UNIVERSITY OF JOHANNESBURG

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| **PROGRAM** | : | BACCALAUREUS TECHNOLOGIAE<br>*CHEMICAL ENGINEERING* |
| **SUBJECT** | : | **CHEMICAL ENGINEERING TECHNOLOGY 4 (HEAT AND MASS)** |
| **CODE** | : | **WARC432** |
| **DATE** | : | SSA WINTER EXAMINATION<br>17 JULY 2018 |
| **DURATION** | : | (**SESSION 1**) 08:00 - 11:00 |
| **WEIGHT** | : | 40 : 60 |
| **TOTAL MARKS** | : | 100 |


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| **EXAMINER** | : | DR N. MAZANA | 720000739 |
| **MODERATOR** | : | OBOIRIEN BILAINU | 720043632 |


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| **NUMBER OF PAGES** | : | 3 |

**INSTRUCTIONS** : WORK ACCURATELY AND ANSWER ALL QUESTIONS.
NON-PROGRAMMABLE CALCULATORS PERMITTED
(ONLY ONE PER CANDIDATE).

**QUESTION 1** **[20 marks]**

Determine the rate of heat transfer by conduction per unit area, by means of conduction for a furnace wall made of fire clay. Furnace wall thickness is 6" or half a foot. Thermal conductivity of the furnace wall clay is 0.3 W/m·K. The furnace wall temperature can be taken to be same as furnace operating temperature which is 650$^0$C and temperature of the outer wall of the furnace is 150$^0$C.

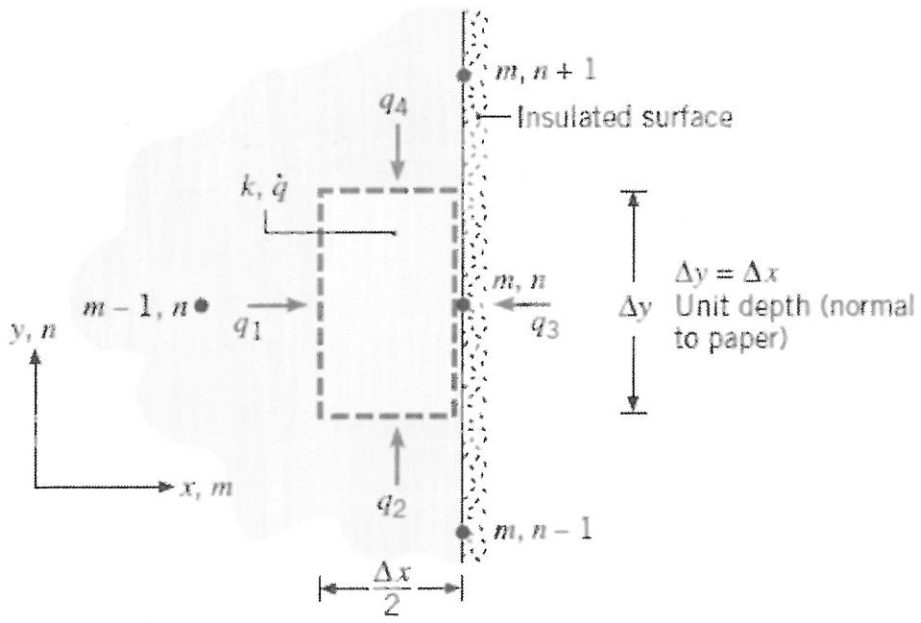
**QUESTION 2** **[20 marks]**

Using the energy balance method derive the finite-difference equation for the (m,n) nodal point located on a plane, insulated surface of a medium with uniform heat generation. Assume that $q_3 = 0$.

Formulas:

$$\dot{E}_{\text{in}} + \dot{E}_g = 0$$

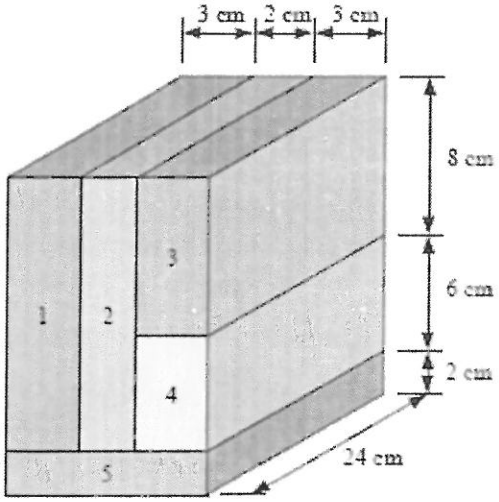
$$\sum_{i=1}^{4} q_{(i)\to(m,n)} + \dot{q}(\Delta x \cdot \Delta y \cdot 1) = 0$$



## QUESTION 3 [30 marks]

**Given:** A composite consisting of five sections, as shown in the figure.
k1 = k3 = 80 W/mK, k2 = 120 W/mK, k4 = 100 W/mK, and k5 = 150 W/mK.

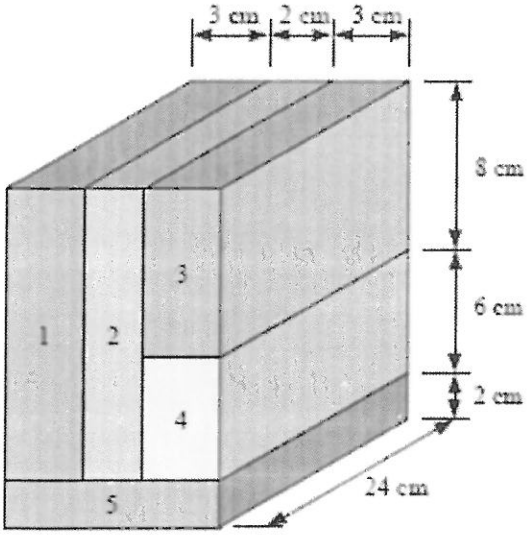
Find: Construct the thermal circuit model and find the total thermal resistance.




**Assumptions:** 1-D steady-state conduction.

## QUESTION 4 [30 marks]

Given: Same composite as in Question 2. $T_{left}$ = 20 ºC, $T_{right}$ = 80 ºC; h = 15 W/m$^2$K on both sides.




**Find:** Heat transfer rate through the composite.
**Assumptions:** 1D steady-state conduction.