Rich's Mechanical – Electrical Systems Study Notes:

Mechanical and Electrical Equipment for Buildings

Quiz – Context for building system design **Chapter 1**

- The three phases of the design process are generally known as: conceptual design, schematic design, and design development.
- Although plans can and do change during all phases of the design process, to ensure a smooth process, fundamental decisions about the building should be made during the: Conceptual design phase
- Which of the following is an example of design intent? The building will be green, with a focus on indoor environment quality
- Which of the following is an example of design criteria? No building space will experience more than 1,000 ppm CO
- Which of the following building requirements are written in prescriptive language? Pipes in a roof drainage system shall measure no less than 3" in diameter
- Which of the following entities is most likely to generate building design standards? The American Society of Heating, Refrigerating and Air-Conditioning Engineers.
- The term "energy efficiency" in architecture can best be described as: conserving energy as well as balancing outputs and inputs.
- Which of the following maxims reflect an overall design philosophy that encompasses the concept of sustainability? Consider nature as both model and context.
- Which of the following building features embody the design philosophy "manage storage"? cisterns that capture rainwater for re-use within the building.
- Which of the following characteristics best exemplify a passive climate control system? The system / building components play multiple roles.
- Which of the following examples best characterizes a "hybrid" building system? Ceiling fans aid in natural ventilation, reducing mechanical cooling loads.

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Quiz – Climate, Comfort, and Design Strategies **Chapter 2**

- A heat pump returns **> 200%** of its electrical input as heat to a building when the outdoor air is above freezing.
- Which of the following countries has the largest ecological footprint? U.S.
- Which country has the lowest per-capita CO output? Bangladesh
- The greatest energy end use in U.S. buildings is: space heating
- The only renewable construction material in widespread use in North America is: Wood
- "Embodied energy" is best defined as: the amount of energy needed to obtain, process, fabricate, and transport a unit of building material.
- For a given surface area, aluminum requires about **100** times as much embodied energy as wood.
- The typical building demolition process currently wastes potentially recyclable materials because: the cost of labor is generally higher than the cost of energy needed to produce new materials.
- Which of the following is not a useful initial guideline for designing buildings so that they can be recycled? Use only recycled structural steel
- Which of the following is a useful initial guideline for designing buildings so that they can be recycled?
    - Design the structure to be separable from the other building parts and easily disassembled.
    - Avoid material combinations that make recycling elements difficult.
    - Maximize utilization of on-site natural forces, such as sun and wind.
- Which of the following are characteristics of a "smart" building? Photoelectric controls turn off electric lighting when daylighting is adequate.
- When the gross resource demands of an area constitute an environmental footprint greater than 1.0, which of the following is true? The area's resource use is out of proportion with its population and requires the resources of other areas that may have resource surpluses.

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Quiz – Site and Resources **Chapter 3**

- A heat pump returns **> 200%** of its electrical input as heat to a building when the outdoor air is above freezing.
- In order to provide noise reduction of 20 dB(A) for a noise-shadow angle of 90 degrees, how high would a wall have to be? 20ft.
- As wind passes through a gap in a windbreak, what happens to it? It accelerates in the direction of flow.
- What is the primary difference between "climate" and "weather"? weather is a daily event; climate is what happened over the past decades.
- Which of the following are climate characteristics? Humidity
- Compared to a rural environment, a city receives **30% less** ultraviolet radiation in the winter.
- A building in North America that is intended to take advantage of its site for the purpose of passive solar heating: would be longer in the east-west direction and shorter in the north-south direction.
- Following the principles of naturalistic site design, which layer of a building would be the best location for most mechanical equipment? Subsurface layer
- The slope of a building that is constructed within the boundaries of its solar envelope: would correspond to the altitude angle of the sun for about 2 hours before and after noon on December 21.
- Which of the following tools might be most use to the designer to determine solar availability on a particular site? Compass and a sunpath chart
- Plants can play several important roles on a building site. Which of the following is not one of those roles: to promote warmth in the winter.
- Plants can play several important roles on a building site. The following are some of those roles: as shading devices during the summer, to enhance privacy, and to slow winter winds.

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Quiz – Heat Flow **Chapter 4**

- The insulating value of clothing is measured in CLO units, which is equivalent to: 0.88 ft2 F/Btu (or the equivalent of a typical American man's business suit in 1941).
- The heat transfer process of "conduction" is primarily dependent upon: a difference in surface temperatures.
- ASHRAE "comfort zones" are primarily defined by: relative humidity and dry bulb air temperature.
- "Mean radiant temperature" can be defined as: the uniform temperature of a surrounding enclosure in which radiant transfer from the human body would equal the actual radiant heat transfer within a building space.
- Humphreys and Nicol's equation for indoor comfort differs from other comfort models in that: it does not take relative humidity into account.
- The "design conditions" for a building are important to consider when initiating the design process because: they consider statistical extremes that may occur at the building site.
- Which of the following locations would be a poor candidate for an evaporative cooling strategy? Houston
- Which intersection of relative humidity and air temperature is outside the ASHRAE comfort zone? 60% and 86% F
- What is the recommended low humidity limit for the ASHRAE comfort zone? There is no recommended low humidity limit.
- A heat sink, for the purposes of high-mass cooling, could be described as: a facility for rejecting heat accumulated by a building.

