MINISTRY OF EDUCATION AND CULTURE
UNIVERSITAS NEGERI SURABAYA
FACULTY OF ENGINEERING
MAJORING IN MECHANICAL ENGINEERING
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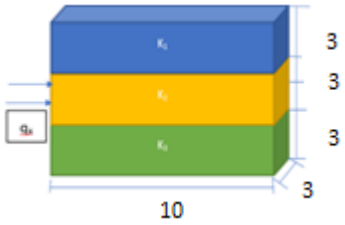
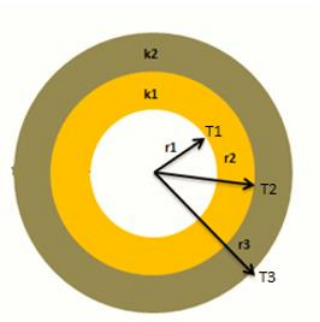
SUMATIVE EXAM EVEN SEMESTER 2019/2020

Courses/SKS	: HEAT TRANSFER AND MASS/2
Depart / Prog / Member	: Mechanical Engineering/S1 PTM /2018
Lecture	: Ika Nurjannah, S.Pd., M.T./ Dr. Mohammad Effendy, S.T, M.T
Date and time	: Tuesday, 07 June 2020
Time	: 100 minutes

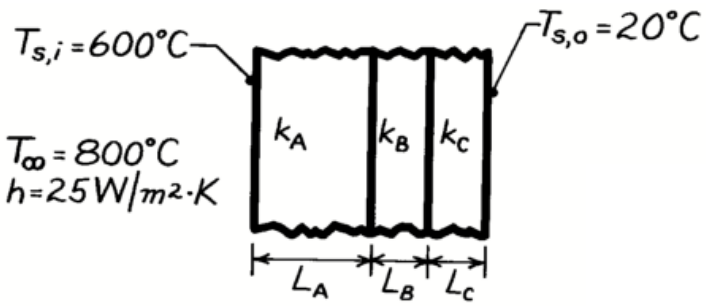
1. A block-shaped object made of three different materials is being heated. The object has a height of 9 m (each layer is 3 m), 10 meters long, and 3 m wide. The temperature on the left side of the beam T_1 is 25^0C while the temperature is on the right side of the beam T_2 is 150^0C. if $k_1 = 1.5\frac{W}{m.K}$, $k_2 = 1.6\frac{W}{m.K}$, dan $k_3 = 1.3\frac{W}{m.K}$, and convection and radiation heat transfer are negligible. What is the heat transfer rate (q_x)? **30 point**



2. A hollow sphere consisting of several layers of material consisting of copper and silver, each of which has a thermal conductivity of 385 W/m.K and 410 W/m.K. The thickness of the coating on the ball is r_1= 7 cm, r_2 = 14 cm and r_3 = 30 cm. If the outside temperature (T_3) of the ball is 170^0C. The heat transfer on the coated ball is 560 W. What is the temperature on the inner surface of the ball (T_1) ? **30 Point**



3. A composite wall is formed from 3 different materials, if k_A = 20 W/m.K and k_c = *50 W/m.K*. length of material A of 0,3 m while the length of material B is half the length of material A and the length of C is the same as material B. Based on the data from the image determine:
   a. Draw a thermal circuit for that condition **20 Point**
   b. K_B **20 Point**



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Surabaya, 5 Mei 2020

Validated by,

Quality Assurance Unit Mechanical Engineering Department	Allied Team
(Ika Nurjannah, S.Pd., M.T)	(Dr. I Made Arsana, S.Pd., MT)

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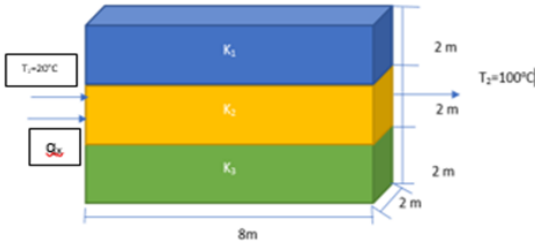
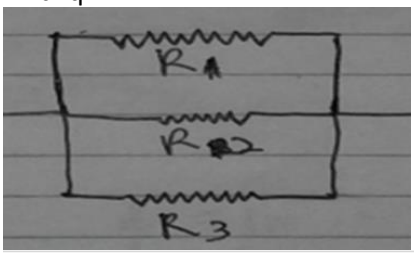
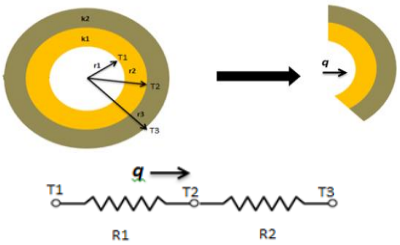
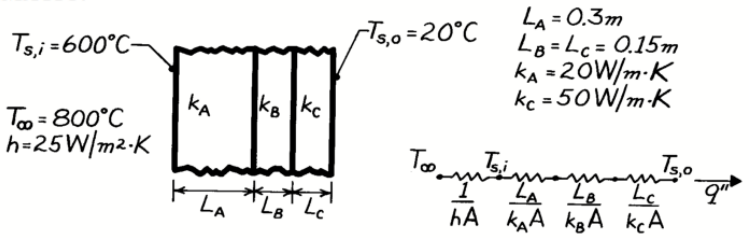
Test answer key

