1. The entire output of a supercharged four stroke cycle oil engine is used to drive on air compressor. The air enters the compressor at 20\(^0\)C and is delivered to a cooler which removes heat at the rate of 1340 kJ/min. The air leaves the cooler at 60\(^0\)C and 1.72 bar. Part of this air flow is used to supercharge the engine which has a volumetric efficiency of 0.70 based on induction manifold condition of 60\(^0\)C and 1.72 bar. The engine has six cylinders of 90 mm bore and 100 mm stroke runs at 2000 rev/min and delivers an output torque of 147 Nm. The mechanical efficiency of the engine is 0.75. Determine (a) the engine indicated mean of effective pressure, (b) air consumption in kg/min, and (c ) air flow into compressor in kg/min.

2. A simple jet carburettor is required to supply 5 kg of air and 0.5 kg of fuel per minute. The fuel specific gravity is 0.75. The air initially at 1 bar and 300 K. Calculate the throat diameter of the choke for a flow velocity of 100 m/s. Velocity coefficient is 0.8. If the pressure drop across the fuel metering orifice is 0.80 of that of choke, calculate orifice diameter assuming, $C_{df}=0.60$ and $\gamma=1.4$.

3. An internal combustion engine works on Diesel cycle with a compression ratio of 8 and expansion ratio of 5. Calculate the air-standard efficiency.

4. An engine using fuel of calorific value 42000 kJ/kg has a brake thermal efficiency of 30%. Find its brake specific fuel consumption in kg/kW-h.

5. A test on a single cylinder, four stroke oil engine having bore 18 cm and stroke 36 cm gives the following result; speed 285 rev/min; brake torque, 393 Nm; indicated mep-7.2 bar; fuel consumption-3.5 kg/h; cooling water flow-4.5 kg/min; cooling water temperature rise- 36\(^\circ\)C; air-fuel ratio by mass-25; exhaust gas temperature-415\(^\circ\)C; barometric pressure-1.013 bar, room temperature 21\(^\circ\)C. The fuel has a calorific value of 45200 kJ/kg and contains 15% by mass of hydrogen. Determine
(a) indicated thermal efficiency
(b) volumetric efficiency based on atmospheric conditions

Draw up a heat balance in terms of kJ/min explaining clearly the content of such term.

Take $R=0.287$ kJ/kgK; $C_v$ for dry exhaust gases=$1.005$ kJ/kgK; and for superheated steam $C_p=2.05$ kJ/kgK.