انتقال الحرارة ثرموديناميكا

Tanta University
Faculty of Engineering
Mechanical Power Engineering Department

First-Term Exam (2007/2008)
Third Year & **Heat Transfer**
Time Allowed **3 hrs**

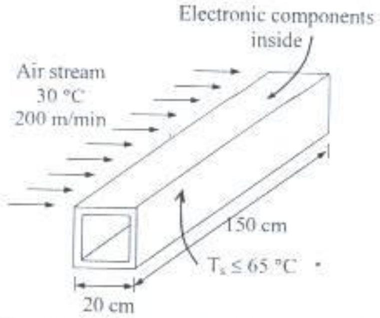
To the Exam Committee: Pleas allow the **Heat Transfer Tables** inside the exam theater.

Answer the following questions. "Neat and clear answers are appreciated"

Question No. 1:

a) What is the meaning of friction factor and how it can be related to the heat transfer coefficient in forced convection over flat plate.

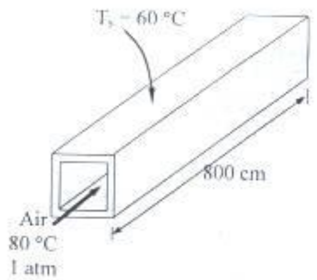
b) The components of an electronic system are mounted inside a 1.5 m long horizontal duct whose cross section is (20 cm × 20 cm). The components in the duct are not allowed to come into direct contact with air, and thus are cooled by air stream at 30 °C flowing over the outer surface of the duct with a velocity of 200 m/min. If the outer surface temperature of the duct is not to exceed 65 °C for safe operation of components, determine the total power rating of the electronic components that can be mounted into the duct.



Question No. 2:

a) What does the logarithmic mean temperature difference represent for flow in a tube whose surface temperature is constant?. Why do we use the logarithmic mean temperature instead of the arithmetic mean temperature?

b) Hot air at atmospheric pressure and 80 °C enters an 8 m long uninsulated square duct of internal cross section (20 cm × 20 cm) that passes through the attic space of a house at a rate of 0.15 m^3/s as shown. The duct is observed to be nearly isothermal at 60 °C. Determine the exit temperature of the air and the rate of heat loss from the duct to the attic space.



Question No. 3:

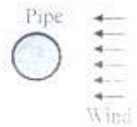
a) What is the Chimney effect? Deduce how is it physically generated.

b) Consider a 0.5 m × 0.7 m thin rectangular plate in a room of 25 °C. One side of the plate is maintained at a temperature of 90 °C, while the other side is insulated. What is the convection heat transfer rate from the plate for the following situations:
(1) plate is vertical, (2) plate is horizontal with the hot surface facing upward, (3) plate is horizontal with the hot surface facing downward.

Question No. 4:

a) What are the physical and mathematical meanings of Reynolds number, Grashof number and Prandtl number? Describe the effect of these numbers on the intensity of the convection heat transfer.

b) In a manufacturing facility, a horizontal circular pipe, 20 cm diameter and 4 m long, is used for transmitting a flow of melted Glycerin. The pipe is situated in a free space area, thus the pipe is usually under the effect of wind whose average velocity is 0.8 m/s, as shown in the figure. The outer surface temperature of the pipe is observed to be 172 °C while the ambient air condition is 25 °C. Determine the rate of heat energy dissipated from the pipe.



Question No. 5:

a) What is the heat exchangers and when it can be classified as being compact? Do you think a double pipe heat exchanger can be classified as a compact heat exchanger

b) What is the fouling effect and what are the common factors affecting the fouling process? How does fouling affect the overall heat transfer coefficient of a heat exchanger?

c) Do you advise to design heat exchangers with high values of NTU? Justify your answer and mention any limitation.

d) Hot oil is to be cooled by water in a one-shell pass and eight-tube passes heat exchanger. The tubes are thin walled and are made from copper with an internal diameter of 1.4 cm and have overall heat transfer coefficient of 310 W/m2 °C. The length of each tube pass is 5 m. Water flows through the tubes at a rate of 0.2 kg/s, and the oil through the shell at a rate of 0.3 kg/s. The water and the oil enter at temperatures of 20 °C and 150 °C, respectively. Determine the rate of heat transfer in the heat exchanger and the outlet temperatures of the water and the oil

Notes:

1) Specific heats of water and oil are 4.18 and 2.13 kJ/kg °C, respectively.