SUMATIVE EXAM EVEN SEMESTER 2019/2020

Question	Answer	Poin
1. A block-shaped object made of three different materials is being heated. The object has a height of 9 m (each layer is 3 m), 10 meters long, and 3 m wide. The temperature on the left side of the beam T_1 is 25^0C while the temperature is on the right side of the beam T_2 is 150^0C. if $k_1 = 1.5\frac{W}{m.K}$, $k_2 = 1.6\frac{W}{m.K}$, dan $k_3 = 1.3\frac{W}{m.K}$, and convection and radiation heat transfer are negligible. What is the heat transfer rate (q_x)?	Known: $P = L = 8\ m$ $l = 2\ m$ $t = 6\ m$ $t_1 = 2m$ $t_2 = 2\ m$ $t_3 = 2\ m$ $T_1 = 20°C = 293.15°K$ $T_2 = 100°C = 373.15°K$ $k_1 = 1.5\frac{W}{m°K}$ $k_2 = 1.6\frac{W}{m°K}$ $k_3 = 1.3\frac{W}{m°K}$  Find qx  $\frac{1}{R_{123}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$ $\frac{1}{R_{123}} = \frac{1}{\frac{L}{k_1A_1}} + \frac{1}{\frac{L}{k_2A_2}} + \frac{1}{\frac{L}{k_3A_3}}$ $R_{123} = \left(\frac{1}{\frac{L}{k_1A_1}} + \frac{1}{\frac{L}{k_2A_2}} + \frac{1}{\frac{L}{k_3A_3}}\right)^{-1}$ $R_{123} = \left(\frac{k_1A_1}{L} + \frac{k_2A_2}{L} + \frac{k_3A_3}{L}\right)^{-1}$ $R_{123} = \left(\frac{k_1(t_1 \times l)}{L} + \frac{k_2(t_2 \times l)}{L} + \frac{k_3(t_3 \times l)}{L}\right)^{-1}$ $R_{123} = \left(\frac{1.5\frac{W}{m°K}(2\ m \times 2\ m)}{8\ m} + \frac{1.6\frac{W}{m°K}(2\ m \times 2\ m)}{8\ m} + \frac{1.3\frac{W}{m°K}(2\ m \times 2\ m)}{8\ m}\right)^{-1}$ $R_{123} = \left(\frac{1.5\frac{W}{m°K} \times 4\ m^2}{8\ m} + \frac{1.6\frac{W}{m°K} \times 4\ m^2}{8\ m} + \frac{1.3\frac{W}{m°K} \times 4\ m^2}{8\ m}\right)^{-1}$ $R_{123} = \left(\frac{6\frac{Wm}{°K}}{8\ m} + \frac{6.4\frac{Wm}{°K}}{8\ m} + \frac{5.2\frac{Wm}{°K}}{8\ m}\right)^{-1}$ $R_{123} = \left(0.75\frac{W}{°K} + 0.8\frac{W}{°K} + 0.65\frac{W}{°K}\right)^{-1}$ $R_{123} = \left(2.2\frac{W}{°K}\right)^{-1}$ $R_{123} = 0.4545\frac{°K}{W}$	30
2. A hollow sphere consisting of several layers of material	Known k1 385 W/m.C k2 =410 W/m.C	30

consisting of copper and silver, each of which has a thermal conductivity of 385 W/m.K and 410 W/m.K. The thickness of the coating on the ball is r_1= 7 cm, r_2 = 14 cm and r_3 = 30 cm. If the outside temperature (T_3) of the ball is 170^{0}C. The heat transfer on the coated ball is 560 W. What is the temperature on the inner surface of the ball (T_1) ?	r1=5cm = 0,05m r2=10cm = 0,1m r3=24cm = 0,24m T3 =150 ^{o}C qx= 560 W  Answer ❖ Rtotal = $\frac{r2-r1}{4\pi K1r2r1} + \frac{r3-r2}{4\pi K2r3r2}$ Rtotal = $\frac{0,1m-0,05m}{4.3,14.385W/m.C.\ 0,1m.0,05m} + \frac{0,24m-0,1m}{4.3,14.410W/m.C.0,24m.0,1m}$ Rtotal = $\frac{0,05}{24,178W/C} + \frac{0,14}{25,748W/C}$ Rtotal = 0,007C/W ➢ qx= $\frac{\Delta T}{Rtotal}$ 560W = $\frac{T1-423\ °K}{0,007W/K}$ T1- 150 $°C = 560\ W\ x\ 0,007°C$/W T1=153,92 $°C$ So T1 = 153,92$°C$	
3. A composite wall is formed from 3 different materials, if k_A = 20 W/m.K and k_c = *50 W/m.K*. length of material A of 0,3 m while the length of material B is half the length of material A and the length of C is the same as material B. Based on the data from the image determine: a. Draw a thermal circuit for that condition b. K_B	**KNOWN:** Thicknesses of three materials which form a composite wall and thermal conductivities of two of the materials. Inner and outer surface temperatures of the composit also, temperature and convection coefficient associated with adjoining gas. **FIND:** Value of unknown thermal conductivity, k_B. **SCHEMATIC:**  	40

ASSUMPTIONS: (1) Steady-state conditions, (2) One-dimensional conduction, (3) Constant properties, (4) Negligible contact resistance, (5) Negligible radiation effects.

ANALYSIS: Referring to the thermal circuit, the heat flux may be expressed as

$$q'' = \frac{T_{s,i} - T_{s,o}}{\frac{L_A}{k_A} + \frac{L_B}{k_B} + \frac{L_C}{k_C}} = \frac{(600-20)^\circ C}{\frac{0.3\ m}{20\ W/m\cdot K} + \frac{0.15\ m}{k_B} + \frac{0.15\ m}{50\ W/m\cdot K}}$$

$$q'' = \frac{580}{0.018 + 0.15/k_B}\ W/m^2. \qquad (1)$$

The heat flux may be obtained from

$$q'' = h\left(T_\infty - T_{s,i}\right) = 25\ W/m^2\cdot K\,(800\text{-}600)^\circ C \qquad (2)$$

$$q'' = 5000\ W/m^2.$$

Substituting for the heat flux from Eq. (2) into Eq. (1), find

$$\frac{0.15}{k_B} = \frac{580}{q''} - 0.018 = \frac{580}{5000} - 0.018 = 0.098$$

$$k_B = 1.53\ W/m\cdot K. \quad <$$

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Exam Rubric Odd Semester 2019/2020

