جامعة طنطا
القسم : هندسة القوى الميكانيكية
إمتحان نهاية الفصل الدراسى الثانى 2023/2022
الدرجة النهائية : 75 درجة
كلية الهندسة

| | | |
|---|---|---|
| المادة: محركات حرارية (ب) | كود المقرر: MEP3209 | الفرقة: الثالثة ميكانيكا قوى |
| تاريخ الإمتحان: الأحد 2023/6/11 | زمن الإمتحان: 3 ساعات | عدد صفحات الإمتحان: ورقة واحدة بوجهين |

**إستخدم الرسم كلما أمكن وإفترض أي بيانات ناقصة للحل**

**السؤال الأول :- ( 15 درجة )**

أ) إشرح مع الرسم حلقة استهلاك الوقود؟ موضحا بجدول تأثير قوة الخليط على غاز العادم؟

ب) أذكر متطلبات محرك الاشعال بالشرارة التي يجب أن يوفرها جهاز تحضير الخليط (سواء خلاط أو حقن)؟ ولماذا لا يفى الخلاط البسيط بهذه المتطلبات؟ ثم أذكر التعديلات التصميمية للمكربن البسيط حتى يفى بتلك المتطلبات؟

ج) من خلال دراستك لمادة محركات الإحتراق الداخلى افترض قيم نمطية لما يلى :

- متطلبات الخليط ( قيمة $A/F$ ) فى حالات التشغيل الرئيسية المستقرة لمحرك بنزين
- الخلوص بين كباس وحوض المضخة المستقيمة - قطر الخانق وقطر فوهة الوقود فى الخلاط
- قيم ضغط الحقن فى محركات الديزل ذات غرف الإحتراق المفتوحة والمسبقة - فرق الضغط عند الخانق في الخلاط

**السؤال الثانى : ( 25 درجة )**

أ) يريد سائق شاحنة ديزل أن يصعد مرتفع عن طريق الضغط على دواسة الوقود, وضح بالرسم مراحل حركة كباس مضخة الحقن لتغير الحمل إذا كان إمداد الوقود إلى المحرك يتم عن طريق : 1- مضخة مستقيمة 2- مضخة دائرية

ب) إشرح مع الرسم كيف يمكن التغلب على مشكلة بدء الإدارة على البارد عند إستخدام كل من :

- مكربنة سولكس - محرك حقن بنزين طراز *KE-Jetronic*

ج) إشرح مع الرسم كل من:

- منحنى معدّل ضغط الوقود (Fuel accumulator) بعد إيقاف محرك حقن بنزين طراز *K-Jetronic*
- منحنى معدّل الإشعال (Combustion Rate) في كل من محركى البنزين والديزل
- علاقة تأخير الاشتعال والسرعة في محرك الديزل

**السؤال الثالث :- ( 15 درجة )**

أ) يستخدم الضغط في ماسورة سحب الهواء إلى محرك الاشعال بالشرارة بعد صمام الخنق في زيادة نسبة الوقود في الخليط عند فتحات خانق كبيرة. إشرح منظومة الحمل الكامل في نظام *K-Jetronic* التي تستخدم هذا الأسلوب في التحكم ؟

ب) أذكر تأثير العوامل الآتية على آداء رشاش الحقن فى محرك الديزل:

- تكون الرش - إتجاه الرش

ج) أذكر متطلبات منظومة حقن الديزل؟ ثم اشرح مع الرسم أنواع منافث الحقن المختلفة ونوع غرف الاحتراق المناسبة لكل نوع؟

**السؤال الرابع :- ( 20 درجة )**

أ) اشتق تعبير نسبة الهواء / الوقود فى المكربن عند أخذ قابلية الانضغاط بنظر الاعتبار ؟