2) For one-shell pass and multiple tube passes:

$$\varepsilon = 2\left\{1+c-\sqrt{1-c^2}\,\frac{1+\exp\left[-NTU\sqrt{1+c^2}\right]}{1-\exp\left[-NTU\sqrt{1+c^2}\right]}\right\}^{-1}$$

Thermophysical properties of air at different temperatures.

T (°C)	ρ (kg/m³)	μ (kg/m s)	K (W/m °C)	C_p (J/k °C)	Pr
15	1.224	1.802×10^{-5}	0.02476	1006	0.7323
20	1.204	1.825×10^{-5}	0.02514	1007	0.7309
25	1.184	1.849×10^{-5}	0.02551	1007	0.7296
30	1.164	1.872×10^{-5}	0.02588	1007	0.7282
35	1.145	1.895×10^{-5}	0.02625	1007	0.7268
40	1.127	1.918×10^{-5}	0.02662	1007	0.7255
45	1.109	1.941×10^{-5}	0.02699	1007	0.7241
50	1.092	1.963×10^{-5}	0.02735	1007	0.7228
60	1.059	2.008×10^{-5}	0.02808	1007	0.7202
70	1.028	2.052×10^{-5}	0.02881	1007	0.7177
80	0.9994	2.096×10^{-5}	0.02953	1008	0.7154
90	0.9718	2.138×10^{-5}	0.03024	1008	0.7132
100	0.9458	2.181×10^{-5}	0.03095	1009	0.7111
120	0.8977	2.264×10^{-5}	0.03235	1011	0.7073

With best wishes, *Dr. Kh. khodary*

جامعة طنطا
كلية الهندسة

امتحان الفصل الدراسي الأول
العام 2007/2008
يناير 2008

الفرقة: الثالثة ميكانيكا قوى
(لائحة جديدة / لائحة قديمة)
المادة: محركات حرارية (2)
الزمن: ثلاث ساعات

أجب عن الأسئلة الآتية :-

استخدم الرسم كلما أمكن ذلك

السؤال الأول

أ- اشرح بالتفصيل مع الرسم كيف تؤثر العوامل الآتية على أداء كل من محرك البنزين والديزل :-
نسبة الخليط - توقيت الصمامات - توقيت الاشتعال والحقن - غرفة الاحتراق

ب- اشرح العوامل التي تؤثر على القدرة القصوى للمحرك؟

ج- اشرح مع الرسم مراحل الاحتراق في كل من محرك البنزين والديزل؟

د- اشرح مع الرسم طبيعة الدق والفرق بينهما في كل من محرك البنزين والديزل؟ ثم اذكر الآثار الضارة للدق بالمحرك؟

السؤال الثاني

أ- اشرح مع الرسم قطاع ذا اسطوانة 1- محرك رباعي الأشواط 2- محرك ثنائي الأشواط

ب- عرف ما يلي :-
نسبة الانضغاط - درجة الامتلاء - CC - القدرة الفرملية - S.F.C.

ج- اشرح مع الرسم التصميمات المختلفة لترتيب الاسطوانات في محركات الاحتراق الداخلي

د- اشرح المنظومات المختلفة لتغذية الوقود لمحركات البنزين والديزل؟

السؤال الثالث

أ- اذكر سبعة فروق بين محرك البنزين والديزل؟

ب- اشرح الأنواع المختلفة للفرامل (الداينامومتر) المستخدمة لقياس قدرة المحرك؟

ج- اشرح صيانة واختبار دورة التبريد بالمحرك؟

د- اشرح كيف يمكن حساب زمن مرور جبهة اللهب في غرفة الاحتراق وبالتالي تحديد توقيت الشرارة

هـ- اشرح بالتفصيل كيف تؤثر العوامل الآتية على الدق في محرك البنزين :-
نسبة الهواء/الوقود - توقيت الاشتعال - وضع الخانق المغذي - حركة الخليط

و- اشرح بالتفصيل كيف تؤثر العوامل الآتية على الدق في محرك الديزل :-
رقم السيتان للوقود - معدل الحقن - درجة حرارة وضغط الهواء - حركة الهواء/الوقود

السؤال الرابع

١- اشرح مع الرسم والتفصيل تجربة عملية لتقييم أداء محرك احتراق داخلي إشعال بالشرارة؟

٢- محرك احتراق داخلي إشعال بالضغط ثنائي الأشواط ذو ستة أسطوانات قطر أسطوانته 110 مم وطول الشوط 120 مم أجريت له تجربة عملية وأخذت له القراءات الآتية :-