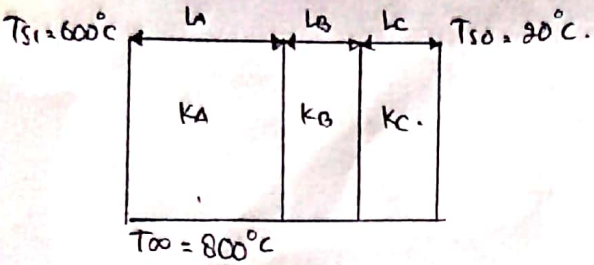
Heat transfer and Mass

NO	ESSAI	SCORE	MAKS SCORE
1	answer the questions correctly	30	30
	answer the question but there is still something wrong	20	
	answered the question but was wrong	10	
2	answer the questions correctly	30	30
	answer the question but there is still something wrong	20	
	answered the question but was wrong	10	
3	answer the questions correctly	40	40
	answer the question but there is still something wrong	25	
	answered the question but was wrong	10	

Nama : Sisca Apriliana.
Nim : 1805034009.

UAS PERPAN 1.

(3.) Diket:
$k_A = 20\ W/mK$. $h = 25\ W/m^2K$.
$k_C = 50\ W/mK$.
$L_A = 0{,}3\ m$
$L_B = L_C = 0{,}15\ m$
$T_{si} = 600^\circ C = 873\ K$
$T_{so} = 20^\circ C = 293\ K$
$T_\infty = 800^\circ C = 1073\ K$.



$h = 25\ W/m^2K$.

Ditanya :
a. Gambar thermal sirkuit
b. k_B.

Jawab :

a. T_∞ — T_{si} — T_1 — T_2 — T_{so}

$\frac{1}{hA}$ $\frac{L_A}{K_A \cdot A}$ $\frac{L_B}{K_B \cdot A}$ $\frac{L_C}{K_C \cdot A}$

b. $q'' = h(T_\infty - T_{si})$
$= 25\ W/m^2K\ (1073 - 873)\ K$.
$= 25\ W/m^2K \cdot 200\ K$.
$= 5000\ W/m^2$.

$$q'' = \frac{T_{si} - T_{so}}{\frac{X_A}{K_A} + \frac{X_B}{K_B} + \frac{X_C}{K_C}}$$

$$5000\ W/m^2 = \frac{(873 - 293)\ K}{\frac{0{,}3\ m}{20\ W/mK} + \frac{0{,}15\ m}{K_B} + \frac{0{,}15\ m}{50\ W/mK}}$$

$$5000\ W/m^2 = \frac{580\ K}{0{,}015\ m^2/W + \frac{0{,}15\ m}{K_B} + 0{,}003\ m^2/W}$$

$$5000\ W/m^2 = \frac{580}{0{,}018 + \frac{0{,}15}{K_B}}\ W/m^2$$ diatas yaa...

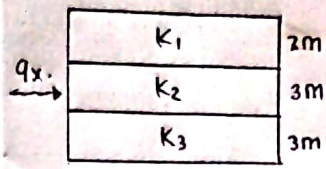
$$5000\left(0{,}018 + \frac{0{,}15}{K_B}\right) = 580$$

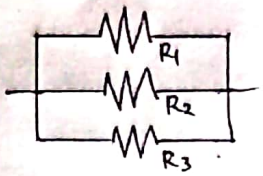
$$750 = 490\ K_B$$

$1{,}53\ W/mK = K_B$ //

(1) Diket :
$t = 9\ m$ $T_1 = 25^\circ C = 298\ K$.
$P = 10\ m$ $T_2 = 150^\circ C = 423\ K$.
$L = 3\ m$ $K_1 = 1{,}5\ W/mK$.
$K_2 = 1{,}6\ W/mK$
$K_3 = 1{,}3\ W/mK$.

Ditanya = q_x ?
Jawab :





$$\frac{1}{R_{tot}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R_{tot}} = \frac{1}{\frac{L}{K_1 A_1}} + \frac{1}{\frac{L}{K_2 A_2}} + \frac{1}{\frac{L}{K_3 A_3}}$$

$$R_{tot} = \left(\frac{K_1 A_1}{L} + \frac{K_2 A_2}{L} + \frac{K_3 A_3}{L}\right)^{-1}$$

$$R_{tot} = \left(\frac{1{,}5\ W/mK \cdot 9\ m^2}{10\ m} + \frac{1{,}6\ W/mK \cdot 9\ m^2}{10\ m} + \frac{1{,}3\ W/mK \cdot 9\ m^2}{10\ m}\right)^{-1}$$

$$= \left(\frac{13{,}5\ W/mK}{10\ m} + \frac{14{,}4\ W/mK}{10\ m} + \frac{11{,}7\ W/mK}{10\ m}\right)^{-1}$$

$$= (1{,}35\ W/K + 1{,}44\ W/K + 1{,}17\ W/K)^{-1}$$

$$= (3{,}96\ W/K)^{-1}$$

$R_{tot} = 0{,}2525\ K/W$

$$q_x = \frac{\Delta T}{R_{tot}} = \frac{(423 - 298)\ K}{0{,}2525\ K/W}$$

$$= \frac{125}{0{,}2525}\ W$$

$q_x = 495{,}05\ W$ //

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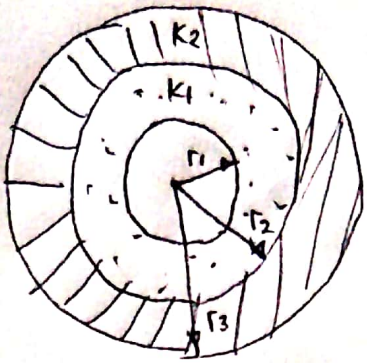
② Diket =

$k_1 = 385\ W/mK$.
$k_2 = 410\ W/mk$.
$r_1 = 7cm = 0{,}07\ m$
$r_2 = 14\ cm = 0{,}14\ m$.
$r_3 = 30\ cm = 0{,}3\ m$.
$T_3 = 170^\circ C = 443\ K$.
$q = 560\ W$.



