**CMGT 235 – Electrical and Mechanical Systems**

Department of Construction Management 🏵 California State University, Chico

Exam #1 [100 points]

**You may work together as a group or individually. Every student SHALL complete their own answer sheet.**

Solution

|  |
| --- |
| Name: |
| Name: |
| Name: |

1. The floor plan for a 16 ft x 32 ft cabin with 1 bedroom and 1 bathroom is shown below. The cabin located in Bellevue, Washington is being built on a SOG and with a flat roof. Wall height is 8ft.

8 pts

1. Highlight the windows with a yellow highlighter and write the area of each window along the outside of the window and the area of the entry door next to the door. Outside temperature is 10°F and inside temperature is 78°F.

**Window Specifications**

Living Room 2 ft x 4 ft and 6 ft x 4 ft

Bedroom 2 ft x 3 ft and 5 ft x 3 ft

Bathroom 3 ft x 3 ft

Entry Door 7 ft x 3 ft

Floor SOG (2 in thick edge insulation, R=5)

9

24

Diagram

Description automatically generated

8

8

24

21

15

6

1. Determine the total R-value and U-Factor for the roof and walls. Use the R-Value lookup table provided in class. Assume winter. For all answers, use 2-decimals for R-Values and 3-decimals for U-Factor.

9 pts

Roof Construction

0.4375 x 1.25 = 0.55

|  |  |
| --- | --- |
| Component | R-Value |
| Outside Air Film | 0.17 |
| Asphalt Shingles | 0.44 |
| 1” Air gap | 1.00 |
| 7/16” OSB Plywood Sheathing | 0.55 |
| 5 1/4" Fiberglass Batt (high density) | 21.00 |
| 5/8” Drywall | 0.56 |
| Inside Air Film | 0.68 |
| Total Roof Assembly R-Value | 24.40 |
| U-Factor (Use Three Decimals) | 0.041 |

Wall Construction - 2x6 Wood Framing 16in O.C.

20 pts

Wall Construction

0.375 x 1.25 = 0.47

|  |  |  |
| --- | --- | --- |
| Component | R (Between stud) | R (At stud) |
| Outside Air Film | 0.17 | 0.17 |
| 3/8" plywood siding | 0.47 | 0.47 |
| 1 Layer 15-lb Felt (R=0.06) | 0.06 | 0.06 |
| 5/8” Structural Plywood Sheathing | 0.77 | 0.77 |
| 2x6 Framing | --- | 6.88 |
| R-21 Cavity Insulation | 21.00 | --- |
| Interior ½” Gypsum Board | 0.45 | 0.45 |
| Inside Air Film | 0.68 | 0.68 |
| Total Wall Assembly R-Value | 23.60 | 9.48 |
| U-Factor (Use Three Decimals) | 0.042 | 0.105 |

10 pts

1. Determine the average U-Factor for the wall. Show all calculations

Ravg = (1.5/16) x 9.48 + (14.5/16) x 23.60 =22.28

Uavg = 0.045

1. Determine the U-Factor for the windows and the entry door (show calculations)

2 pts

|  |  |
| --- | --- |
| Component | U-Factor |
| Windows R-3 | 0.333 |
| Entry Door R-5 | 0.200 |

8 pts

1. Determine the areas shown in the table below (show all calculations)

|  |  |
| --- | --- |
| Gross Wall Area | (2 x 16 ft x 8 ft) + (2 x 32 ft x 8 ft) = 768 ft2 |
| Total Window Area | 24 + 9 + 6 + 15 + 24 + 8 + 8 = 94 ft2 |
| Entry Door Area | 21 ft2 |
| Net Wall Area | 768 ft2 – (94 ft2 + 21 ft2)= 653 ft2 |

10 pts

1. Calculate (Round all answers to whole number) the rate of heat loss due to transmission for:

Walls

qwalls = U x A X ΔT = 0.045 x 653 x (78°F - 10°F) = 1,998 BTUH

Windows

qwindows = U x A X ΔT = 0.333 x 94 x (78°F - 10°F) = 2,129 BTUH

Door

qdoor = U x A X ΔT = 0.200 x 21 x (78°F - 10°F) = 286 BTUH

Roof

qroof = U x A X ΔT = 0.041 x (16ft x 32ft) x (78°F - 10°F) = 1,427 BTUH

SOG

qslab = Uf x L = 35 x (2x16ft + 2x32ft) = 3,360 BTUH

2 pts

1. Calculate the total rate of heat loss due to transmission.

qtransmission = 1998 + 2129 + 286 + 1427 + 3360 = 9,200 BTUH

1. Determine the rate of heat loss due to infiltration for an ACH = 1.2

5 pts

qinfil = 0.018 x 1.2 x (4096 ft3) x (78°F - 10°F) = 6,016 BTUH

2 pts

1. Calculate the Total Rate of Heat Loss for the home

qtotal = 9,200 BTUH + 6,016 BTUH = 15,216 BTUH

4 pts

1. A 5-ton air conditioner is equivalent to how many BTUs of air conditioning?

BTUs = 5 ton x 12,000 BTU/ton = 60,000 BTU

4 pts

1. A heat pump has a cooling effect of 12,000 BTUH and an input power of 1200 W. What is the COP?

Pout = 12,000 Btuh x 1 kW/3,414 Btu = 3.5 kW

COP = Pout / Pin = 3.5 kW / 1.2 kW = 2.9

Use a Psychometric Chart to answer the following questions.

6 pts

1. A space at sea level is 65°F and RH = 30%

Find the other properties of the air in that space.

|  |  |
| --- | --- |
| DB | **65°F** |
| RH | **30%** |
| WB | 49.1 °F |
| Humidity | 27 Gr/lb |
| VP | 0.19 In Hg |
| Enthalpy | 19.9 Btu/lb |
| Vs | 13.3 ft3/lb |
| Dew Point | 32.8 °F |

1. A residential steam boiler contains 30 gallons of water that is stored at 55°F. How much heat must be added to convert the water to steam at 220°F?

10 pts

One gallon of water weighs 8.34 lb

M = 30-gal x 8.34 lb / gal = 250 lb

Sensible Heat 55°F to 212°F

Q = M x C x ∆T = 250 lb x 1 Btu/lb°F x (212°F - 55°F) = 39, 250 Btu

Latent Heat 212°F to Vapor

Q = 970 Btu/lb x 250 lb = 242,500 Btu

Sensible Heat vapor @212°F to 220°F

Q = M x C x ∆T = 250 lb x 1 Btu/lb°F x (220°F - 212°F) = 2,000 Btu

Total Heat (Enthalpy) = 39,250 Btu + 242,500 Btu + 2,000 Btu = 283,750 Btu