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Quiz – Design for Heating and Cooling **Chapter 5**

- ASHRAE has defined "acceptable" indoor air quality as: air in which there are no harmful concentrations of known contaminants and with which 80% or people exposed do not express dissatisfaction.
- About how much "new" air would an indoor space have after one hour of ventilation at the rate of 1 air change per hour (ACH)? 63%
- For the best diffusion of incoming air throughout a building, an air-to-air heat exchanger should operate under which condition? With the exchanger located at a central forced-air fan.

- The exhaust capacity of a principal residential building exhaust fan should be at least **50%** of the total HVAC system airflow capacity.
- Which of the following is a true statement about a breathable wall? The wall system is dependent upon a building being under negative pressure, such that airflow is being forced out.
- The most common energy source for regenerating desiccant cooling devices today is: natural gas
- A **30%** relative humidity change will affect a person's comfort about as much as 25°F (1°C) change in temperature.
- Which filter type is considered least effective in cleaning air? Media, air washer, adsorption, **panel.**
- A generally accepted air exchange rate for air cleaning equipment is: 6-10 air changes per hour
- Which compound can be used as a "canary in the coal mine" to warn of the buildup of other pollutants? CO2

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Quiz – Interior Air Quality **Chapter 6**

- Which projection method is best described as "a two-dimensional graph of the sun's position in Cartesian coordinates, with the azimuth plotted on the horizontal axis and altitude on the vertical axis?" rectilinear projection
- A horizontal overhang in the Northern Hemisphere would provide the best sun-shading protection for what type of condition? A south-facing window in the summer.
- In the United States, the vertical shadow angle is sometimes also called: the profile angle
- The baseline of a shading mask corresponds to which aspect of a building? A building wall
- A properly sized horizontal overhang can provide 100% shading only when: the solar-window azimuth is 0 degree.
- Movable shading devices have not been implemented as widely as possible because: building managers perceive them as expensive to maintain and prone to breakdowns.
- The sun's position on May 21 would be the same as on: July 21
- Anywhere on the Earth's surface, what is the greatest deviation between true and magnetic north? 50degrees
- The vertical shadow angle for 100% shading would extend from: a window sill to the outer edge of an overhang.
- One would expect the sun to describe a similar path through the sky in which pair of cities: Portland, OR and Boston

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Quiz – **Chapter 7**

- The type of heat that results in a change in moisture content is called: latent heat
- Conductance (C) is expressed as: Btu/h through 2 ft2 of a given material when the temperature difference across the material is 1 degree F
- Radiant barriers are best applied to roof assemblies in: warm climates
- When calculating the U-factor for a framed wall system, which of these variables needs to be considered? Thermal bridging through framed portions.
- One of the advantages of a window assembly that uses an inert gas in the air gap is: the inner surface of the glass can be maintained at a temperature near that of the indoor environment.
- The typical framed wall assembly (in cold climates) has moved in the past decades from R-7 insulation batts between 2-in. x 4-in. studs to: R-26 batts between 2” x 6” studs plus insulation sheathing
- Which type of low-emission coating is characterized by a low U-factor, a low solar heat gain coefficient (SHGC), and a low visible transmittance (VT)? Low-transmission low-E
- The highest rate of heat gain or loss in a building today is usually a result of: outside air infiltration.
- The air-change method of infiltration calculation is commonly used as a tool during early design because: it does not require detailed information about a building or its spatial arrangement.
- Design heat loss can be best described as: an estimation of the worst likely hourly heat flow from a building to the surrounding environment based upon a chosen outside temperature.

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Quiz – **Chapter 8**

- Solar savings fraction (SSF) is best defined as: the extend to which a solar design reduces a building's auxiliary heat requirement relative to a reference energy conserving building.
- According to Fig. 8.10, for a square foot of south-facing double glazing in Madison, WI, what is the average daily net heating in November? 100 Btu/ft2 day
- Which wall system is an example of an indirect gain system? Split-face masonry units, **Trombe wall**, insulating glass, wood frame.
- Which city would provide a reasonable and effective location for a roof pond climate control system? Cleveland, Houston, **Phoenix**, Boston.
- Active solar heating differs from passive solar heating in that: it uses mechanical equipment to collect and store solar energy.
- Which of the following is an accurate guideline for the proper maintenance of cross-ventilation in a building? Internal obstructions within the building must have a total opening area equal to or greater than that of the required outlet area.
- Night ventilation of thermal mass works best in climates with a large diurnal swing in temperature.
- Which of the following strategies cannot be considered a passive strategy? Roof ponds, earth tubes, stack ventilation, **mechanical air-conditioning**.
- In order for a cooling tower 30 ft (9 m) high and containing wetted pads of 16 ft^2 (1.5 m^2) to provide exit air flow of 700 cfm (0.33 m^3/s), what would the difference between the design dry bulb and mean coincident wet-bulb temperature be? 9 degree F
- One of the most influential variables in determining the performance of earth (coolth) tubes is: the conductivity of the surrounding soil

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Quiz – **Chapter 9**

- Which thermal comfort determinant can usually not be accomplished without mechanical assistance?. Air quality
- In the HVAC design process, component sizing typically occurs before which process? Resolving conflicts with other building systems.
- A skin-load dominated building tends to be best suited for a local, room-by-room HVAC scheme because: the building may have differing but simultaneously occurring needs across short distance.
- One ton of cooling capacity is equivalent to: the useful cooling effect of one ton (12,000 Btu/h) of ice.
- ASHRAE Standard 90.2 calls for thermostats capable of a temperature range of: 55 degree F to 85 degree F
- What is a disadvantage of using refrigerants that produce no chlorofluorocarbons and thus constitute a low threat to environment? Machines that use these refrigerants may be less efficient and thus involve higher energy consumption, some of these refrigerants contain harmful chemicals, and natural hydrocarbon refrigerants are flammable and explosive.
- The absorption refrigeration cycle needs about **2** times the heat-rejection capacity of the vapor compression refrigeration cycle.
- Even though no change in total heat content occurs, evaporative cooling is accompanied by: an increase in relative humidity
- Which of the following materials has the highest emittance? Aluminum, galvanized steel, concrete tile, **white granular-surface bitumen**.
- Locating a heat source below a window: evens out the temperature in a room but increases heat loss through the window.
- The common sizing procedure for wood-burning heating devices assumes a **20%** moisture content of the wood fuel.