Ditanya = T_1 ?

Jawab.

$$R_{total} = \frac{r_2 - r_1}{4\pi k_1 r_2 r_1} + \frac{r_3 - r_2}{4\pi k_2 r_3 r_2}$$

$$= \frac{0{,}14\ m - 0{,}007\ m}{4 \cdot 3{,}14 \cdot 385\ W/mK \cdot 0{,}14m \cdot 0{,}07m} + \frac{0{,}3\ m - 0{,}14\ m}{4 \cdot 3{,}14 \cdot 410\ W/mK \cdot 0{,}3\ m - 0{,}14\ m}$$

$$= \frac{0{,}07}{47{,}39\ W/K} + \frac{0{,}16}{203{,}1\ W/K}$$

$$= 0{,}0015\ K/W + 0{,}0008\ K/W$$

$$= 0{,}0023\ K/W$$

$$q_x = \frac{\Delta T}{R_{total}}$$

$$560\ W = \frac{T_1 - T_3}{0{,}0023\ K/W}$$

$$560 \cdot 0{,}0023\ K = T_1 - 443\ K$$

$$1{,}208\ K = T_1 - 443\ K$$

$$T_1 = 444{,}28\ K$$

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No.

Date :

3.) Diket : $L_A = 0{,}3\ m$ (x_a)

$L_B = L_C = 0{,}15\ m$ (x_b, x_c)

$k_A = 20\ W/mk$

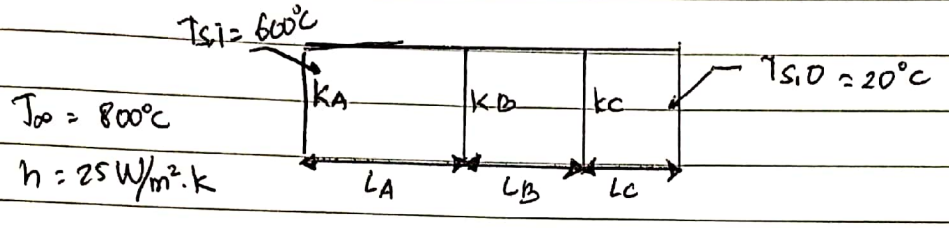
$k_C = 50\ W/mk$

$T_{s,i} = 600°C = 873\ k$

$T_\infty = 800°C = 1073k$

$T_{s,o} = 20°C = 293k$

$h = 25\ W/m^2k$



Ditanya = a.) Gambar thermal circuit untuk kondisi tsb ?

b.) k_B ?

Jawab = a.) T_∞ — T_{si} — T_1 — T_2 — T_{so} (kondisi steady)

$\frac{1}{h A}$ $\frac{x_A}{k_A A}$ $\frac{x_B}{k_B A}$ $\frac{x_C}{k_B A}$

b.) $q' = h\,(T_\infty - T_{s,i})$

$= 25 W/m^2k\ (1073 - 873)k$

$= 25 W/m^2k \cdot 200k$

$= 5000\ W/m^2$

$q' = \dfrac{T_{s,i} - T_{so}}{\frac{x_A}{k_A} + \frac{x_B}{k_B} + \frac{x_C}{k_B}}$

$5000\ W/m^2 = \dfrac{(873 - 293)k}{\frac{0{,}3m}{20 W/mk} + \frac{0{,}15m}{k_B} + \frac{0{,}5m}{50\ W/m.k}}$

$5000 W/m^2 = \dfrac{580\ W/m^2}{0{,}018 + \frac{0{,}15m}{k_B}}$

$5000\left(0{,}18 + \frac{0{,}15}{k_B}\right) = 580$

$90 + 750 = 580\ k_B$

$k_B = 1{,}53\ W/mk$

Dipindai dengan CamScanner

UAS PERPAN

Nama
No. Salsabila Mega F
Date : 18050524002
SI PTM

1.) Diket : $L = 10\ m$ $T_1 = 25°C = 298\ k$

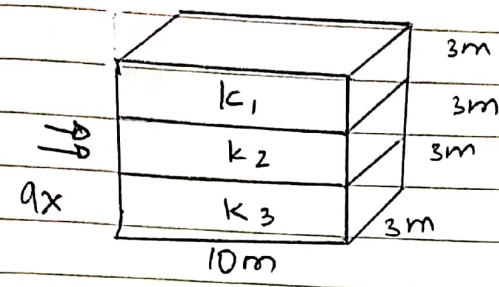
$t_1 = 3\ m$ $T_2 = 150°C = 423\ k$

$t_2 = 3\ m$ $k_1 = 1{,}5\ W/mk^2$

$t = 3\ m$ $k_2 = 1{,}6\ W/mk^2$

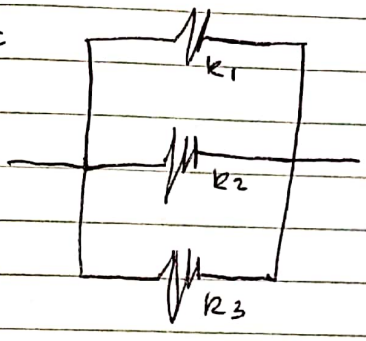
$k_3 = 1{,}3\ W/mk^2$

$T_1 = 298\ k$



Ditanya = q_x ?

