Please, answer the following questions: (Total Marks 100)

1) Identify the following statement as true or false with correcting the false parts: (10 Marks)

1.1) The tubes in a fire tube boiler are located outside the shell or drum. In contrast, the tubes in a water tube boiler are contained within the shell or drum.

1.2) The air leakage into a steam condenser decreases the pressure of steam on the shell side.

1.3) The thinner the tubes of a steam condenser, the smaller the heat transfer rates.

1.4) The fouling on the cooling water side of steam condensers increasing the rate of heat rejection.

1.5) Segmental baffles in steam condensers of the shell-and-tube type are used for re-directing the steam in the shell of condensers and supporting the tubes as well.

1.6) The steam supply to the turbine is controlled so that the speed of rotation of the turbine shaft should remain constant at 4000 rpm irrespective of the load.

1.7) In an impulse turbine, the steam admission is full while in a reaction turbine, the steam admission is part.

1.8) The degree of reaction in an impulse turbine is higher than zero, while in a reaction turbine it is equal to zero.

1.9) Rateau turbine is a velocity compounded multi-stage reaction turbine while Curtis turbine is a pressure compounded multi-stage reaction turbine.

1.10) The drain cooler serves in heating the drain water in order to protect the condenser pump from cavitation.

2) _Give a scientific expression for each of the following statements:_ (10 Marks)

2.1) The point at which solid phase (ice), liquid phase (water) and gas phase (steam) coexist at the same time in equilibrium.

2.2) A closed pressure vessel in which steam is generated for use externally to itself by the direct application of heat resulting from the combustion of fuel or by the use of electricity or nuclear energy.

2.3) An automatic pressure relieving device for vapor service, which actuated by the static pressure up-streams and opens once the pressure increases over the popping pressure.

2.4) A device that makes the steam condenser work under vacuum.

2.5) A method for determining the reheating pressures between the stages in a multi-stage turbine corresponding to the maximum output power.

2.6) The pressure ratio corresponding to the maximum mass flow rate of steam in a steam nozzle.

2.7) A single stage reaction turbine with 50% degree of reaction.

2.8) The ratio of the summation of the isentropic enthalpy drop in the stages to the Rankine enthalpy drop in a multi-stage turbine.

2.9) The device that separates the steam in the cascade back system of closed feed water heaters in order to reduce the steam pressure as well as to protect the condenser pump from cavitation.

2.10) A heat recovery unit applied for heating the feed water before entering the boiler using the exhaust gases from the boiler furnace.

3) A vessel having a volume of 10 m^3 contains 0.1 m^3 of saturated water and 9.9 m^3 of saturated steam at a pressure of 1 bar. Heat is transferred until the vessel is filled with dry and saturated steam. Determine:
a) The dryness fraction in the initial state, b) The internal energy in the initial and final states, c) The amount of heat transferred to the vessel. (20 Marks)

3) In a regenerative plant, initial steam conditions are 28 bar and 400°C. Exhaust pressure is 25 mm Hg abs. and the dryness fraction is 90%. Steam is bled for heating the feed water at two points such that the enthalpy drop is divided equally before first extraction, between bleeding points and after second extraction.
The condensate from each heater is pumped into the feed line on its boiler side. Assuming a straight line expansion in the turbine and ideal conditions at each heater exit, determine the bleeding pressures, the amounts of bled steam, and the thermal efficiency, as well as the turbine internal efficiency. (20 Marks)

5) A steam turbine is governed by throttling, and the specific steam consumption at half load is 3 kg/kW.h. The nozzle box pressures at half load and full load are 27.2 bar and 49 bar respectively. The temperature of steam leaving the boiler is 292°C. The condenser pressure is 0.05 bar. Draw the Willans lines and determine the following in case of no load, ¼ , ¾ and full loads:
a) Specific steam consumption, b) nozzle box pressure.
Determine also the turbine internal efficiency and the cycle efficiency at ½ and full loads. (20 Marks)

6) A surface condenser is designed to condense 5000 kg of dry steam per hour at 50°C. The ID and OD of the tubes used in the condenser are 15 mm and 18 mm respectively. The condensed water is available at 20°C and its rise in temperature is limited to 10°C. The velocity of water inside tubes is 2.7 m/s. The outer heat transfer coefficient on the steam side is 5000 W/m^2K and the inner heat transfer coefficient on the water side is 3200 W/m^2K. The fouling factor on the water side is 0.0002 m^2K/W and on the steam side is 0.00009 m^2K/W. The thermal conductivity of the tube material is 80 W/m.K. Assuming there is no under-cooling of the condensate, calculate the total number of tubes required and the tube length if the number of tube passes is 2. (20 Marks)