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Quiz – **Chapter 10**

- The acronym "HVAC" stands for: heating, ventilating, and air conditioning.
- One of the attractions of dispersing large building HVAC systems into smaller elements is that: large equipment rooms are not required

- A distribution tree that flows from rooftop central air-handling units: reduces duct size on lower floors.
- Integrating vertical distribution trees with structure can bring the advantage of: saving prime floor space.
- Which type of HVAC system best serves the interior, always-hot zones of internal load-dominated buildings? Single duct, VAV
- Which HVAC system has the smallest distribution tree in the all-air system class? Single duct
- Which air-water system functions by mixing incoming air with room air by way of high-pressure jets? Water-loop heat pumps, radiant panels with supplementary air, fan-coils with supplementary air, **induction systems**.
- How much cooling capacity would likely be required to condition a 100,000 ft² (9,290 m²) auditorium? 500 tons
- Which boiler type is preferred for energy conservation? Steam to hot-water converter, **modular boiler**, package-type steel boiler.
- Geo-exchange systems are often not useful in urban areas because: city infrastructure systems, such as water and electricity mains, must be circumvented.

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Quiz – **Chapter 11**

- When a light source produces energy over the entire visible spectrum in approximately equal quantities, the light appears as: white
- The relationship between illuminance and luminance for an opaque surface is best described as: luminanace is illuminance as modified by reflectance.
- A diffuse surface will exhibit uniform brightness if the spacing between light sources does not exceed approximately **1.5** times their distance from the material.
- The SI unit of luminous intensity is the: candela
- Illuminance is best defined as: the density of luminous energy, expressed as lumens per unit area.
- Photometric readings are usually taken at the height of a "working plane" because; this approximates the height of typical visual tasks
- Illuminance is measured more frequently than luminance because: design recommendations for lighting levels are typically given in terms of illuminance.
- Illuminance levels and illuminance categories are used to: establish quantitative lighting system design criteria.
- "Veiling reflections" are primarily a problem that occurs with; VDTs and specular surfaces

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Quiz – **Chapter 12**

- Which of the following light sources has the highest luminous efficacy? Metal halide lamp
- Electric lighting in nonresidential buildings accounts for **25% to 60%** of all electric energy used in the United States.
- The standard sky design condition established by the Commission Internationale d'Eclairage (CIE) for daylighting calculations is: a completely overcast sky
- At a solar altitude of 30 degrees, one can expect a daylight illuminance of about 10,000 lux with no direct sun and **40,000 lux** with direct sun.
- The brightest area of luminance in a cloudy sky is: at the zenith
- Operating a 120-V lamp at 125 V would result in lowered: lumens, power consumption (Watts), efficacy (lumens per Watt), **hours of life**.
- "Long-life" lamps are best avoided because: they are costly and inefficient.
- Energy-efficient lamps are typically rated at a lower **wattage** than regular lamps.
- The **MR-16** lamp is most widely used in accent and display lighting applications.
- Which ballast type is now largely history? **Magnetic**, hybrid, electronic, multilevel.

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Quiz – **Chapter 13**

- ANSI/ASHRAE/IESNA Standard 90.1 sets forth design requirements for efficient use of energy for the following environmental systems of a building: lighting, HVAC, electrical, power, water, and energy management systems.
- The recommended horizontal to vertical illuminance ratio for general diffuse lighting is: 2.5:1
- In commercial buildings lighting is estimated to account for **over 60** percent of the building's electric energy consumption.
- Which of the five generic types of lighting delivery systems directs between 90% and 100% of light output from the luminaire up to the ceiling and upper walls? Indirect
- The coefficient of utilization (CU) for a luminaire is an indication of: the effectiveness of a luminaire in delivering light in a given space.
- The **zonal cavity** method can be used to calculate uniform illuminance in a space.
- The inverse square law is used to: estimate the illuminance from a point light source
- Which of the following are not light loss factors (LLF): room surface dirt depreciation, lamp burnouts, **lamp lumen appreciation**, luminaire surface depreciation.
- Which of the following will affect the coefficient of utilization (CU) for a luminaire: **the reflectances of room surfaces**, the reflectance of the outside ground plane, the lumen output of installed lamps, luminaire-related light loss factors.