Jawab :



$$\frac{T_1}{R_{tot}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R_{tot}} = \frac{1}{\frac{L}{k_1 A_1}} + \frac{1}{\frac{L}{k_2 A_2}} + \frac{1}{\frac{L}{k_3 A_3}}$$

$$k_{tot} = \left(\frac{k_1 A_1}{L} + \frac{k_2 A_2}{L} + \frac{k_3 A_3}{L}\right)^{-1}$$

$$k_{tot} = \left(\frac{1{,}5\ W/mk \cdot gm^2}{10\ m} + \frac{1{,}6\ W/mk \cdot gm^2}{10m} + \frac{1{,}3\ W/mk \cdot gm^2}{10m}\right)^{-1}$$

$$= \left(\frac{13{,}5\ W/k}{10} + \frac{14{,}4\ W/k}{10} + \frac{11{,}7\ W/k}{10}\right)^{-1}$$

$$= (1{,}35\ W/k + 1{,}44\ W/k + 1{,}17\ W/k)^{-1}$$

$$= (3{,}96\ W/k)^{-1}$$

$$= 0{,}25\ k/W$$

$$q_x = \frac{\Delta T}{R_{tot}}$$

$$= \frac{(423 - 298)\ K}{0{,}2525\ K/W}$$

$$= \frac{125\ W}{0{,}2525} = 495{,}05\ W$$

Dipindai dengan CamScanner

Date :

7.) Diket : $k_1 = 385\ W/m.k$ Ditanya : T_1 ?

$k_2 = 410\ W/m.k$

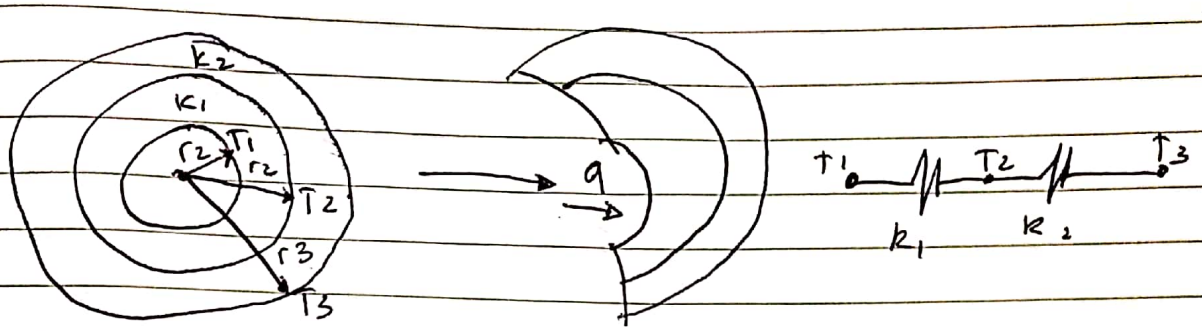
$r_1 = 7\ cm = 0,07\ m$

$r_2 = 14\ cm = 0,14\ m$

$r_3 = 30\ cm = 0,3\ m$

$T_3 = 170°C$

$q_x = 560\ W$



Jawab : $k_{tot} = \frac{r_2 - r_1}{4\pi k_1 r_2 r_1} + \frac{r_3 - r_2}{4\pi k_2 r_3 r_2}$

$= \frac{0,14\ m - 0,07\ m}{4 \cdot 3,14 \cdot 385\ W/m.k \cdot 0,14\ m \cdot 0,07\ m} + \frac{0,3\ m - 0,14\ m}{4 \cdot 3,14 \cdot 385\ W/m.k \cdot 0,3\ m \cdot 0,14\ m}$

$= \frac{0,07}{47,39\ W/k} + \frac{0,16}{203,1\ W/k}$

$= 0,0015\ K/W + 0,0008\ K/W$

$= 0,0023\ K/W$

$q_x = \frac{\Delta T}{k\ total}$

$560\ W = \frac{T_1 - T_3}{0,0023\ K/W}$

$560 \cdot 0,0023 = T_1 - 443\ K$

$1,288 = T_1 - 443\ K$

$T_1 = 444,288\ K$

Dipindai dengan CamScanner

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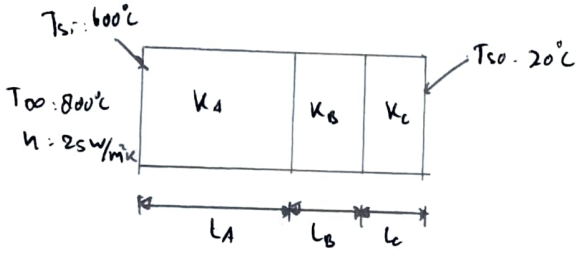
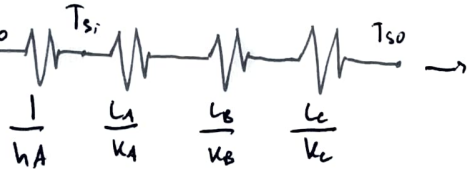
Prodi : Pend. Teknik Mesin
Mata Kuliah : Perpindahan Panas

3) Diket
L_A : 0,3 m
L_B : 0,5 L_A
: 0,5 (0,3)
: 0,15 m
T_{si} : 600°C : 873 K
T_∞ : 800°C : 1073 K
T_{so} : 20°C : 293 K
h : 25 W/m² K
k_A : 20 W/m K
k_C : 50 W/m K
L_C : L_B
: 0,15 m



Dit : a. gambar thermal circuit
b. k_B

Jawab : a. 

b. $q'' = h(T_\infty - T_{si})$
$= 25\ W/m^2K\ (1073 - 873)\ K$
$= 25\ W/m^2\ (200)$
$= 5000\ W/m^2$

$q'' = \dfrac{T_{si} - T_{so}}{\frac{L_A}{k_A} + \frac{L_B}{k_B} + \frac{L_C}{k_C}}$