- عند سرعة دوران المحرك 2700 لفة في الدقيقة.
- تصرف الوقود 0.65 كجم في زمن 40 ثانية
- تصرف ماء التبريد 300 لتر في زمن قدره 50 ثانية
- الارتفاع في درجة حرارة ماء التبريد 10 °م
- ضغط الضغط عبر فوهة صندوق الهواء لقياس معدل تصرف الهواء للمحرك 35 سم ماء.
- قطر فوهة صندوق الهواء تساوي 7.5 سم.
- معامل تصرف الهواء عبر الفوهة 0.65
- الحمل على الفرملة عند تشغيل جميع الأسطوانات 80 كجم
- عند قطع الحريق عن أحد الأسطوانات أصبح الحمل على الفرملة 61 كجم عند السرعة المذكورة.
- درجة حرارة غازات العادم 550 °م.

المطلوب :-

- حساب الموازنة الحرارية للمحرك (KW).
- رسم العلاقة بين القدرة الفعالة للمحرك وكلا من الكفاءة الحرارية والكفاءة الميكانيكية عند السرعة المذكورة.

$$\text{القدرة الفعالة } (KW) = \frac{\text{الحمل على الفرملة (كجم)} \times \text{سرعة دوران المحرك}}{1000}$$

مع التمنيات الطيبة بالنجاح

د/ الشاذلي عبد الجبار الشاذلي

ميكانيكا موائع - ميكانيكا قوى

TANTA UNIVERSITY
FACULTY OF ENGINEERING
MECH. POWER DEPART.
THIRD YEAR

FLUID MECHANICS EXAM.
Winter Semester 2007/2008
Time allowed: 3 hours

Please, answer all the following questions:

1) Give a scientific expression for each of the following statements:

1.1) *The ratio of the kinematic viscosity to the thermal diffusivity.*

1.2) *The ratio of the inertia force to the viscous force.*

1.3) *The ratio of the flow velocity to the sonic speed.*

1.4) *The sum of the deformation drag and the form drag.*

1.5) *The sudden rise in pressure of water flowing in a pipe that creates knocking (noise) due to sudden closure of a valve.*

1.6) *The flow region near the solid wall where the effect of viscosity is observed.*

1.7) *The ratio of the flow area to the wetted perimeter in a flow channel.*

1.8) *The line describing the sum of the pressure head and the velocity head of a liquid flowing in a pipe.*

1.9) *The ratio of the velocity head at the outlet of the nozzle to the hydraulic head at the inlet of the pipe.*

1.10) *The region of low pressure due to separation of flow on the downstream side of immersed bodies where the velocity is generally the highest.*

1.11) *The ratio of the shear stress at the wall of a flow channel to the dynamic pressure.*

1.12) *The dimensionless pressure gradient in the axial direction of one-dimensional pipe flow.*

1.13) *Fully-developed, one-dimensional, laminar flow without body forces in a long straight pipe.*

1.14) *Fully-developed, one-dimensional, laminar flow without body forces between two stationary parallel flat plates.*

1.15) *Fully-developed, one-dimensional, laminar flow without body forces between two parallel flat plates, one of which is at rest and the other is moving parallel to the fixed plate.*

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2) *Water is being discharged, from a reservoir, through a pipe 4 km long and of 50 cm diameter to another reservoir having water level 12.5 m below the first reservoir. It is required to feed a third reservoir, whose water level is 15 m below the first reservoir, through a pipe line 1.5 km long to be connected to the pipe at a distance of 1 km from its entrance. Find the diameter of this new pipe, so that the flow into both the reservoirs may be the same. Assume f for all the pipes as 0.032.*

3.1) *Find an expression for calculating the time of flow from one reservoir into another reservoir through a long pipe.*

3.2) *Two tanks of 8 m and 3 m diameters are connected by a 300 m long and 25 cm diameter pipe. The level of water in the bigger tank is 10 m higher than that in the smaller tank. Determine the time taken to flow 18000 liters of water. Take the Darcy-Weissbach friction coefficient for the pipe to be 0.015.*

3.3) *Water flows through a pipe line 1.5 km long, 15 cm diameter and 5 mm thick with a velocity of 3 m/s. Determine the increase in pressure when a valve at the outlet section of the pipe line is suddenly closed. Find also the time taken by the pressure wave to return at the valve end after the valve is closed. Take the Bulk's modulus of elasticity of water as* $\mathbf{2.1\times10^{9}}$ ***Pa****, and the Young's modulus of elasticity of the pipe material is equal to* $\mathbf{21\times10^{10}}$ ***Pa****.*