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Quiz – **Chapter 14**

- Daylighting qualifies for a LEED© credit if a daylight factor of **2% in 75%** of all occupied spaces is achieved.
- In general, with a sidelighting system any interior area more than **30** feet from a window will need to be electrically lit.
- Daylight within a space is generally most evenly distributed when: bilateral lighting from opposite walls is used.
- In general, daylight will penetrate further into a space and have a more uniform quality if windows are placed: high on a wall
- Daylight factor (DF) is defined as the ratio of: indoor illuminance to available outdoor illuminance.
- The externally reflected component (ERC) of the total daylight factor (DF) represents: the light reflected from exterior obstructions excluding the ground-reflected light.
- The recommended daylight factor for difficult prolonged tasks, such as drafting, is: 4.0 – 8.0%
- One daylighting design guideline suggests that there should be sufficient workplane illuminance from a window up to a distance of **2.5** times the head height of the window (height of the window above the desk plane).
- The daylighting analysis method that produces a family of daylight factor contours within a room rather than individual daylight factors at specific points is: Graphic Daylighting Design Method (GDDM).
- Which daylighting analysis method(s) work(s) only for a rectilinear space. CIE method and IESNA Lumen Method

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Quiz – **Chapter 15**

- The purpose of a luminaire is to hold, protect and electrify a lamp-and to: control and direct the lamp output.
- Shielding of lamps is accomplished with: reflectors, baffles, and louvers.
- The maximum reflectance of the best silver reflectors is about: 95%
- The coefficient of utilization (CU) is the: ratio of lumens reaching a work plane to lamp-generated lumens.
- The luminaire efficacy rating (LER) is the: ratio of fixture lumen output per watt of lamp input.
- Control function(s) for lighting systems include: switching and dimming.
- For fluorescent lamps, dimming down to **40%** of output is possible without substantially reducing luminous efficacy.
- The method used to calculate the average maintained illuminance in a space is the: zonal cavity method.

- The zonal cavity method divides a space into the following cavities: ceiling cavity, floor cavity, and room cavity.
- The illuminance at a given location from a point light source-for any given lamp/luminaire combination- is a function of: distance between the fixture and the illuminated surface.

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Quiz – **Chapter 16**

- Which of the following is not a recommended energy efficiency strategy for residential lighting? Provide for multiple light levels in all areas, use daylight in areas occupied during the daylight hours, **use incandescent lamps throughout**, provide dimming and switching for accent lighting.
- Design criteria for residential spaces are included in which of the following publications: ASHRAE Standard 90.1, DOE : Energy Efficient Lighting for the Home, **IESNA publication RP-11: Design Criteria for Interior Living Spaces,** DWLH: Lighting Handbook.
- Which of the following is not an appropriate design guideline for lighting classrooms in an educational facility:
    - provide equipment that is extremely hardy, vandal proof, and as low-maintenance as possible,
    - use some type of daylight compensation,
    - **use incandescent lamps for generation classroom illumination**,
    - incorporate low-brightness luminaries for high VCP in all viewing directions.
- The greatest challenge in lighting a commercial office space is: providing adequate lighting for varied visual tasks while avoiding glare on computer monitors.
- Which of the following is not an advantage to using desk lamps for task lighting in an office:
    - Luminance ratios in the near and far surround can exceed recommended levels.
    - The problem of furniture layout and layout changes is eliminated.
    - Energy requirements are lowered because of short distances between light source and task
    - Maintenance is greatly simplified because the fixtures are readily accessible.
- The term light trespass is defined as: unwanted light on private property.
- Which of the following is not a fiber-optic lighting technology application:
    - Retail display lighting
    - Accent lighting
    - Stair and path lighting
    - Street lamps
- Hollow light guide technology is used to conduct light from one place to another by using the principle of: reflectance

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Quiz – **Chapter 17**

- The goal of architectural acoustics is as follows: design spaces to meet hearing needs.
- Humans can hear sounds with frequencies ranging from: 20 to 20,000 Hz
- In architectural acoustics, frequency is sometimes referred to as:
    - Pulse
    - Tone
    - **Pitch**
    - Hz
- Which of the following terms does not relate to sound magnitude: sound frequency
- Decibel is best defined as the following: a numerical scale devised to conveniently describe sound magnitude.
- Sound intensity level changes by 3 dB with every doubling or halving of power and changes by **6** dB with every doubling or halving of the distance from a point source.
- A typical sound pressure level (dBA) for human breathing is 10, and for a jet plane takeoff is 150. The threshold of discomfort is about **80** dBA.
- Which of the following is not a correct conclusion regarding annoyance as a result of noise. Annoyance is:
    - Greater for high-frequency than low-frequency noise
    - Greater for intermittent than continuous noise
    - Greater for moving noise than for fixed-location noise

    - **Greater for nonsense noise (foreign language) then information-bearing noise (a neighbor's radio).**
- Prolonged exposure to high noise levels can lead to hearing loss. Which of the following agencies publishes acceptable noise exposure limits for workers.
- **OSHA**
- ASHRAE
- ANSI
- ALEX
- The Articulation Index (AI) is determined by reading a carefully selected set of phonetically balanced nonsense syllables to a test audience in the presence of different levels of background noise. An AI (ratio of correctly identified syllables to total syllables) of **0.5** is usually deemed an acceptable level of intelligibility for a male voice.

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Quiz – **Chapter 18**

- The two primary acoustical characteristics of an enclosed space are: absorption and reverberation.
- The term used to define a material's sound absorption characteristic is: coefficient of absorption.
- Reverberation is the persistence of sound after a sound source has ceased. Such persistence of sound is a result of: repeated reflections.
- Reverberation time (TR) is defined as the time required for the sound pressure level to decrease **60** dB after the sound source has stopped producing sound.
- The converse of reverberation is articulation. An articulate environment keeps each sound event separate rather than running them together. Spaces for speech activities should be: more articulate, less reverberant.
- Most indoor spaces contain the following sound fields: a near field, a reverberant field, and a free field.
- Sound power level (PWL) is a measure of the amount of sound generated by a source **independent** of its environment.
- The noise reduction coefficient (NRC) is: an arithmetic average of absorption coefficients at four frequencies.
- The optimum reverberation time in seconds, for speech, can be approximated using a formula based on the **spatial volume** of the space.
- Concave domes, vaults, or walls will lead reflected sound into certain areas of a room. This is called: focusing
- **Ray diagramming** is a design procedure for analyzing the reflected sound distribution throughout a hall using the first reflection only.
- Generally, sound amplification systems will be required in spaces larger than 50,000 ft^2.