$5000\ W/m^2 = \dfrac{(873 - 293)\ K}{\frac{0,3m}{20\ W/mK} + \frac{0,15m}{k_B} + \frac{0,15}{50\ W/mK}}$

$5000\ W/m^2 = \dfrac{580\ K}{0,015\ m^2K/W + \frac{0,15m}{k_B} + 0,003\ m^2K/W}$

$5000\ W/m^2 = \dfrac{580\ K}{0,018 + \frac{0,15m}{k_B}}\ W/m^2K$

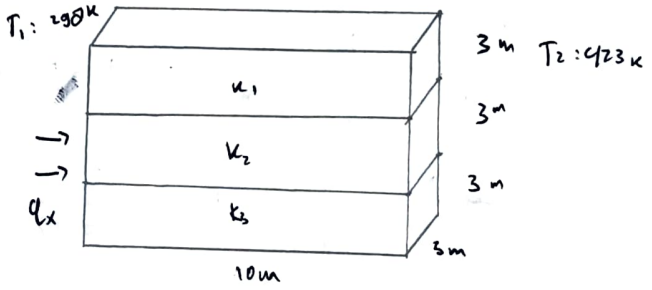
$5000\ W/m^2 \left(0,018 + \frac{0,15m}{k_B}\right) = 580\ W/m^2$

$90 + \frac{750}{k_B} = 580$

$750 = 490\ k_B$

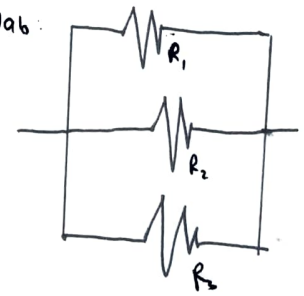
$1,53\ W/mK = k_B$

1) Diketahui
PL : 10m
t_1 : 3m
t_2 : 3m
t_3 : 3m
l : 3m
T_1 : 25°C : 298 K
T_2 : 150°C : 423 K
k_1 : 1,5 W/mK
k_2 : 1,6 W/mK
k_3 : 1,3 W/mK
$A_{1,2,3}$: 3m x 3m : 9m²



Dit : q_x ?

Jawab :



$\frac{1}{R_{tot}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

$\frac{1}{R_{tot}} = \frac{1}{\frac{L}{k_1A_1}} + \frac{1}{\frac{L}{k_2A_2}} + \frac{1}{\frac{L}{k_3A_3}}$

$R_{tot} = \left(\frac{k_1A_1}{L} + \frac{k_2A_2}{L} + \frac{k_3A_3}{L}\right)^{-1}$

$$R_{tot} = \left(\frac{1{,}5\ W/mK \cdot 9m^2}{10\ m} + \frac{1{,}6\ W/mK \cdot 9m^2}{10\ m} + \frac{1{,}3\ W/mK \cdot 9m^2}{10\ m} \right)^{-1}$$

$$= \left(\frac{13{,}5\ W/K}{10} + \frac{14{,}4\ W/K}{10} + \frac{11{,}7\ W/K}{10} \right)^{-1}$$

$$= \left(1{,}35\ W/K + 1{,}44\ W/K + 1{,}17\ W/K \right)^{-1}$$

$$= \left(3{,}96\ W/K \right)^{-1}$$

$$= 0{,}2525\ K/W$$

$$q_x = \frac{\Delta T}{R_{tot}}$$

$$= \frac{(423 - 298)\ K}{0{,}2525\ K/W}$$

$$q_x = \frac{125}{0{,}2525}\ W$$

$$= 495{,}05\ W$$

2) Diket:

$k_1 = 385\ W/mK$

$k_2 = 410\ W/mK$

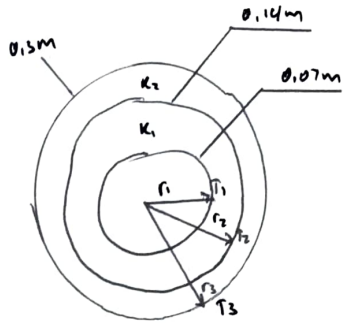
$r_1 = 7cm = 0{,}07\ m$

$r_2 = 14cm = 0{,}14\ m$

$r_3 = 30cm = 0{,}3\ m$

$q = 560\ W$

$T_3 = 170°C = 443\ K$



$$R_{tot} = \frac{r_2 - r_1}{4\pi k_1 r_2 r_1} + \frac{r_3 - r_2}{4\pi k_2 r_3 r_2}$$

$$= \frac{(0{,}14 - 0{,}07)\ m}{4 \cdot 3{,}14 \cdot 385\ W/mK \cdot 0{,}14\ m \cdot 0{,}07\ m} + \frac{(0{,}3 - 0{,}14)\ m}{4 \cdot 3{,}14 \cdot 410\ W/mK \cdot 0{,}3\ m \cdot 0{,}14\ m}$$

$$= \frac{0{,}07}{47{,}4\ W/K} + \frac{0{,}16}{216\ W/K}$$

$$= 0{,}00148\ K/W + 0{,}00074\ K/W$$

$$R_{tot} = 0{,}00222\ K/W$$

$$= 0{,}0023\ K/W$$

$$Q = \frac{\Delta T}{R_{tot}}$$

$$560\ W = \frac{T_1 - T_3}{0{,}0023\ K/W}$$

$$560 \cdot 0{,}0023\ K = T_1 - 443\ K$$

$$1{,}288\ K = T_1$$

$$T_1 = 444{,}288\ K$$

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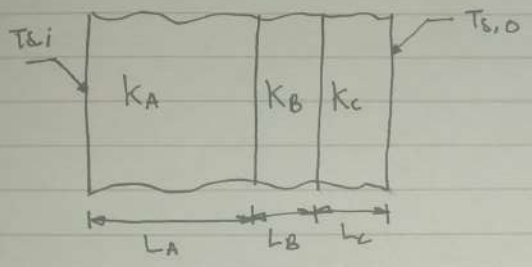
UAS

