Building Science Specialist Board
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2021 MECHANICAL SYSTEMS EXAM

Introduction to HVAC Systems, Thermal Comfort and Indoor Air Quality

1. Describe the typical functions of an HVAC system
2. Describe the difference between “all air systems”, “air/water systems” and “all water systems”
3. Describe how commercial HVAC design differs from residential design
4. Discuss the different terms/metrics used for heating and cooling equipment efficiency and capacity
5. Recognize the advantages and disadvantages of the various HVAC systems
6. Describe the importance of establishing zones for the purposes of space conditioning
7. Describe the importance of the ASHRAE Standard 55 comfort zone and explain the difference between Predicted Mean Vote and Predicted Percent Dissatisfied
8. Define “operative temperature” and demonstrate how it is calculated
9. List common indoor air contaminants and their sources including particulate matter, Second Hand Smoke, carbon monoxide, carbon dioxide, Radon, Ozone, Formaldehyde, Acrolein, Mould
10. Calculate the concentration of various contaminants given rates of contaminant generation
11. Describe how indoor contaminants can be controlled through source control, air exchange, air filtration
12. Calculate the outdoor air requirement for a zone according to ASHRAE Standards 62.1 and 62.2
13. Define ventilation effectiveness and be able to calculate i
14. Describe what a MERV rating on a filter represents and how different MERV values impact filtration.

Thermodynamics

14. Calculate state properties of moist air, refrigerant, and steam
15. Explain the thermodynamic cycles that are relevant to HVAC (Carnot, Reverse Carnot, Rankine Power, Rankine Refrigeration)

Psychrometrics

16. Describe the difference between sensible and latent heat energy in moist air
17. Demonstrate how the psychrometric chart can be used to illustrate common HVAC processes (e.g. air mixing, heating and humidification, typical air conditioning) and the impact of these processes on dry and wet bulb temperature, relative humidity, enthalpy and moisture content
18. Demonstrate proper use of the enthalpy/humidity ratio scale and the sensible heat/total heat ratio scale
19. Describe how by-pass factors can be used to approximate the state of air following humidification when only a portion of the air comes in contact with a cold coil

Heating and Cooling Loads

20. Explain the purpose of Design Days
21. Calculate the sensible and latent heat losses associated with air leakage
22. Estimate air leakage using the air change method and the crack method
23. Explain what parameters are considered in heating load calculations and how they differ from those considered in cooling load calculations
24. Calculate the peak heating load for a building (conduction losses and air leakage) with a constant indoor temperature
25. Describe the various sources of internal gains and how they impact sensible and latent loads
26. Describe how heat is transmitted through opaque envelope elements
27. Calculate the total solar heat gain and conduction gains/losses through windows
28. Calculate the heat gain contribution from occupants based on the number of occupants and metabolic rate
29. Calculate the heat gain from lighting and equipment
30. Conduct a sensible heat balance on a single zone and identify whether heating or cooling is required
31. Conduct a latent heat balance on a single zone and identify whether humidification or dehumidification is required
32. Describe how increased thermal mass can impact cooling load
33. Calculate the peak cooling load for a building

HVAC Equipment

34. Describe common heat exchangers in HVAC (shell and tube, cross-flow air coils, plate and frame), where they are typically used and what factors influence the quantity of heat transferred.
35. List the various types of heating and cooling equipment available for both commercial and residential applications and how their efficiencies typically compare
36. Discuss the operating requirements for condensing equipment
37. Describe the equipment required for a chilled water plant and how they are connected to one another
38. Describe how an air conditioner works
39. Describe how an air source heat pump works
40. Calculate pipe and duct losses for various dimensions and fittings
41. Use the fan and pump laws to describe the factors that influence fan and pump performance
42. Describe the difference between heat recovery ventilation systems and energy recovery ventilation systems
43. Understand the advantages and disadvantages of dedicated outdoor air systems (DOAS)'
44. Describe the components required for a typical HVAC control system
45. Discuss the importance of deadbands on a thermostat