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Quiz – **Chapter 19**

- The process of converting acoustical energy into heat is called: sound absorption
- Absorption techniques are generally useful and effective: to change room reverberation characteristics
- Structure-borne sound transmission is generally more **difficult to control** than airborne sound.
- The noise reduction (NR) between two spaces separated by a barrier is defined as: the difference between the sound intensity levels in the two rooms.
- The mass law is based on the principle that: the larger the mass, the less it will vibrate.
- Stiffness in a panel construction reduces damping, making it a good: transmitter.
- The stiffness of a barrier is a function of its **material composition** and the rigidity of its mounting.
- Transmission loss for a cavity wall increases with the width of the air space at the rate of 5 dB per doubling. Performance can be improved still further by: filling the void with porous, sound-absorbent material.
- **Speech privacy** is a function of the degree of sound isolation provided by the barriers between rooms and the ambient sound level in the receiving room.
- An AI (Articulation Index) of 0 indicates: ideal speech privacy
- Which of the following is not a reason that impact noise is at least as serious a problem as airborne noise:
    - **Resilient cushioning materials eliminate vibration**

    - There is no air cushion between the source and the structure
    - Additional mass does not usually block impact noise.
    - The entire structure constitutes a network of parallel paths for sound transmission.
- Which of the following is not a form of isolation for structure-borne sound.
    - Floating a floor
    - **Reducing mechanical equipment sound power**
    - Suspending a ceiling
    - Isolating piping

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Quiz – **Chapter 20**

- There is a finite quantity of water in the Earth and its atmosphere. The process whereby this water constantly circulates, powered by about one-fourth of the Earth's solar energy is called the: hydrologic cycle.
- A designer needs to determine the plumbing facilities needed for a project by: consulting the International Plumbing Code or other applicable code.
- The procedure for rough sizing of the storage capacity for cisterns depends upon the monthly average rainfall, the monthly water usage, and the: catchment area yield.
- In a typical cistern system, a **roof washer** gets the dirtiest first runoff from the roof.
- By using **porous** pavement, more storm water can be retained on site.
- Gutterless sloped roofs with gravel-filled trenches skirting the building perimeter is one site design approach for **rainwater recharging**.
- In new suburban developments with no storm sewers, **recharge basins** are sometimes used to deliver storm water to the ground.
- The size of gutters and leaders depends upon the horizontal projected area of a roof and on the **design rainfall rate**.
- Routing storm water inside a building can be a problem because of: sweaty pipes

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Quiz – **Chapter 21**

- At what point during the hydrologic cycle do foreign substances contaminate water?
    - During precipitation
    - During evaporation
    - **When rainfall contacts surfaces**
    - While water is stagnant
- What causes hardness in water?
    - Bicarbonate, carbonate, or hydroxide components
    - **Calcium and magnesium salts**
    - Wastes from abandoned dumps
    - Corrosion byproducts
- The water treatment process typically begins with which of the following steps:
    - **Filtration**
    - Pasteurization
    - Aeration
    - Disinfection
- Water is heated to encourage evaporation. As the water turns to vapor, pollutants are left behind. The water is collected as it condenses. This process is referred to as: distillation
- When sizing hot water systems for commercial and institutional buildings it is important to consider: the trade off between recovery time and storage capacity
- A truly passive solar water heating system does not:
    - Use pumps to force the fuild into the collector
    - Have lower operating costs than active systems
    - Install storage tanks above the collectors
    - **Rely on gravity for circulation**
- A direct passive solar water heating system: utilizes only one fluid, the water to be heated.

- A conventional water closet historically used 3.5 gal or more per flush while a watersaver water closet uses **1.7 to 3.5 gallons.**
- A dishwasher uses between 12 and 18 gal per cycle. Clothes washing machines use **40 to 55** gal for a full-sized load. (?)
- Supplying water throughout buildings at pressures sufficient to operate plumbing fixtures is a concern for the designer. The **hydromneupmatic** method of distribution uses pumps to force water into sealed tanks, compressing the air within.
- Water is often used for landscape irrigation. A water conserving irrigation approach uses emitters to slowly and steadily supply water onto the ground surface at each plant. This method is referred to as: drip irrigation.

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Quiz – **Chapter 22**

- The average U.S. residential usage of water is about 140 g/cd; all potable water. With attention to recycling and the matching of water to usage, this potable water usage could be cut by: 25%
- Composting toilets are gaining mainstream acceptance and are now appearing in homes and institutional buildings. Proper **ventilation** is a key to a successful composting toilet system.
- The only separation between the unpleasant and dangerously unhealthy gases in sanitary drainage pipes and the air breathed by room occupants is the **water** caught in the fixture trap after each discharge from a fixture.
- In residential design, when designing a layout and sizing the piping system for sanitary drainage, the first step is to: identify where fixtures are located.
- When designing a multistory office building it is common to have a bathroom for executives located away from the central core of the building. An important thing to remember as a designer is that the greater the horizontal distance from the core: the more vertical clearance that will be needed to allow the drain to slope.
- Septic tank sizes are commonly selected on the basis of **code requirements** that consider the number of bedrooms in the building or the number of waste fixture units served.
- Aerobic treatment units depend upon air bubbled through the sewage to achieve digestion. These systems require **smaller** tanks than septic systems.
- **Living Machines** cost less to construct and maintain, use less energy, are kinder to the environment, and are more pleasant to look at than conventional commercial sewage treatment plants.
- Water from washing machines with dirty diaper loads, from kitchen sinks, and from dishwashers is referred to as: dark graywater (?)
- Graywater reuse opportunities are more limited than those for rainwater, because:
    - Graywater requires extensive treatment to eliminate contaminants
    - **Of increase threats from graywater pathogens**
    - Of foamation from soap in the graywater
    - People don't like the color of graywater