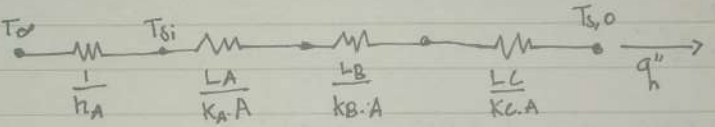
3. Diket : $L_A = 0{,}3$ m
$L_B = L_C = 0{,}15$ m
$k_A = 20$ W/m.K
$k_C = 50$ W/m.K
$T_{s,i} = 600°C = 873K$
$T_{s,o} = 20°C = 293K$
$T_\infty = 800°C = 1073K$
$h = 25$ W/m².K



Ditanya : a) Gambar thermal circuit ?
b) k_B ... ?

Asumsi : - kondisi steady state

Jawab : a)



b) $q''_h = h(T_\infty - T_{s,i})$
$= 25\ W/m^2.K\ (1073-873)K$
$= 25\ W/m^2K \cdot 200K$
$= 5000\ W/m^2$

$$q''_h = \frac{T_{s,i} - T_{s,o}}{\frac{L_A}{k_A} + \frac{L_B}{k_B} + \frac{L_C}{k_C}}$$

$$5000\ W/m^2 = \frac{(873-293)K}{\frac{0{,}3m}{20\ W/m.K} + \frac{0{,}15m}{k_B} + \frac{0{,}15m}{50\ W/m.K}}$$

$$500\ W/m^2 = \frac{580}{0{,}015\ m^2/W + \frac{0{,}15\ m}{k_B} + 0{,}003\ m^2/W}$$

$$500\ W/m^2 = \frac{580}{0{,}018 + \frac{0{,}15}{k_B}}\ W/m^2$$

$$500\left(0{,}08 + \frac{0{,}15}{k_B}\right) = 580$$

$$\Leftrightarrow 750 = 490\ k_B$$

$$k_B = 1{,}53\ W/m.K\ //$$

1. Diketahui : L = 10 m

$t_1 = t_2 = t_3 = 3m$

$A = 3m$

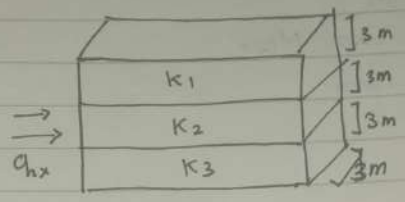
$T_1 = 25°C = 298\ K$

$T_2 = 150°C = 423\ K$

$K_1 = 1,5\ W/m.K^2$

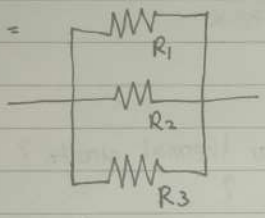
$K_2 = 1,6\ W/m.K^2$

$K_3 = 1,3\ W/m.K^2$



Ditanya = q_x ... ?

Jawab =



$$\frac{1}{R_{tot}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R_{tot}} = \frac{1}{\frac{L}{K_1A_1}} + \frac{1}{\frac{L}{K_2A_2}} + \frac{1}{\frac{L}{K_3A_3}}$$

$$R_{tot} = \left(\frac{K_1A_1 + K_2A_2 + K_3A_3}{L}\right)^{-1}$$

$$R_{tot} = \left(\frac{1,5\ W/m.K \cdot 9m^2 + 1,6\ W/m.K \cdot 9m^2 + 1,3\ W/m.K \cdot 9m^2}{10m}\right)^{-1}$$

$$= \left(\frac{13,5\ W/K + 14,9\ W/K + 11,7\ W/K}{10}\right)^{-1}$$

$$= (1,35\ W/K + 1,49\ W/K + 1,17\ W/K)^{-1}$$

$$= (3,96\ W/K)^{-1}$$

$$= 0,25\ K/W$$

$$q_x = \frac{\Delta T}{R_{tot}}$$

$$= \frac{(423 - 298)\ K}{0,2525\ K/W}$$

$$q_x = \frac{125}{0,2525}\ W$$

$$= 495,05\ W$$

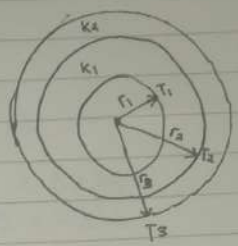
2. Diketahui : $k_1 = 385$ W/m.k $T_3 = 170°C = 443$ K

$k_2 = 410$ W/m.k $q_{hx} = 560$ W

$r_1 = 7$ cm $= 0,07$ m

$r_2 = 14$ cm $= 0,14$ m

$r_3 = 30$ cm $= 0,3$ m



Ditanya : T_1 ... ?

Jawab :

$$R_{total} = \frac{r_2 - r_1}{4\pi k_1 . r_2 . r_1} + \frac{r_3 - r_2}{4\pi . k_2 . r_3 . r_2}$$

$$= \frac{0,14m - 0,07m}{4 . 3,14 . 385 \text{ W/m.K} . 0,14m . 0,07m} + \frac{0,3m - 0,14m}{4 . 3,14 . 385 \text{ W/m.K} . 0,3m . 0,14m .}$$

$$= \frac{0,07}{47,39 \text{ W/K}} + \frac{0,16}{203,1 \text{ W/K}}$$

$$= 0,0015 \text{ K/W} + 0,0008 \text{ K/W}$$

$$= 0,0023 \text{ K/W}$$

$$q_{hx} = \frac{\Delta T}{R_{total}}$$

$$560 \text{ W} = \frac{T_1 - T_3}{0,0023 \text{ K/W}}$$

$$560 . 0,0023 = T_1 - 443 \text{ K}$$

$$1,288 = T_1 - 443 \text{ K}$$

$$T_1 = 444,288 \text{ K} //$$

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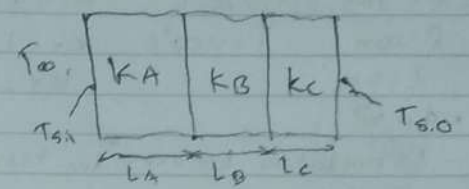
NIM : 1805052401 4
KELAS : PTM 18

