



SEAGOING ENGINEER OFFICER CLASS 1

CERTIFICATE OF COMPETENCY

APPLIED HEAT

Time allowed: 3 hours

INSTRUCTIONS :-

This paper consists of NINE questions where

Candidates are required to attempt ANY SIX questions.

All questions carry equal marks.

Pass marks: 50 %

CANDIDATES ARE NOT ALLOWED TO WRITE ON OR DEFACE THIS PAPER

This paper consists of this page and FOUR other printed pages.

Notes to Candidates:-

- i) Write down your name in the top right-hand corner on the first page of the answer sheets.
- ii) Write down the question number in the top left-hand corner on each page.
- iii) Answer each question on a new page.
- iv) No need to copy the questions' details onto the answer sheets.
- v) **Switch off all your mobile phones and communication devices when in the examination room.**
- vi) **Return all the question paper(s), the used and unused answer sheets before leaving the examination room.**
- vii) **Do not disturb other candidate(s) in the examination room.**
- viii) **Do not attempt to take any photos or recordings of any question papers and/or answer sheets.**
- ix) The progress of the examination is being recorded by close-circuit television (CCTV) and voice recorders in the examination room.

If the above rules from item v) to viii) are infringed, candidates will be regarded as having failed the examination as a whole and will not be accepted for re-examination for such period as may be decided by the Director.

考生注意事項：-

- i) 在答題紙首頁右上角寫上姓名。
- ii) 在每頁答題紙的左上角標明回答的問題題號。
- iii) 每一條問題另開新頁作答。
- iv) 不需要抄寫問題到答題紙上。
- v) 進入試場後，把手機及所有通信設備關閉。
- vi) 離開試場前，交回所有試卷、所有用過和未用過的答題紙及草稿紙。
- vii) 試場內不可干擾其他考生。
- viii) 切勿嘗試拍攝或錄取任何試卷或答案。
- ix) 考試期間試場內會有閉路電視(CCTV)和錄音系統進行記錄。

如果違反上述 v) 至 viii) 規則，即當作所有考試不及格，以及在處長決定的期間內不得重考。

1. A four-cylinder, single-acting, two-stroke cycle internal combustion engine receives and rejects heat at constant volume. The stroke volume of each cylinder is 244 cm^3 , and the clearance volume is 58 cm^3 .

The minimum pressure and temperature are 1 bar and 38°C respectively. The maximum temperature is $2,200^\circ\text{C}$. The index of compression is 1.4.

Calculate:

- (a) the mean effective pressure; and
- (b) the indicated power when the speed is 65 rev/s

2. The velocity of steam at inlet to a simple impulse turbine is 1,000 m/s, and the nozzle angle is 20 degrees. The blade speed is 400 m/s and the blades are symmetrical. Determine the blade angles if the steam is to enter the blade without shock. If the friction effects on the blades are negligible, calculate the tangential force on the blades and the diagram power for a mass flow of 0.75 kg/s. What is the axial thrust and the diagram efficiency?

3. In an ammonia refrigeration plant, the single-stage single acting compressor operates at 4 rev/s between pressures of 1.588 bar and 13.89 bar. The compressor has a bore of 130 mm and stroke 150 mm. The volumetric efficiency is 80% and the mechanical efficiency is 90%. The vapour is dry saturated leaving the evaporator and the ammonia leaves the condenser as a liquid at 32°C .

Calculate:-

- (a) the mass flow rate of refrigerant;
- (b) the cooling load; and
- (c) the power required to drive the compressor.

C_p for liquid ammonia is 4,620 J/kgK. The compression is assumed to be isentropic.

4. A diesel engine works on dual combustion cycle, takes in air at 1.01 bar, 20°C and the maximum cycle pressure is 69 bar. The compression ratio is 18/1. Assume that the heat added at constant volume is equal to the heat added at constant pressure. Sketch the cycle on a p-v diagram and calculate:-
- the thermal efficiency; and
 - the mean effective pressure
- For air: $\gamma=1.4$; $C_p=1.005$ kJ/kgK; $C_v=0.718$ kJ/kgK
5. Steam is supplied to an engine at 17.5 bar 300°C and expanded isentropically to 0.07 bar. Calculate:
- the dryness fraction of the steam at the end of expansion; and
 - the Rankine efficiency.
- Show by a sketch how the Rankine cycle appears on a temperature-entropy diagram
6. Steam is generated in a boiler at 25 bar 300°C from feed water at 130°C at the rate of 20,000 kg/h, and the engine develops 2300 kW. The daily fuel consumption is 33 tonne and the calorific value of the fuel is 43 MJ/kg. Calculate:
- the boiler efficiency;
 - the equivalent evaporation per kg of fuel from and at 100°C; and
 - the overall efficiency of the plant.
7. In an open cycle gas turbine plant, a heat exchanger is included to heat the air before entering the combustion chamber by the exhaust gases from the engine. The gases enter the heat exchanger at 300°C and 140 m/s and leave at 240°C and 10 m/s. The air enters exchanger at 300°C and the air/fuel ratio is 84. Calculate the temperature of the air at the exchanger exit, taking the specific heats as 1.1 kJ/kgK for the gases, and 1.005 kJ/kgK for air.

8. A single-acting air compressor takes in air at 1 bar and delivers it at 4 bar, the cylinder is 300 mm diameter, stroke 450 mm, and it runs at 5 rev/s. Initially the index of compression was 1.15 and after running for some time the index of compression was found to be 1.35. Neglecting clearance, calculate the power absorbed in each case and the percentage increase in power.

$$\text{Area under } pV^n \text{ curve} = \frac{p_1V_1 - p_2V_2}{n - 1}$$

9. Two copper pipes of a telemotor system are each 76 m long and 13 mm internal diameter when filled with oil at 16°C. Calculate the quantity of oil in litres that will be released into the replenishing tank from the pipes when the temperature rises to 30°C. Neglect the amount of oil in the cylinders.

Coefficient of linear expansion of copper = $1.7 \times 10^{-5}/^{\circ}\text{C}$

Coefficient of volumetric expansion of oil = $7.7 \times 10^{-4}/^{\circ}\text{C}$

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