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Quiz – **Chapter 23**

- Which of the following are considered "high-grade" recyclable resources?
    - **Glass**
    - Industrial waste
    - Liquid
    - Solid waste
- Which of the following is a usable byproduct of landfill decomposition?
    - Straw bales
    - **Methane gas**
    - Rammed earth
    - Geothermal steam
- It may not always be worthwhile to incorporate recycling space or facilities into building designs because: not all communities collect recyclables
- Which of the following waste-disposal machines is unlikely to be used in the future?
    - Garbage compactor

    - Sink-based garbage disposer
    - **Incinerator**
    - Composting toilet
- The sacrificed rentable floor space involved with deploying multiple recycling collection bins in an office is offset in part by: the reduced cost of trash hauling / disposal
- A refuse baler/compactor can reduce trash to **10%** of its original volume.
- The primary advantage of a vacuum-based waste disposal system is that: lines can be small and contents can be moved horizontally and vertically.
- Which of the following is a popular use for food waste disposal in dense urban settings?
    - **Composting for rooftop gardens**
    - Incineration for building heat
    - Composting for methane to power absorption chillers
    - Urban ranching; deploying goats to eat the scraps
- The exterior area required for trash collection in a residential building of 16 to 25 units is: 48 ft2
- Which service core type is typically best for flexibility of rentable area?
    - Edge
    - **Detached**
    - Corner
    - Random

Mechanical and Electrical Equipment for Buildings

Quiz – **Chapter 24**

- The majority of the standards for fire protection in the United States are generated by: the National Fire Protection Association (NFPA)
- Which of the following is not a common ignition source for building fires?
    - Chemical
    - Mechanical
    - Electrical
    - **Nuclear**
- The normal concentration of oxygen in air is: 21%
- In the United States, most commercial building fires are now extinguished with: an automatic sprinkler system
- Which of the following building features inhibit fire protection efforts?
    - Elevated water storage tanks
    - **Escalators**
    - High ceilings
    - Thermal mass
- Evacuation and fire protection in high-rise buildings can be problematic because fire fighting equipment cannot usually reach higher than: 90 ft
- Exterior fire escapes are generally no longer permitted because: smoke plumes rising from windows can render these devices unusable early in a fire.
- In order of importance, it is most important to fire-protect: columns, girders, beams, and the floor slab
- Supplying fresh air to a smoke-free stair entirely from the top or bottom is not advisable because: it is tool likely that open doors near the source would deplete fresh air for the rest of the stair.
- Sprinkler and smoke removal systems are sometimes at cross-purposes because: the buoyancy of smoke is reduced by cooling water
- Which of the following is not a typical fire alarm system type?
    - Central station
    - Household
    - Remote-station protective signaling
    - **Laser relay**
- In a reinforced-concrete building, reinforcing rods can be used as lightning conductors only if: the rods are welded, not tied
- Which of the following fire types should be counteracted with a Class C fire extinguisher?
    - Grease fires
    - Wood fires
    - **Live electrical fires (?)**
    - Plastic fires

- The advantage of using inerting gas and clean-agent fire-suppression chemicals over water is that: they can protect a building's contents, not just the structure.

Mechanical and Electrical Equipment for Buildings

Quiz – **Chapter 25**

- The unit of electric current is: the Ampere
- The name given to the force driving electron flow between positive and negative terminals is: voltage
- In a series circuit, voltages and resistances are: added
- In a parallel circuit, current at each load depends upon: the resistance of each load
- Direct current can be defined as a condition where: a flow of current takes place at a constant rate in the same direction around a circuit
- Which of the following is not a typical use of dc power?
    - **High-voltage transmission lines**
    - Building controls
    - Telephones
    - Battery powered devices
- The overall load factor is: the ratio between the average and maximum power demands of a building
- A "ratchet" clause in a utility billing plan is disadvantageous for which type of user? Users with a low yearly load factor
- Devices that carry the description "energy management" have a primary function of controlling: energy use.
- What is the primary disadvantage of an automatic instantaneous demand control system for electric power? The system cannot readily adapt to varying load patterns.

