



UNIVERSITY EXAMINATIONS 2019/2020

FOURTH YEAR SECOND SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR OF SCIENCE IN MECHANICAL ENGINEERING EMM 404 THERMODYNAMICS III

DATE: MAY 2019

TIME: 2 ½ HOURS

INSTRUCTIONS TO CANDIDATES

1. You should have the following for this examination:
 - Answer booklet
 - Scientific Calculator
2. This paper contains **FIVE** questions
3. **Answer Question One and any other two Questions**
4. Maximum marks for each part of a question are as indicated
5. All symbols have their usual meaning unless specified otherwise
6. Use clear and neat sketches
7. **Mobile phones** are not allowed in examination rooms.
8. Programmable calculators are prohibited
9. Start each question on a fresh page

This paper consists of 3 printed pages.

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QUESTION ONE

- a) An air standard dual combustion cycle has a mean effective pressure of 10 bar. The minimum pressure and temperature are 1 bar and 17°C respectively, and the compression ratio is 16/1. Calculate the maximum cycle temperature when the cycle efficiency is 60 bar. (15marks)
- b) In an air standard otto cycle, the maximum and minimum temperatures are 1400 and 15°C. The heat supplied per kg of air is 800kJ. Calculate the compression ratio and the cycle efficiency. Calculate also the ratio of maximum to minimum pressure (15 marks)

QUESTION TWO

Find the ideal cycle efficiency and steam consumption of a reheat cycle operating between pressures of 30 and 0.04 bar, with a superheat temperature of 450°C. Assume that the first expansion is carried out to the point where the steam is dry saturated and that the steam is reheated to the original superheat temperature. The feedpump term may be neglected (20 marks)

QUESTION THREE

The following particulars refer to a steam plant consisting of a boiler, economizer and a superheater: steam pressure = 14bar; mass of steam generated = 5000 kg/h; mass of coal used = 675 kg/h; calorific value of coal = 29800 kJ/kg; temperature of feed water entering the economizer = 30°C; temperature of feed water leaving the economizer = 130°C; dryness fraction of steam leaving the boiler = 0.97; temperature of steam leaving the superheater = 320°C. Determine:

- (a) the overall efficiency of the plant (5 marks)
- (b) the percentage of the available heat used in the boiler, economizer and superheater respectively (15 marks)

QUESTION FOUR

Determine the size of the cylinder for a double acting air compressor of 40kW indicated power, in which air is drawn in at 1 bar and 15°C and compressed according to the law $pV^{1.2} = \text{constant}$ to 6 bar. The compressor runs at 100 rpm with average piston speed of 152.5m/min. neglect clearance volume (20 marks)

Question FIVE

A three-stage single acting reciprocating compressor has perfect intercooling. The pressure and temperature at the end of suction stroke in low pressure cylinder is 1.013 bar and 15°C respectively. If 8.4 m³ of free air is delivered by the compressor at 70 bar per minute and the work done is minimum, calculate:

(a) Low pressure and High Pressure delivery pressures (5 marks)

(b) The ratio of cylinder volumes (5 marks)

(c) Total indicated power (5 marks)