Tutorial 2a: Energy flowpaths

Q1. Describe the principal factors affecting each of the following heat transfer processes within buildings: natural convection at internal surfaces; longwave radiation exchange; infiltration and inter-room air flow; and intra-room air movement.

1. Natural convection: surface-to-air temperature difference, surface roughness, direction of heat flow and characteristic dimensions.
2. Longwave radiation: inter-surface temperature difference, surface emissivity, room geometry and content (dictating view factors), and surface reflection (diffuse, specular or mixed).
3. Infiltration: pressure distribution, leakage distribution, buoyancy forces, and occupant interactions.
4. Intra-room air movement: flow regimes (laminar, turbulent or mixed), boundary temperatures and velocities, distribution of heat flux and momentum inputs, and occupant interactions.

Q2. Explain the effect on a room's heating load in winter of applying a low emissivity coating to 1) the inside surface of a double glazed window; and 2) the innermost, cavity-facing surface of the same window.

1. The low-ε coating reduces the longwave flux transfer between the room surfaces and the window and so reduces the overall heat loss. The window inside surface is cold.
2. Now the longwave flux transfer can take place with the window inside surface and transfer, via conduction, to the innermost cavity-facing surface. At this point, the heat loss is arrested because the low-ε coating reduces the radiation exchange across the cavity. Thus, the window inside surface is warmer at the expense of a slightly higher heat loss.

Q3. Describe <u>two</u> circumstances in which it would be advisable to model wall conduction in three dimensions.

1. At corners, where dissimilar materials may inter-penetrate or where the the material comprising the corner is a significant proportion of the overall construction and therefore its omission may seriously impact on the result.
2. Where thermal bridges are present such as at the junction of the wall and a window frame.

Q4. State the advantages and disadvantages of locating insulation on the innermost position of the walls of a room.

Advantages:

1. Hides the thermal capacity of the wall that may otherwise give rise to an increased peak plant demand due to the initial rush of energy to capacity at plant start-up in an intermittent scheme.
2. The risk of surface condensation is lower because the inside surface temperature is likely to remain above the dew point temperature of the adjacent air.

Disadvantages:

1. Hides the thermal capacity of the wall that may otherwise help to minimise the peaks and maximise the troughs of plant demand and so promote good load levelling.
2. Solar radiation penetrating windows and striking the internal surface cannot be readily stored in the construction since the insulation will act as a barrier. A space experiencing high solar energy penetration is likely to overheat or need cooling.
3. The risk of interstitial condensation is greater in the case of internally located insulation since a substantial portion of the construction may fall below the dew point temperature of moist air permeating through the construction in the absence of an effective vapour barrier.

Q5. Differentiate between long- and short-wave radiation.

Shortwave radiation comprises visible light and ultraviolet radiation. Longwave radiation is infrared radiation. While the Sun radiates energy mainly in the form of visible light, with small amounts of ultraviolet and infrared radiation; for this reason solar radiation is usually considered shortwave radiation. The radiation emitted from bodies at terrestrial temperatures is longwave.

Q6. When modelling external surface longwave radiation exchange, list <u>five</u> influencing factors that must be taken into account.

1. cloud cover/type;
2. effective sky temperature;
3. temperature of surrounding buildings;
4. ground temperature; and
5. view factors between the surface and the sky, ground and surroundings.

Q7. What is the purpose of a passive solar element in the context of building design? Identify some typical elements.

The purpose is to capture, store and/or transport energy without recourse to mechanical systems. Examples include: solar control devices, sunspaces, phase change materials, desiccant materials, evaporative cooling, induced ventilation and mass walls.