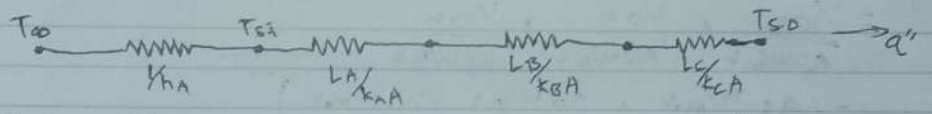
UAS PERPAN 1

3. Diket : $T_\infty = 800^\circ C$
$h = 25\ W/m^2 k$
$k_A = 20\ W/m.k$
$k_C = 50\ W/m.k$
$L_A = 0,30\ m$
$L_C = 0,15\ m$
$L_B = 0,15\ m$
$T_{s,0} = 20^\circ C$
$T_{s,1} = 600^\circ C$



Ditanya : a) gambar thermal circuit ?
b). k_B

a. Thermal circuit



b. $q'' = \dfrac{T_{s,1} - T_{s,0}}{\frac{L_A}{k_A} + \frac{L_B}{k_B} + \frac{L_C}{k_C}}$

$q'' = h(T_\infty - T_{s,1})$
$= 25\ W/m^2.k\ (800-600)^\circ C$
$= 5000\ W/m^2$

$5000\ W/m^2 = \dfrac{(600-20)^\circ C}{\frac{0,3\ m}{20\ W/m.k} + \frac{0,15\ m}{k_B\ W/m.k} + \frac{0,15\ m}{50\ W/m.k}}$

$5000\ W/m^2 = \dfrac{580}{0.018 + 0,15/k_B}\ W/m^2$

Subtitusi untuk fluks dari persamaan

$\dfrac{0,15}{k_B} = \dfrac{580}{q''} - 0,018$

$\dfrac{0,15}{k_B} = \dfrac{580}{5000} - 0,018$

$\dfrac{0,15}{k_B} = 0,098$

$k_B = 1,53\ W/m.k$

2. Diket : $k_1 = 385\ W/m.K$ $\quad T_3 = 170°C \rightarrow 443\ k$

$k_2 = 410\ W/m.k$ $\quad q = 560\ W$

$r_1 = 7cm \rightarrow 0,07m$

$r_2 = 14cm \rightarrow 0,14m$

$r_3 = 30cm \rightarrow 0,3m$



Ditanya : $T_1 = __ k$?

Jawab : $q = \frac{\Delta T}{R_{tot}} = \frac{T_1 - T_3}{R_1 + R_2 + R_3}$

$$q = \frac{T_1 - 443°K}{R_1 + R_2 + R_3}$$

$$560W\left(\left(\frac{r_2 - r_1}{4.\pi.k_1.r_2.r_1}\right) + \left(\frac{r_3 - r_2}{4.\pi.k_2.r_3.r_2}\right)\right) = T_1 - 443°K$$

$$560\,W\left(\left(\frac{0,14m - 0,07m}{4.3,14 \times 385\,W/mk.0,14m.0,07m}\right) + \left(\frac{0,3m - 0,14m}{4.3,14.410\,W/mk.0,3m.0,14m}\right)\right) = T_1 - 443k$$

$$560\,W\left(\left(\frac{0,07}{47,388\,W/k}\right) + \left(\frac{0,16}{216,293\,W/k}\right)\right) = T_1 - 443\,k$$

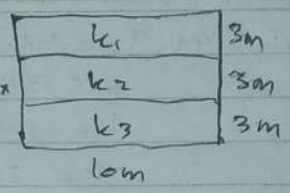
$$\frac{39,2°k}{47,388} + \frac{89\,k}{216,283} = T_1 - 443\,k$$

$$0,827°k + 0,411°k = T - 443\,k$$

$$1,238°k = T_1 - 443\,k$$

$$T_1 = 444,238\,k$$

1. Diket : t = 9m T_1 = 25°C k_1 = 1,5 w/m.k²
P = 10m T_2 = 150°C k_2 = 1,6 w/m.k²
l = 3m k_3 = 1,3 w/m.k²



Ditanya : q_x = ... ?

Jawab : - Perpindahan konveksi dan radiasi diabaikan

$$\frac{1}{\Sigma R_t} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$= \frac{1}{\frac{x_1}{k_1 \cdot A} + \frac{x_2}{k_2 \cdot A} + \frac{x_3}{k_3 \cdot A}}$$

$$= \frac{1}{\frac{10m}{1,5\,W/m.K\,(30m^2)} + \frac{10m}{1,6\,W/m.k\,(30m^2)} + \frac{10m}{1,3\,W/m.k\,(30m^2)}}$$

$$= \frac{1}{\frac{10m}{45\,W/m.k} + \frac{10m}{48\,W/m.k} + \frac{10m}{39\,W/m.k}}$$

$$= \left(\frac{45\,W/m.k}{10m} + \frac{48\,W/m.k}{10m} + \frac{39\,W/m.k}{10m} \right)^{-1}$$

$$= (4,5\,W/k + 4,8\,W/k + 3,9\,W/k)^{-1}$$

$$= (13,2\,W/k)^{-1}$$

$$\Sigma R_t = 0,07575\,W/k$$

$$q_x = \frac{\Delta T}{R_{tot}} = \frac{423°k - 298°k}{0,07575\,W/k}$$

$$= \frac{125°k}{0,07575\,W/k}$$

$$= 1650,165\,W$$