuss the relevance of mep referred to LP cylinder in compound steam engines.
19. Discuss different methods of governing of steam engines.
20. A single cylinder double acting steam engine has steam being admitted at 10 bar, 0.96 dry and exhausted at 0.5 bar. The expansion occurs up to 1.64 bar. Power output from engine is 60 hp at 210 rpm. The cylinder stroke volume is 0.021 m3. Determine the diagram factor.
21. A single cylinder double acting steam engine has bore of 25 cm and stroke to bore ratio of 1.2. What shall be the indicated power output from engine if steam is admitted at 10.35 bar and discharged at 0.34 bar. The diagram factor is 0.81 and cut off occurs at 50% of stroke.
22. In a double acting steam engine the steam is supplied at 6.5 bar and 0.85 dry and exhausted at 0.28 bar. The engine runs with speed of 150 rpm. The diameter of piston is 500 mm and piston

rod has diameter of 64 mm. The expansion ratio at the front end and back end of piston are 10 and 8 respectively. Stroke length is 600 mm. Steam is being supplied at 6.8 kg per ihp. hr. Steam leaving engine is condensed and the feed water at 35_C is sent back. Determine thermal efficieny and total indicated horse power of engine.

23. A steam engine has throttle governing such that it develops 37.5 kW with steam consumption of 1000 kg/hr. The steam consumption at no load is 125 kg/hr. Determine the steam consumption for the indicated power developed being 25.8 kW.
24. Determine the missing quantity of steam at cut-off, release and percentage reevaporation for the double acting steam engine having following details.

Steam pressure at cut-off = 6 bar, the cut-off point is at distance of 38 cm from zero.
Steam pressure at release = 3 bar, the point of release is at distance of 8.3 cm from zero.
Steam pressure at beginning of compression = 1.05 bar, the point of start of compression is at distance of 1.3 cm from zero.
Clearance length = 0.86 cm
Speed of engine = 150 rpm
Steam consumption = 270 kg/hr
Steam is supplied dry saturated.

1. Mean stroke volume = 7300 cm3

Unit -5

1. Describe the principle of jet propulsion.
2. Classify the jet propulsion engines.
3. Define and give mathematical expressions for thrust power, propulsive power and propulsive efficiency.
4. Compare turbojet engine with other jet propulsion engines.
5. Compare between solid propellent rocket engine and liquid propellant rocket engines.
6. Discuss the working of turboprop, ramjet and pulse jet engines
7. Considering a jet propulsion unit to have isentropic compression and expansion and heat supply at constant pressure show that thrust developed per kg of air per second for negligible velocity of approach can be given by; $[2C_P \cdot T_a (t - 1)$ Here t is the ratio of absolute temperature after combustion and before combustion, r_p is compression ratio and T_a is absolute atmospheric temperature