Mechanical and Electrical Equipment for Buildings

Quiz – **Chapter 26**

- A power utility will most likely find overhead transmission economically feasible for voltages greater than: 5,000 V
- Which of the following transmission line methods is the most expensive? Type I burial
- A "step down" transformer: has a greater number of turns in its primary coil than its secondary coil
- In a transformer, **power capacity** remains constant.
- A load center pad-mounted unit substation would typically have a primary voltage range of: 2.5–15kV
- The most popular form of exterior transformer installation for individual buildings is: mounted on a concrete pad
- Oil-insulated transformers can be expensive to install indoors because: they must be placed in a fire-resistant vault
- The use of non-flammable liquid coolants has largely been discontinued in transformers because: the coolants contain PCBs, which are banned in new installations
- Which of the following is not a valid electrical switch class?
    - 250 V
    - 600 V
    - **1.5 kV**
    - 5 kV
- The advantage of using a contactor rather than a switch is that: a contactor can be remote-controlled
- To protect against all types of weather conditions, one should specify an equipment enclosure of type: 4
- A "drawout" switchboard is: a type of switchboard that has circuit breakers mounted in a movable drawer
- Almost all indoor unit substations use **dry-type** transformers.
- Which of the following would be a typical dimension of a single-phase uninterruptible power supply (UPS) unit?
    - 6”x6”x12”
    - 18”x10”x24”
    - **36”x12”x36”**
    - 60”x24”x36”

Mechanical and Electrical Equipment for Buildings

Quiz – **Chapter 27**

- Which building electrical sub-system includes panelboards and circuit breakers?
    - **Wiring and raceways**
    - Power-handling equipment
    - Utilization equipment
    - Limiters
- In a typical building electrical power system wiring closet, dry-type transformers are typically placed between: plug-in busways and 120-V panelboards
- The current rating of an electrical service item is determined by: the maximum temperature at which its components can operate at full load.
- Which type of interior wiring system is typically only used in industrial applications? Insulated cables in open raceways
- A single conductor of No. 8 AWG standard **is referred to as a "wire".**
- A conductor's current-carrying capacity is referred to as its: ampacity
- Use of AC cable is typically confined to: dry locations
- A busway or busduct is ideally used when it is necessary to carry large amounts of current.
- The advantage of using a cablebus over a busduct is that: it has higher amperes-per-dollar first-cost
- Lighting tracks are generally rated at: 20 A
- Raceways have now become a major architectural consideration that must be addressed early in the design process because: the proliferation of computers and networking equipment require the distribution channels to be much wider than before
- In a two-level underfloor duct system, ducts are run near the center of a bay in a depressed-slab system: to avoid the steel in beams or joist near columns

Mechanical and Electrical Equipment for Buildings

Quiz – **Chapter 28**

- Electrical energy cost is directly related to energy consumption, except in the case of:
    - **Utility demand charges**
    - Low-wattage bulbs
    - Industrial applications
    - Three-phase contractors
- Which of the following occupancy types exhibits the highest air-conditioning load?
    - Art gallery
    - Cafeteria
    - **Auditorium**
    - School classroom
- A 120/208-V single-phase, three-wire system would be used primarily to serve: a single family residence or small commercial building
- The best distribution system for a large, multistory building that principally uses fluorescent or HID lamps is: 277 / 480-V, 3-phase, 4-wire
- Which of the following ***is not*** a maxim for the safe grounding of a secondary wiring system?
    - The neutral wire in a secondary system must never be interrupted by switched or other devices
    - The neutral wire must be connected to the ground only at one point, the service entrance.
    - **The neutral wire must be color-coded yellow on any insulation color other than blue, along at least half the conductor length.**
    - The neutral must be color-coded white, natural gray, or by three continuous white stripes on any insulation color other than green, along the entire conductor length.
- To avoid the risk of electric shock, it is recommended that appliance housings be grounded to a: cold-water pipe
- In the design procedure for wiring a building, one would compute panel loads before: feeder and protective equipment ratings are computed
- In commercial spaces, an electrical closet might be preferable to a stand-alone panelboard for a building of **6** or more stories.

- Which of the following would be a good location for an electrical closet? a location where conduits can enter and leave the location vertically and horizontally
- Which of the following volt-amperage values would be logical for a 15-A residential circuit operating at 25% expansion?
    - 1440 V-A
    - 1920 V-A
    - **1150 V-A**
    - 1520 V-A
- To accommodate a home office worker, master bedrooms should be provided with a minimum of: 6 duplex 15-A or 20-A receptacles connected to at least two different circuits.
- For the purpose of predicting overall building electrical load, continuous loads should be calculated at **125%** of their actual value.
- If a building's emergency power supply consists of batteries, the batteries must have a full-load capacity of: 90 minutes

Mechanical and Electrical Equipment for Buildings

Quiz – **Chapter 29**

- Increases in PV module efficiency, new materials, and other initiatives have brought the cost of PV (per peak Watt) to about: $0.25 - $0.50
- "Insolation" is best defined as: the amount of solar energy received by a given area, measured in Wh/m2
- Today's commercial two-layer PV arrays have a maximum insolation-to-electric energy conversion rate of: 12%
- The tilt angle of a PV array, to capture maximum insolation when the sun is lowest, should be: equal to the site latitude plus 15 degrees
- A direct-connected PV array is used to power applications such as filling an elevated water tank because: a slow, interruptible fill rate does not adversely affect the water's usability.
- A PV system battery is generally expected to supply all of an installation's electrical requirements for a period of **3** days of cloudy weather.
- Which PV system battery type requires the least maintenance?
    - Lead-calcium
    - Lead-acid
    - **Sealed**
    - Lead-antimony
- The primary difference in design for a stand-alone PV system and for a grid-connected system is that: a stand-alone system must provide the entire electric load, while a grid-connected system may provide part of the load
- Which of the following is not a factor for determining the system requirements for a stand-alone PV array?
    - The daily electricity usage
    - The period of time for which the battery must supply the electric load without recharge
    - The available insolation
    - **The reliability of the local electric grid**
- The acronym BIPV stands for: building intergraded photovoltaic

Mechanical and Electrical Equipment for Buildings

Quiz – **Chapter 30**

- Which type of intrusion-detection system sensor is no longer used in new construction?
    - Normally closed contact
    - **Normally open contact**
    - Mechanical motion detector
    - Photoelectric device
- Master stations in residential intercom systems differ from remote stations in that: they allow selective calling

