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.

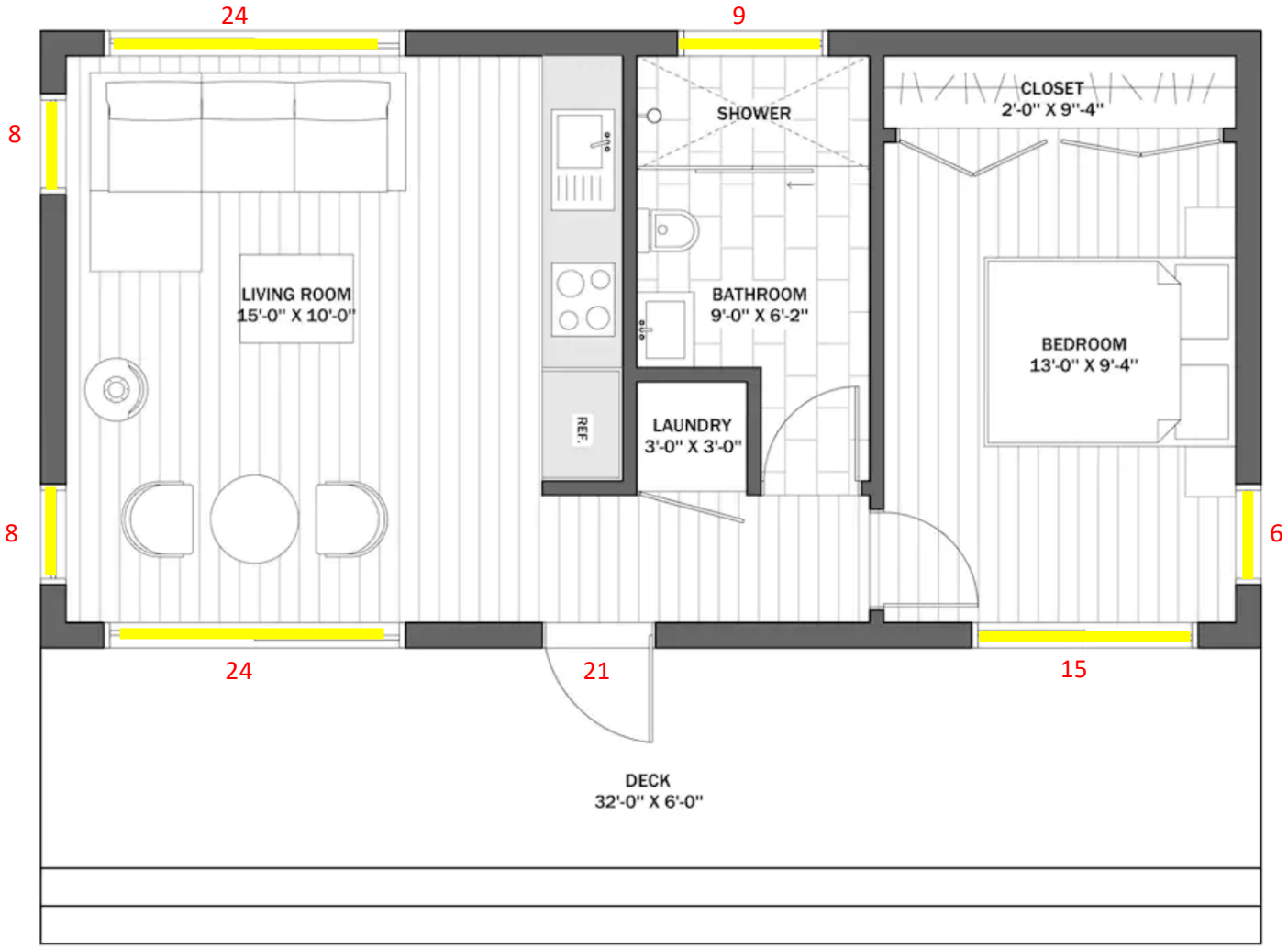
Name:	Solution
Name:	
Name:	

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 A. 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)



B. 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

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

0.4375 x 1.25 = 0.55

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

20 pts

Wall Construction

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

0.375 x 1.25 = 0.47

10 pts

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

R_{avg} = (1.5/16) x 9.48 + (14.5/16) x 23.60 =22.28

U_{avg} = 0.045

2 pts D. Determine the U-Factor for the windows and the entry door (show calculations)

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

8 pts E. 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 ft^2
Total Window Area	24 + 9 + 6 + 15 + 24 + 8 + 8 = 94 ft^2
Entry Door Area	21 ft^2
Net Wall Area	768 ft^2 – (94 ft^2 + 21 ft^2) = 653 ft^2

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

Walls

q_{walls} = U x A X ΔT = 0.045 x 653 x (78°F - 10°F) = 1,998 BTUH

Windows

$q_{windows}$ = U x A X ΔT = 0.333 x 94 x (78°F - 10°F) = 2,129 BTUH

Door

q_{door} = U x A X ΔT = 0.200 x 21 x (78°F - 10°F) = 286 BTUH

Roof

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

SOG

q_{slab} = Uf x L = 35 x (2x16ft + 2x32ft) = 3,360 BTUH

2 pts G. Calculate the total rate of heat loss due to transmission.

$q_{transmission}$ = 1998 + 2129 + 286 + 1427 + 3360 = 9,200 BTUH

5 pts H. Determine the rate of heat loss due to infiltration for an ACH = 1.2

q_{infil} = 0.018 x 1.2 x (4096 ft^3) x (78°F - 10°F) = 6,016 BTUH

2 pts I. Calculate the Total Rate of Heat Loss for the home

q_{total} = 9,200 BTUH + 6,016 BTUH = 15,216 BTUH

4 pts 2. 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 3. A heat pump has a cooling effect of 12,000 BTUH and an input power of 1200 W. What is the COP?

P_{out} = 12,000 Btuh x 1 kW/3,414 Btu = 3.5 kW

COP = P_{out} / P_{in} = 3.5 kW / 1.2 kW = 2.9

Use a Psychometric Chart to answer the following questions.

6 pts 4. 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 ft^3/lb
Dew Point	32.8 °F

10 pts 5. 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?

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 ΔT = 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 ΔT = 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