QUESTION 1 [30 Marks]

Consider an ideal Otto cycle has a compression ratio of 9.2 and uses air as the working fluid. At the beginning of the compression process, air is at 98 kPa and 27°C. The pressure is doubled during the constant-volume heat-addition process. Accounting for the variation of specific heats with temperature, determine:

a) the sketch of $P - V$ diagram of the cycle, **(5 Marks)**
b) the maximum temperature and pressure that occur during the cycle, **(8 Marks)**
c) the net work output, **(5 Marks)**
d) the thermal efficiency (based on variation of specific heats) **(5 Marks)**
e) the mean effective pressure for the cycle, **(7 Marks)**

QUESTION 2 [20 Marks]

A gas-turbine power plant operates on the simple Brayton cycle between the pressure limits of 100 and 1200 kPa as shown in **Figure Q2**. The working fluid is air, which enters the compressor at 30°C at a rate of 150 m^3/min and leaves the turbine at 500°C. Using variable specific heats for air and assuming a compressor isentropic efficiency of 82 percent and a turbine isentropic efficiency of 88 percent, determine:

a) the net power output,

b) the back work ratio, and

c) the thermal efficiency.

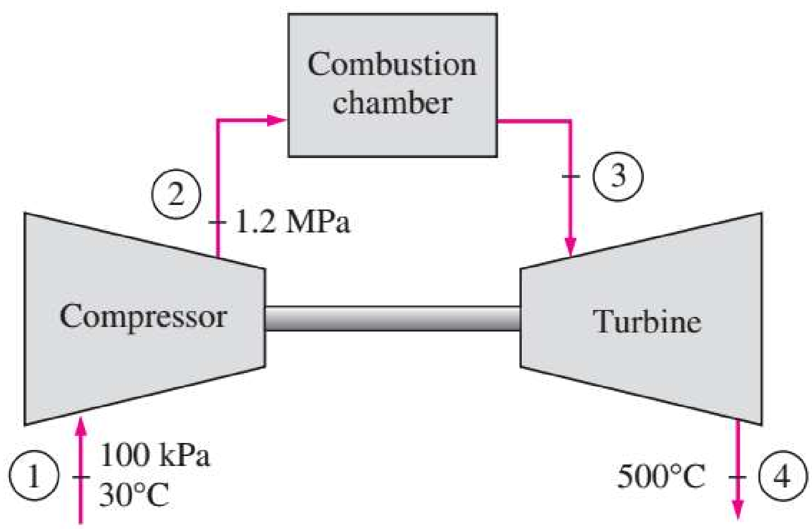

Figure Q2

QUESTION 3 [50 Marks]

Consider a steam power plant that operates on a regenerative Rankine cycle and has a net power output of 150 MW as shown in **Figure Q3**. Steam enters the turbine at 10 MPa and 500°C and the condenser at 10 kPa. The isentropic efficiency of the turbine is 80 percent, and that of the pumps is 95 percent. Steam is extracted from the turbine at 0.5 MPa to heat the feedwater in an open feedwater heater. Water leaves the feedwater heater as a saturated liquid. Show the cycle on a T-s diagram, and determine:

a) the mass flow rate of steam through the boiler, and

b) the thermal efficiency of the cycle.

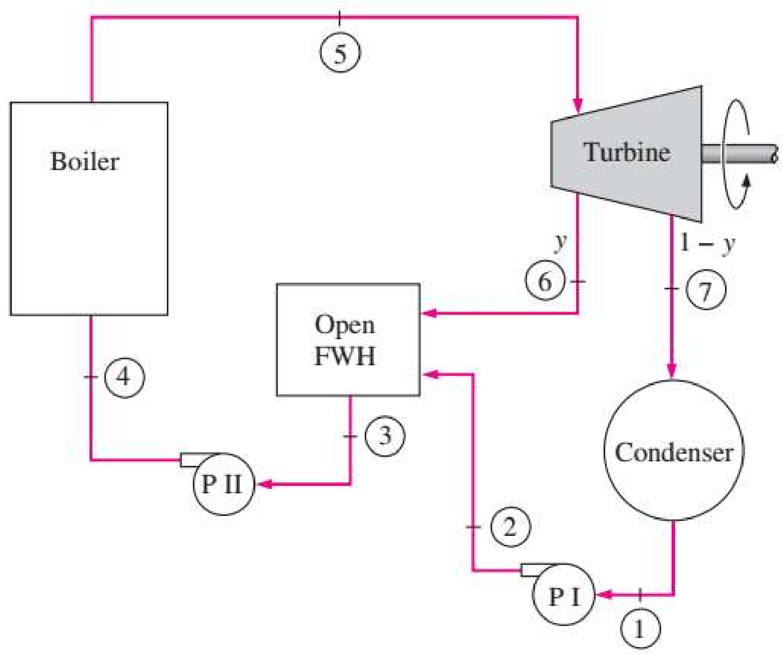

Figure Q3

END OF EXAMINATION PAPER