ب) محرك احتراق داخلى إشعال بالشرارة رباعى الأشواط ذو ستة إسطوانات، قطر إسطوانته 90 مم، وطول شوط مكبسه 100 مم، سرعة دوران المحرك 3000 لفة / دقيقة، يراد اختيار خلاط لهذا المحرك يستخدم نظام حوض الموازنة لتعديل آداء الخلاط ونافورة الوقود لنظام الحمل الكامل على التوازى وذلك ليناسب آداء المحرك عند ظروف التشغيل الآتية:

أولا: عند فتحة خانق جزئية:

- معامل الهواء الزائد $\alpha = 1.185$ , المعدل النوعى لإستهلاك الوقود = 280 جم/كوات ساعة , والقدرة الفرملية 40 كوات

ثانيا: عند فتحة خانق كاملة:

- المعدل النوعى لإستهلاك الوقود 320 جم/ كوات ساعة , والقدرة الفرملية 70 كوات , والكفاءة الحجمية 0.8 محسوبة عند الظروف 1 بار و 30° م

إتخذ : - كثافة الوقود المستخدم 730 كجم/م$^3$ , معامل تصرف الهواء عند عنق الخلاط 0.8

معامل تصرف الوقود فى فوهات وقود الخلاط 0.9 , إرتفاع الوقود فى غرفة العوامة 5 سم ,

شفة المنفث 2 مم , قطر فوهة وقود الخلاط الرئيسى 1 مم

الصيغة الكيميائية للوقود $C_8H_{18}$ , أكبر سرعة لسريان الهواء فى الخلاط 100 م / ث

إحسب:

أ- قطر عنق الخلاط (سم)

ب- قطر فوهة وقود حوض الموازنة (مم)

جـ- قطر فوهة نظام الحمل الكامل (مم)

د- معامل الهواء الزائد عند الحمل الكامل

**إنتهت الأسئلة**

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**مع أطيب الأمنيات بالنجاح والتوفيق**

**أ.د/ الشناوى عبد الحميد الشناوى**

الإجابة بالقلم الأزرق أو الأسمر أو الرصاص
لا تضع أي علامات مميزة في كراسة الإجابة

**Mechanical Power Engineering Department**
**Faculty of Engineering**
**Tanta University**

| | | |
|---|---|---|
| Final Exam | Course Title: Thermal Power Stations | 3rd Year |
| Course Code: MEP 3214 | | No of Pages: 2 |
| Date: 18th June 2023 | Full Marks: 85 | Allowed time: 3 hours |

**Request from the Exam Committee:** Students **are allowed** to use their steam chart and tables; however, students **are not allowed** to write in or **exchange** these materials.
**Notes for Students:** Answer **all questions**. **Neat and clear** answers will be appreciated.

**Question No. 1 (25 Marks):**

1.1) Give the scientific expression of the following statements:
a) The generated power from 1 kg/s of air flow in the power station.
b) The rate of fuel consumed for producing a power of 1 kw from the turbine.
c) It is used to describe the elemental efficiency of a differential stage in a process.
d) A method used mainly to decrease the fuel consumption in the gas turbine power station.
e) A method applied for increasing the power of the turbine through increasing the mass flow rate expanded inside it.

1.2) An open simple gas turbine power plant is coupled to an electrical generator and uses 22.8 kg/s air. The pressure ratio is 4.2. Maximum and minimum cycle temperatures are 714 °C and 27 °C respectively. The compressor isentropic efficiency is 80% and the turbine polytrophic efficiency is 84.5%. Mechanical and generator efficiencies are 90% and 98% respectively.
a) Draw the layout diagram of the gas turbine considered,
b) Represent the cycle on the T-S diagram,
c) Calculate the cycle efficiency,
d) Determine the isentropic efficiency of the turbine,
e) Find the output power in kw,
f) Calculate the S.F.C, assuming the combustion chamber efficiency to be 86.7% and the C.V of the fuel used is 42000 kJ/kg,
g) What will be the cycle efficiency with 75% regenerator effectiveness.