- "Premise wiring" can be defined as: the system of raceways, boxes and outlets dedicated to communication systems, excluding audio signals.
- A clear wall space of **4 to 6 ft.** is needed for the service entrance of a multiple-dwelling telephone system.
- Light-emitting diode (LED) school clocks are best utilized: in low-ambient situations.
- In a two-channel sound system, the preamp would be located between: the program selector and the distribution switch bank
- Signal system riser closets should have a minimum net area of **20 ft2** and a minimum clear wall of **5ft.** for cabinet mounting.
- According to Fig. 30.20, the designer of a machine shop that uses a punch press would want to install an industrial signal system that employed a device at least as loud as: a conventional horn
- Remote-control signaling differs from automated signaling primarily in that: the signal initiation in an automated system is non-manual
- Which of the following minimum standards does not fall under the definition of "open architecture," in building-automation system (BAS) terms?
    - Supply required system information at any I/O port
    - Permit access to databases at any workstation
    - Use networks for information transfer at one or more levels
    - **Integrate as much as possible with the building's structure**
-

Mechanical and Electrical Equipment for Buildings

Quiz – **Chapter 31**

- Elevators can account for as much as **10%** of a 25-story building's construction cost.
- An elevator's counterweight should be equal to the weight of: an empty car plus 40% of the rated live load.
- Which of the following is not an elevator control equipment type?
    - Drive control
    - Operating control
    - Supervisory control
    - **Spin control**
- Gearless traction machines are usually used for passenger service, with car capacities between: 2,000 lb. and 4,000 lb.
- Which of the following is not an advantage of a geared traction machine over a gearless machine?
    - A geared machine is smaller
    - A geared machine is cheaper
    - A geared machine is faster
    - **A geared machine required less maintenance**
- To completely allow passengers to simultaneously enter and exit an elevator doorway, an opening **48"** wide may be necessary.
- The minimum ADA-permitted door opening for an elevator is: 36"
- Which of the following elevator drive control mechanisms is no longer employed?
    - Thyristor control os an asynchronous as traction motor
    - **Rheostatic control of an ac traction motor**
    - Thyristor control of a dc transition motor
    - Variable-voltage, variable-frequency control of an asynchronous as traction motor.
- Which type of elevator drive control mechanism is best suited to buildings with a maximum rise of 250 ft (76.2 m) and a maximum car speed of 350 fpm (106.7 m/m)?
    - **Thyistor controlled ac motor**
    - Variable voltage dc motor control
    - Variable voltage, variable frequency ac motor control
    - Thyristor controlled dc motor
- An elevator system using selective collective operation has the advantage of: shorter waiting periods

Mechanical and Electrical Equipment for Buildings

Quiz – **Chapter 32**

- In tall buildings, the sky lobby is an attractive option for designers because: it mitigates the annoyance passengers would normally feel from a long trip.
- The main advantage of hydraulic elevator systems is that: they do not require a penthouse machine room or a heavily braced roof over the shaft.
- Besides the number of telescoping sections, the main difference between a single-jack and dual-jack hydraulic elevator systems is that: the car exerts a lateral structural load on the building in the single-jack system, while the dual-jack system carries the load directly to the ground.
- The 2:1 roping ratio used in roped hydraulic elevators means that: the car travels twice as far as the piston
- Freight elevators are available as standard designs for capacities of up to **20,000 lb**; beyond this point, they must be specially engineered.
- What is the minimum pit dimension for a 200 fpm (1.02 m/s) freight elevator? 6'-0"
- Limited use/limited application (LU/LA) elevators can carry a load of no more than: 1,400 lb.
- Automated dumbwaiters are also known as: ejection lifts
- Pneumatic tube systems are available in a range of tube diameters from: 2.25" to 6"
- Automated, self-propelled delivery vehicles (robots) generally operate at speeds no greater than: 500 fpm

Mechanical and Electrical Equipment for Buildings

Quiz – **Chapter 33**

- Which of the following is not a typical escalator arrangement?
    - Parallel
    - Crisscross spiral
    - **Parallel helix**
    - Crisscross walk-around
- A designer seeking to avoid the resentment and confusion of building occupants would design a separation between escalators in a crisscross walk-around of no more than: 10ft
- It is not advisable to use the stacked parallel arrangement of escalators beyond **2** floors, as users will become annoyed at the long walk-around.
- Which of the following is not one of the four guidelines of escalator and moving stairway design?
    - Provide well-marked escalators with sufficient traffic-carrying capacity
    - Provide collecting space at intermediate landings so that flow pressure can be relieved
    - Provide a slight setback for the next escalator so that the necessary 180-degree turn can readily be negotiated.
    - **Locate elevator and escalator access areas on the same landing so that passengers can make decisions between the two.**
- All escalators in the United States are installed at an angle of **30** degrees from the horizontal.
- Standard escalators have a maximum rise of: 60 ft.
- Which of the following is not an accepted escalator fire-protection method?
    - Rolling shutters
    - Smoke guards
    - **Ventilated combplates**
    - Sprinklers and vents
- A 32-in. (81-cm) escalator with a maximum rise of 30 ft (9.1 m) would require a **10 hp** motor.
- What is the maximum permissible operating speed of a 3-to-5-degree angle moving ramp with a level entrance? 180 fpm
- What is the carrying capacity of a single-lane moving walkway rated at 100 fpm (0.5 m/s)? 3,000 passengers per hour