



SEAGOING ENGINEER OFFICER CLASS 2

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 boiler produces superheated steam at 30 bar 350°C from feed water at 100°C. Given that the condition of the saturated steam entering the superheater is 30 bar 0.97 dry, calculate:
 - (a) the specific volume of the wet steam;
 - (b) the heat supplied per kilogram of wet steam; and
 - (c) the increase in specific enthalpy due to superheating.

If some of the superheated steam is throttled to 7 bar calculate the temperature of the throttled steam.

2. The cylinder of a single-acting compressor is 225 mm diameter and the stroke of the piston is 300 mm. It takes in air at 0.96 bar and delivers it at 4.8 bar and makes four delivery strokes per second. Assuming that compression follows the law $pv^n = \text{constant}$, and neglecting clearance, calculate the theoretical power required to drive the compressor when the value of the index of the law of compression is 1.35.
3. A single-stage impulse steam turbine operates at 50 rev/s. The mean diameter of the blades is 0.9 m. The enthalpy drop across the nozzles is 400 kJ/kg. If the blade inlet angle is 25 degrees, calculate or determine by any other means the nozzle angle relative to the plane of rotation of the blades to ensure shock free conditions at blade inlet.
4. The temperature of the flame in a furnace is 1,277°C and the temperature of its surrounding is 277°C. Calculate the maximum theoretical quantity of heat energy radiated per minute per square metre to the surrounding surface area.

Stefan-Boltzmann constant, $\sigma = 56.7 \times 10^{-12} \text{ kW/m}^2 \text{ K}^4$

5. From indicator diagram, it was calculated that the power developed in the cylinder of a four-stroke cycle oil engine when operating at 9 rev/s was 220 kW.

Given that engine stroke = 0.5 m, engine bore = 0.27 m, area and length of the indicator diagram 563 mm² and 80 mm respectively, calculate the indicator spring rate (N/mm).

6. Prove that the relationship of temperature and pressure of air under adiabatic expansion is:

$$\frac{T_1}{T_2} = \left\{ \frac{P_1}{P_2} \right\}^{\frac{\gamma - 1}{\gamma}}$$

0.113 m³ of air at 8.25 bar is expanded in a cylinder until the volume is 0.331 m³.

Calculate the final pressure and work done if the expansion is

- (a) Isothermal; and
- (b) Adiabatic, taking $\gamma = 1.4$.

7. The refrigerating effect of a plant using ammonia as the refrigerant is 800 kJ/min. At the exit points of the components the conditions of the refrigerant are:

Evaporator, dry saturated vapour at 1.902 bar

Compressor, vapour at 7.529 bar and 66°C

Condenser, saturated liquid at 7.529 bar

Calculate

- (a) the mass flow of the refrigerant through the plant, in kg/min;
- (b) the heat rejected in the condenser, in kJ/min; and
- (c) the output power of the compressor in kW.

8. A boiler fuel contains 86% carbon and 13% hydrogen. If this fuel is burnt completely with 40% excess air, calculate the mass of each constituent in the flue gas per kg of fuel burnt and calculate the calorific value of one kg of fuel.

Air contains 23 per cent oxygen by mass.

Atomic weight: hydrogen 1, carbon 12.

Calorific value of carbon and hydrogen as 33.7 and 144 MJ/kg respectively.

Explain the meaning of the term Lower Calorific Value.

9. Steam at 15 bar 0.88 dry is mixed with steam at the same pressure superheated to 250°C in the ratio by mass of 3 of wet steam to 2 of superheated steam. The mixture is then passed through a reducing valve and throttled to 8 bar. Assuming no heat losses, calculate the dryness fraction of the steam
- (a) after mixing and before throttling; and
 - (b) after throttling.

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