**Question No. 2 (25 Marks):**

2.1) Assign if the statement is correct or incorrect. Give reasons for your answers:
a) In a simple ideal gas turbine power plant, the optimum pressure ratio for maximum output power depends on the type of the working fluid, while the corresponding cycle efficiency is absolutely independent of the operating medium.
b) The specific heat ratio of monoatomic gases is lower than that for diatomic gases.

2.2) A regenerator is to be designed for an open cycle gas turbine set consisting of a two-stage compressor with inter-cooling and a two-stage turbine with re-heating. The turbine stages are mechanically independent. The H.P.T. drives the compressor, while the L.P.T. provides the power output. Assuming the following data apply at the design operating conditions, estimate the required thermal ratio of the heat exchanger and the allowable gas-side pressure loss, if the unit is to have a specific output of 178 h.p. per kg of air per second and thermal efficiency of 30%.

- Pressure ratio in each compressor stage = 2.5.
- Isentropic efficiency of each compressor stage = 85%.
- Isentropic efficiency of each turbine stage = 85%.
- Pressure loss in the air-side of the heat exchanger and the combustion chamber = 0.275 bar.
- Pressure loss in re-heating combustion chamber = 0.136 bar.
- Pressure loss in the inter-cooling = 0.068 bar.
- Temperature at inlet to both turbines = 1000 k.
- Temperature after inter-cooling = 300 k.
- Ambient temperature = 286 K.
- Ambient pressure = 1 bar.
- The alternation in mass flow rate due to fuel addition is to be neglected. Take for air $c_p = 1.005$ kJ/kg.k and $\gamma = 1.4$.

**Question No. 3 (19 Marks):**

3.1) State three benefits of the reheating process in steam power stations?

3.2) In a regenerative plant, initial steam conditions are 28 bar and 400 °C. Exhaust pressure is 25 mm Hg abs. And the dryness fraction is 90%. Steam is bled for heating the feed water at two points such that the enthalpy drop is divided equally before first extraction, between bleeding points and after second extraction. The condensate from each heater is pumped into the feed line on its boiler side. Assuming a straight-line expansion in the turbine and ideal conditions at each heater exit, determine the bleeding pressure, the thermal efficiency, and the turbine internal efficiency.

**Question No. 4 (16 Marks):**

4.1) For a simple and ideal Brayton cycle, draw the T-S diagram and then drive a relation of the optimum pressure ratio for maximum output power.

4.2) Drive a relation between the isentropic efficiency and the infinitesimal efficiency for a compressor; support the answer with T-S drawings.

*End of the questions*

*Best of Luck*

*Dr. Farid Hammad*

TANTA UNIVERSITY
FACULTY of ENGINEERING
DEPARTMENT OF ELECTRICAL POWER AND MACHINES ENGINEERING
EXAMINATION (THIRD YEAR) STUDENTS OF MECHANICAL ENGINEERING

| | | | |
|---|---|---|---|
| COURSE TITLE: ELECTRICAL POWER | | | COURSE CODE: MPD3248 |
| DATE: 21/6/2023 | TERM: SECOND | TOTAL ASSESSMENT MARKS: 85 | TIME ALLOWED: 3 HOURS |

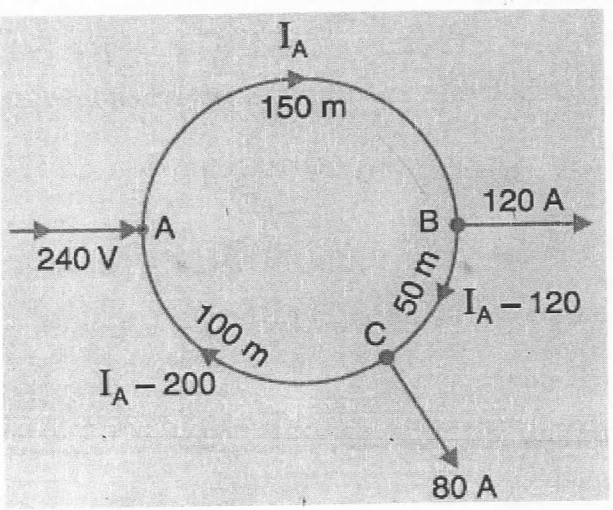
*Notes: Assume any missing data – Answer as many questions as you can.* الامتحان مكون من 3 أسئلة