4.1) *Specify the dimensionless parameters that control the coefficients of drag and lift.*

4.2) *A flat plate 1.1 m × 1.1 m moves at a velocity of 50 km/hr in a stationary air of a specific weight 11.28 N/m*^{3}*. If the lift and drag coefficients are 0.7 and 0.18 respectively, determine*

a) the lift force, *b) the drag force,*
c) the resultant force, *d) the h.p. required to keep the plate in motion.*

5) *For the steady laminar flow of viscous incompressible fluid in a circular tube, the Navier-Stokes equations combined with the continuity equation are reduced to*

$$d^2w/dr^2+(1/r)(dw/dr) = (1/\mu)(dp/dz)$$

where w = w (r) is the flow velocity component in z-direction that is a function of r only.

Find relations for the followings:

a) velocity distribution, *b) maximum velocity,* *c) average velocity,*
d) wall shear stress, *e) skin friction coefficient.* *f) Darcy friction coef.*

with the best wishes

جامعة طنطا – كلية الهندسة
امتحان الفصل الدراسي الأول
٢٠٠٨/٢٠٠٧

السنة الدراسية : الثالثة ميكانيكا قوى
المادة : محطات قوى
الزمن : ٣ ساعات

Answer the following questions:-

The first question :

(a) How is the utilization factor ε_u for cogeneration plants defined?

(b) Steam enters the turbine of a cogeneration plant at 7 Mpa and 500 °C. One- fourth of the steam is extracted from the turbine at 600 kpa pressure for process heating. The remaining steam continues to expand to 10 kpa. The extracted steam is then condensed and mixed with feed water at constant pressure and the mixture is pumped to the boiler pressure at 7 Mpa. The mass flow rate of steam through the boiler is 30 kg/s. Disregarding any pressure drops and heat losses in the piping, and assuming the turbine and the pump to be isentropic, determine the net power produced and the utilization factor of the plant.

The second question :

(a) What are the characteristics of a working fluid most suitable for vapor power cycle?

(b) A combined gas-steam power plant that has a net power output of 450 MW. The pressure ratio of the gas-turbine cycle is 14. Air enters the compressor at 300 K and the turbine at 1400 K. The combustion gases leaving the gas turbine are used to heat the steam at 8 Mpa to 400 °C in a heat exchanger. The combustion gases leave the heat exchanger at 460 K. An open feed water heater incorporated with the steam cycle operates at a pressure of 0.6 Mpa. The condenser pressure is 20 kpa. Assuming all the compression and expansion processes to be isentropic, determine (a) the mass flow rate of air to steam, (b) the required rate of heat input in the combustion chamber, and (c) the thermal efficiency of the combined cycle.

The third question :

(a) Show that the thermal efficiency of a combined gas-steam power plant η_{cc} can be expressed as $\eta_{cc} = \eta_g + \eta_s - \eta_g \eta_s$ where: $\eta_g = w_g/Q_{in}$ and $\eta_s = w_s/Q_{g,out}$ are the thermal efficiency of the gas and steam cycles, respectively. Then prove that the value of η_{cc} is greater than either of η_g or η_s.

(b) Steam at a pressure of 20 bar and a temperature of 240 °C expands isentropically through a convergent-divergent nozzle to a pressure of 3bar. Calculate the steam mass flow rate per square meter of the nozzle exit section a- Assuming equilibrium expansion. b- Supersaturation expansion.

The fourth question :

(a) What is the difference between impulse turbine and reaction turbine?

(b) The blades of an impulse turbine stage have equal tip angles of 35°. The nozzles are inclined at 22° to the plane of rotation. The velocity of steam at the nozzles exit is 660 m/s. The turbine develops 2000 hp. If the steam enters the blades without shock, and the friction reduces the relative velocity of steam by 15% in passing through the blades determine:

a- The stage work per kg/s of steam. b- The blade efficiency.

c- The steam flow rate. d- Axial thrust.

The fifth question :

In an axial flow compressor with a pressure ratio of 6, the inlet air temperature is 20 °C. The mean blade velocity is 200 m/s, and the blade angles at inlet and exit are 45° and 15° respectively. The degree of reaction is 50% the work done factor is 0.86 and the number of stages is 12. considering the axial velocity to be constant during the flow of air through the compressor.

a- Obtain the work done and the rise in total temperature of the air.

b- Determine the isentropic efficiency of the compressor.

