Building Energy Supply Systems and District Energy Networks
22CVP306

Semester 2 2023 Online Short-window Exam paper

This is an online short-window examination, meaning you have a total of **2 hours plus an additional 30 minutes** to complete and submit this paper. The additional 30 minutes are for downloading the paper and uploading your answers when you have finished. If you have extra time or rest breaks as part of a Reasonable Adjustment, you will have further additional time as indicated on your exam timetable.

It is your responsibility to submit your work by the deadline for this examination. You must make sure you leave yourself enough time to do so.

It is also your responsibility to check that you have submitted the correct file.

Exam Help

If you are experiencing difficulties in accessing or uploading files during the exam period, you should contact the Exam Helpline. For urgent queries please call **01509 222900**.

For other queries email examhelp@lboro.ac.uk

You may handwrite and/or word process your answers, as you see fit.

You may use a calculator for this exam.

Answer **THREE** questions.

All questions carry equal marks.

Continues/…

1. a) Draw and describe the operation of a vapour compression refrigeration system. [10 marks]

b) A water chilling plant uses lithium bromide absorption system in which the generator is maintained at 80 °C using a hot-water coil. The evaporator and condenser saturation temperatures are 9 °C and 40 °C respectively, and the refrigeration capacity is 60 kW. It may be assumed that there is no undercooling in the condenser and that the water vapour leaving the evaporator is dry saturated. Assuming that there is a heat exchanger between the absorber and generator, sketch the plant, and calculate:

(i) the heat supplied to the generator [8 marks]
(ii) the heat rejected in the condenser [8 marks]
(iii) the heat rejected in the absorber [7 marks]

You may use: hf at 40°C =167.5 kJ/kg, hg at 80°C = 2643.2 kJ/kg and hg at 9°C =2517.4 kJ/kg. For lithium bromide/water solutions, you may use the data given in Table Q1b.

Table Q1b: Data for lithium bromide/water solutions

	Mass concentration LiBr/mixture	Enthalpy kJ/kg
Weak solution leaving generator	0.60	-90.7
Strong solution leaving absorber	0.51	-172.1
Strong solution entering generator	0.51	-140.7

2. a) Renewable energy and low carbon technologies include solar thermal, solar PV, wind, biomass and heat pumps.

In your own words, for each of these technologies describe:
- the energy resource available including the origin and variability
- how the resource available compares with the typical energy demands of buildings
- reliability and maintenance requirements
- the potential for the technology to contribute to long-term national carbon dioxide emission reduction targets.

[10 marks]

Question 2 continues/…

b) The annual heating demands for a house are 28,000 kWh per year. Heating is supplied by an 80% efficient boiler fuelled by wood pellets with the properties as given in Table 2b.

i) Calculate the total mass and volume of wood pellets needed to meet the heating demand. [2 marks]

ii) Estimate the size of fuel store needed if 14 days of fuel storage are required. [4 marks]

Table 2b: Wood pellet properties

Moisture content (% by mass)	8
Bulk density (kg/m^3)	650
Energy content (kWh/kg)	4.7
Energy density (kWh/m^3)	3200
Ash content (% by mass)	0.5

c) Describe the thermodynamics of a heat engine cycle, by drawing the cycle clearly and explaining the process. [8 marks]

d) Describe the second law of thermodynamics and summarize the entropy changes of a closed system. [5 marks]

e) A heat engine operates on the Carnot cycle. It produces 60 kW of power while operating between temperature limits of 600 ºC and 100 ºC. Calculate the engine efficiency and the amount of heat added. [4 marks]

3. a) List out the advantages and disadvantages of a traditional hydraulic lift with a pump room (not an MRL) versus a traditional traction lift with motor room above. [21 marks]

b) Why is it so important that lift car guides are vertically plumb and true? [6 marks]

c) What is the function of the lift control panel? [6 marks]

4. a) State three typical fuel types and their calorific values. [7 marks]

b) Compare the advantages and disadvantages of selecting a particular fuel type. Discuss requirements of storage, fuel availability, etc. Comment on the factors influencing boiler selection. [18 marks]

c) Describe what factors affect the operating efficiency of a boiler. [8 marks]

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