**Q1:** **(40 marks)**

**1-a)** A 2-wire DC ring distributor is 300 m long and is fed at 240 V at point A. At point B, 150 m from A, a load of 120 A is taken and at C, 100 m in the opposite direction, a load of 80A is taken. If the resistance per 100 m of single conductor is 0.03 Ω, find:

(i) current in each section of distributor

(ii) voltage at points B and C (10 Marks)




**1-b)** Compare between 3-wire and 2-wire DC distribution systems? (10 Marks)

**1-c)** A 2-wire DC street mains AB, 600 m long is feed from both ends at 220V. Loads of 20A, 40A, 50A and 30A are tapped at distances of 100m, 250m, 400m and 500m from the end A respectively. If the cross-section area of distributer conductor is 1cm$^2$, find the minimum consumer voltage take. $\rho = 1{\cdot}7 \times 10^{-6}$ Ω cm. (10 Marks)

**1-d)** Define with writing equations Reserve power, Capacity factor, Diversity factor and Load factor? (10 Marks)

**Q2:** **(25 Marks)**

A. Define the following:

1- Sag 2- span 3- Break down voltage.

B. A string insulator has 3 units, and each unit has a safe working voltage of 15 kV. Find the maximum line voltage on which it can be operated safely and find the string efficiency. The ratio between the capacitance between each unit and capacitance between each unit and earth is 10:1.

**Q3:** **(20 Marks)**

A. Explain using phasor diagram the Ferranti effect for π representation.

B. A 30 MW and 0.95 lagging power factor balanced load receives power through 100 km long three-phase 50 Hz transmission lines. The load terminal line voltage is 66 kV. The transmission line parameters per phase are $R = 0.2\ \Omega$/km, $X_L = 0.5\ \Omega$/km and $Y = 0.06\times10^{-4}\ \Omega^{-1}$/km. Calculate the following: Consider the nominal T-model

1) Sending end voltage
2) Voltage regulation
3) Transmission efficiency.
4) Draw phasor diagram for this load.

**Good Luck**

**Course Examination Committee:**

**Asso. Prof. Doaa Moktar** **Assoc. Prof. Samir Dawoud**

section with a constant cross sectional area of 0.8 $m^2$. The throat and exit cross-sectional areas of the diffuser are 0.65 $m^2$ and 1.0 $m^2$, respectively. Determine:

A) the maximum possible Mach number at the test section,
B) the minimum allowable diffuser throat cross-sectional area,
C) whether or not a supersonic flow can be obtained at the test section,
D) the back pressure for the worst operating condition,
E) the back pressure to choke the flow at the throat of the nozzle,
F) the back pressure for the best operating condition, and
G) the ranges of back pressure for the subsonic, nozzle shock and diffuser shock flow regimes.

## Question No. 4: (20 Marks)

Air flows steadily from a large reservoir at $T_0$ = 313 K and $P_0$ = 300 kPa, through a convergent divergent nozzle into a friction pipe with a diameter of 0.06 m, a length of 2 m and an average friction coefficient is f = 0.005. The flow is considered to be isentropic when followed into the convergent divergent nozzle and reached supersonic condition at the inlet to the friction pipe.

A) If the flow finally reaches a sonic condition exactly at the exit section of the pipe without any shock waves either inside or outside the pipe, determine the throat diameter of the convergent divergent nozzle as well as the inlet and exit flow conditions of the pipe and the back pressure.

B) If the pipe length is reduced to 1.75 m while all operating conditions are maintained same as in case (a), including the back pressure, what will be the exit flow conditions.

C) For the 1.75 m pipe what should be the back pressure to create normal shock wave in the midway of the pipe. Determine the exit flow condition in this case.