The sixth question :

(a) What is the meaning of:

Temperature drop coefficient – Degree of reaction – Flow coefficient

(b) In an axial flow turbine, the flow rate of gases is 20 kg/s, and the axial velocity is constant through a certain stage. The following data have been recorded at the mean diameter: Axial velocity 260 m/s Blade speed 360 m/s

Inlet angle of gases to the moving blades 65°

Exit angle of gases from the moving blades 10°

a- Find the angles of the moving blades.

b- Calculate the degree of reaction.

c- Determine the temperature drop coefficient.

d- Determine the power output from this stage.

ميكانيكا قوى

University of Tanta *College of Engineering* *Mech. Power Eng. Dept.*	**Final Exam** January 2008	*Subject:* ***Refrigeration*** *Students:* ***3rd year Power Mech.*** *Time allowed:* ***3 hours***

- *ONLY tables of refrigeration and air conditioning are allowed (available with students).*
- *Answer ALL questions and assume any missing data and assumptions.*

1. Compare the COP of the standard vapor compression cycle operating between 263 K and 313 K when using R-12, R-22, R-134a or R717 as refrigerants in the following cases:

a) For a simple vapor compression cycle.

b) If the refrigerant leaves evaporator with 10 K superheat and no subcooling in condenser.

c) If the refrigerant leaves condenser with 10 K subcooling and no superheating in evaporator.

2. a) Compare between the aqua-ammonia and lithium bromide-water absorption cycles.

d) Air conditioning is one application of refrigeration. Explain what is meant by air conditioning and show with the aid of sketches and example of using refrigeration in air conditioning.

3. The following data are known for an aqua-ammonia absorption refrigeration system. The system utilizes liquid-to-suction heat exchanger (precooler) and a heat exchanger between the absorber and generator (preheater). Condensing pressure is 1.5 MPa and evaporating pressure is 150 kPa. Generator temperature is 105°C, temperature of strong solution entering rectifying column is 95°C, temperature of liquid leaving condenser is reduced 7°C in the preheater. Assume saturated conditions for the state points:

solution leaving absorber, strong solution leaving preheater,
weak solution leaving generator, ammonia vapor leaving dephlegmator,
ammonia leaving condenser, and ammonia entering absorber.

System capacity is 100 TR. Draw the flow diagram and h-x chart of the system. Neglect all pressure drops in lines and components and determine:

a) The thermodynamic properties of all state points of the cycle.

b) Mass flow rates of all parts of the system.

c) COP and refrigerating efficiency of this cycle.

4. A three-store vapor compression plant uses R-134a as a refrigerant and has evaporation temperatures of 273 K, 263 K and 248 K with cooling loads 50, 40 and 20 TR, respectively. Condensing temperature is 313 K. The system utilizes multiple expansions with flash tanks and multiple compressions. The system utilizes a liquid-to-suction heat exchanger after the intermediate store at 263 K and affects the liquid line with 10 K subcooling. Compressions begin with superheated vapor with 7 K superheat due to line losses. Assume 60 kPa pressure drop in each discharge valve and 30 kPa pressure drop in each suction valve. Assume 100 kPa pressure drop in the condenser and 50 kPa in each evaporator. Determine the work done required for each compressor and the COP of the cycle. Compare with the COP of a simple cycle with all cooling loads served at a single evaporator at a temperature of 248 K.

5. a) Explain with the aid of sketches and charts why should a liquid-to-suction heat exchanger be used in the mechanical vapor compression refrigeration cycle and sketch two different physical arrangement that may be used for this heat exchanger.

b) An aircraft refrigeration cycle is used to maintain a cabinet at 24°C and 90 kPa. The aircraft flies at a constant speed of 720 km/h at a temperature of −20 °C and 76 kPa outside conditions. The cabinet has a cooling capacity of 20 TR. The compressor has a compression ratio of 6 and an efficiency of 93% and that of the cooling turbine is 88%. The turbine supplies 5 kg/s of air into the cabinet. Assume that density of air varies with pressure and temperature, and that density of air entering compressor is 0.76 kg/m3. Neglect all other losses and assume that turbine work is delivered to the compressor. Draw the cycle flow diagram and T-s diagram and determine the turbine work, compressor work, heat rejected and the COP of the cycle.

With best wishes ,,, ***Dr. Alsaied Khalil***