



JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF ENGINEERING AND TECHNOLOGY

**UNIVERSITY EXAMINATION FOR THE DEGREE IN SCIENCE IN RENEWABLE
ENERGY TECHNOLOGY AND MANAGEMENT**

3RD YEAR 1ST SEMESTER 2024/2025 ACADEMIC YEAR

CENTRE: MAIN CAMPUS

COURSE CODE: TEB 1307

COURSE TITLE: STEAM PLANT ENGINE TECHNOLOGY

EXAM VENUE: STREAM: BSc. REN ENGY TEC & MGT

DATE: 7/1/2025 EXAM SESSION:9-11.00AM

DURATION: 2 HOURS

Instructions

- 1. Answer question 1 (Compulsory) and ANY other two questions**
- 2. Candidates are advised not to write on question paper**
- 3. Candidates must hand in their answer booklets to the invigilator while in the examination room.**

QUESTION ONE (COMPULSORY) (30 Marks)

- a. Define the term power cycle. (1 Mark)
- b. Using illustrations, examine the components of a steam turbine power system. (5 Marks)
- c. Examine two common sources of irreversibilities as in steam power plants. (4 Marks)
- d. A steam power plant operates on the ideal reheat Rankine cycle. Steam enters the high pressure turbine at 5 MPa and 400°C and leaves at 2 MPa. Steam is then reheated at constant pressure to 400°C before it expands to 20 KPa in the low pressure turbine. Determine the turbine work output in kJ/kg, and the thermal efficiency of the cycle. Also, show the cycle on a T-S diagram with respect to saturation lines. (15 Marks)
- e. Examine five types of cooling systems used in steam power plant technology. (5 Marks)

QUESTION TWO (20 Marks)

- a. Compare and contrast fire-tube and water tube boilers. (5 Marks)
- b. Examine the selection and design of condensers, feed heaters and de-aerators in steam power plants. (5 Marks)
- c. Consider a steam power plant operating on the ideal Rankine cycle. Steam enters the turbine at 2.5 MPa and 350°C and is condensed in the condenser at a pressure of 80 KPa. Determine the thermal efficiency of this cycle. (10 Marks)

QUESTION THREE (20 Marks)

- a. Compare and contrast subcritical boiler and supercritical boiler. (2 Marks)
- b. Steam is the working fluid for an ideal Rankine cycle. Saturated vapor enters the turbine at 5 MPa and saturated liquid exits the condenser at 0.0075 MPa. The net power output of the cycle is 80 MW. Determine
 - i. Thermal efficiency. (6 Marks)
 - ii. Backward ratio (BWR). (2 Marks)
 - iii. Rate of steam flow in kg/hr. (3 Marks)
 - iv. Rate of work supplied. (2 Marks)
 - v. Rate of work rejected. (2 Marks)
- c. Show that the thermal efficiency for Brayton cycle is $\eta_{th,brayton} = 1 - \frac{1}{r_p^{(k-1)/k}}$ (3 Marks)

QUESTION FOUR (20 Marks)

- a. Boiler mountings are essential for safety, economics and convenience. Examine this statement in light of mandatory requirements for setting-up boiler system. (5 Marks)
- b. A steam plant operates on a simple ideal Rankine cycle between the pressure limits of 4 MPa and 65 KPa. The temperature of the steam at the turbine inlet is 300°C and the mass flow rate of steam through the cycle is 35kg/s. Show the cycle on a T-S diagram with respect to saturation lines, and determine: the thermal efficiency of the cycle and the net power output of the power plant. (11 Marks)
- c. Using illustrations, examine the four processes in a closed Brayton cycle. (4 Marks)

QUESTION FIVE (20 Marks)

- a. Examine the following integral parts of a boiler.
 - i. Superheaters. (2 Marks)
 - ii. Economizers. (2 Marks)
 - iii. Air heaters. (2 Marks)
- b. Using neat diagrams, illustrate three ways of improving the thermal efficiency of basic Rankine cycle. (3 Marks)
- c. A steam plant operates on a simple non-ideal Rankine cycle between the pressure limits of 4 MPa and 65 KPa. The temperature of the steam at the turbine inlet is 300°C and the mass flow rate of steam through the cycle is 35kg/s. The pump efficiency and turbine efficiency are 80% and 90%, respectively. Show the cycle on a T-S diagram with respect to saturation lines, and determine: the thermal efficiency of the cycle and the net power output of the power plant. (11 Marks)