D) Sketch the pressure distribution along the configuration for the above three cases and also represent all of them on a Fanno line.



Tanta University

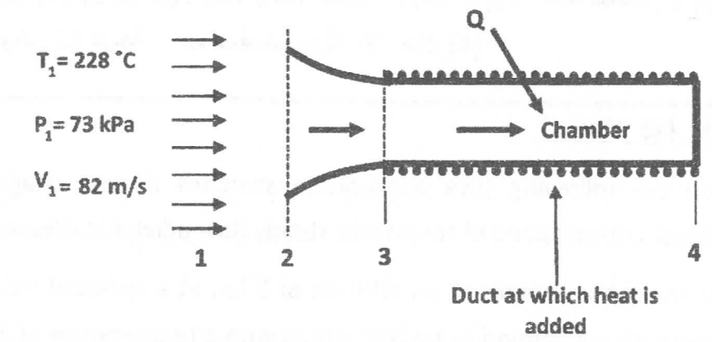
Mechanical Engineering Department
Academic Year 2022/2023
Second Semester Final Exam

Faculty of Engineering

| Third Year Mechanical Power Engineering | | | | |
|---|---|---|---|---|
| Course Title | Gas Dynamics | No. of Pages (4) عدد الصفحات (4) | Date | Wednesday 07/06/2023 |
| Course Code | MEP 3215 | | Allowed time | 3 hrs |


## Question No. 5: (20 Marks)

A constant area combustion chamber (in the shape of a duct) is supplied by air via a convergent intake section from an air free stream which has velocity of 82 m/sec, temperature of 228 K and pressure of 73 kPa, as shown in the figure. The convergent intake has an area ratio of $A_3/A_2$ = 0.5, and it is assumed that the configuration handles the maximum possible amount of air, meanwhile the back pressure is very low so that it cannot affect the flow inside the configuration.




A) On an h-S diagram, draw suitable Rayleigh lines (at least two lines) to represent all possible flow conditions when different amounts of heat (Q) are added. On the diagram show the statuses at sections 1, 2, 3, 4 as well as choking conditions and give appropriate explanations.

B) If the heat is added in the combustion process at a rate of 90 kJ/kg, determine the exit conditions.

C) Determine the maximum rate of heat that can be added without changing conditions at the entrance to the duct?

D) Suppose that sufficient heat can be used to raise the outlet stagnation temperature from the chamber to a required temperature limit of 1600 K. If, also, the back pressure is very low so that it cannot affect the flow inside the configuration, determine the parameters which characterizing the flow in this case.

**END OF QUESTIONS**

With best wishes, *Dr. Kh. Khodary.*

Tanta University

Mechanical Engineering Department
Academic Year 2022/2023
Second Semester Final Exam

Faculty of Engineering

| Third Year Mechanical Power Engineering | | | | |
|---|---|---|---|---|
| Course Title | Gas Dynamics | No. of Pages (4) عدد الصفحات (4) | Date | Wednesday 07/06/2023 |
| Course Code | MEP 3215 | | Allowed time | 3 hrs |

**Notes:**

- **Students are allowed to use their Gas Dynamics Tables,**
- يُسمح للطلاب باستخدام جداول مادة الديناميكا الغازية الخاصة بهم
- **Answering question number 01 is compulsory, while you can choose to answer only 3 questions from 2 to 5 to get the Maximum grade of 85.**
- الإجابة على السؤال رقم 01 إلزامي ، بينما يمكنك اختيار الإجابة على 3 أسئلة فقط من 2 إلى 5 للحصول على الدرجة القصوى وهي 85 درجة - عدد صفحات ورقة الإمتحان (4)

## Question No. 1: (25 Marks)

A) Briefly define the following (use appropriate sketches if any): stagnation condition, maximum speed, critical speed of sound and steady flow adiabatic ellipse. **(4 Marks)**

B) An aircraft is flying horizontally at an altitude of 5 km at a constant velocity of 750 m/s. The atmospheric air is assumed to be isothermal with a temperature of 20 °C. The aircraft passes directly over an observer who is stationary on the ground. Do you suggest that the observer will hear the sound of the aircraft before or after it passes directly over him? Determine the time period from the overhead position of the observer before or after the sound of the aircraft can be heard by the observer? **(5 Marks)**

C) Using suitable diagrams, demonstrate the operational performances of a convergent divergent nozzle for a fixed inlet stagnation condition and various values of pack pressure.

(**Hint**: required diagrams include: $P/P_o$ versus x, $P_e/P_o$ versus $P_b/P_o$ and $\frac{\dot{m}\sqrt{RT_o}}{A^* P_o}$ versus $P_b/P_o$)

**(6 Marks)**

D) For a subsonic flow entering a convergent duct will the exit Mach number may exceed more than unity, and/or, for a supersonic flow entering a convergent duct will the exit Mach number may decrease less than unity? Proof your answer. **(3 Marks)**



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Mechanical Engineering Department
Academic Year 2022/2023
Second Semester Final Exam

Faculty of Engineering

| Third Year Mechanical Power Engineering | | | | |
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E) Demonstrate why supersonic diffusers are commonly used in air breathing engines as the turbojet and the ramjet. What are the shortcomings of the supersonic fixed geometry when used as supersonic intake diffusers in jet engines? **(3 Marks)**

F) For variable geometry supersonic diffuser used in a jet engine, if the design flight Mach number $M_\infty$=3.5, determine the required inlet to throat area ratios and the limiting Mach numbers values for starting up the jet engine. **(4 Marks)**

## Question No. 2: (20 Marks)

Air flows steadily from a large reservoir at $T_0$ = 37 °C and $P_0$ = 100 kPa into a **supersonic convergent-divergent nozzle**. The nozzle is designed to have an exit area of $A_e$ = 0.2 $m^2$ and design flow rate of 15 kg/s.

A) Assuming steady one dimensional isentropic flow, determine:
   - A.1) Exit Mach number, back pressure, exit velocity, exit pressure and exit temperature at design condition;
   - A.2) The lowest back pressure for which there will be no supersonic flow on the nozzle;
   - A.3) The back pressure which cause a normal shock wave at the nozzle exit section;
   - A.4) The back pressure which causes a normal shock wave at the mean average section between the throat and exit area of the nozzle. If this back pressure is applied, determine the values of exit flow velocity, Mach number and temperature.

B) If the convergent divergent nozzle has an efficiency of 90%, determine the actual values of mass flow rate, exit Mach number, back pressure, exit velocity, exit pressure and exit temperature.

## Question No. 3: (20 Marks)

In a fixed-geometry wind tunnel, air is drawn in by means of a fan. The stagnation temperature and the stagnation pressure of the supply air are 300 K and 100 kPa, respectively. The nozzle has a throat cross-sectional area of 0.4 $m^2$ and discharges into a test

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**Mechanical Power Engineering Department**
**Mechanical Power Engineering Program Students**

Faculty of Engineering

| | | | | |
|---|---|---|---|---|
| **Course Title** | Refrigeration and Air-Conditioning (b) | **Academic Year 2022/2023** **Second Semester Exam** | **Course Code** | **MEP3207** |
| **Year/ Level** | 3rd Year Mechanical Power | | | |
| **Date** | **04-June-2023** | **No. of Pages (2)** | **Allowed time** | **3 hrs** |
| | | | **Total Assessment Marks: 75** | |

**Remarks: Request from the Exam Committee:**
Kindly allow students to use their Refrigeration and Air-Conditioning Tables and Charts; however students are not allowed to write in or exchange these materials.

**Notes for Students**: **Neat and clear** answers will be appreciated. **Assume any missing data**.

## Question Number (1)

**[16 points]**

a) **Show** with details the theory of operation of the two types of desiccant materials. **List** the benefits of desiccant systems. Also, **explain** the methods of dehumidification capacity control in desiccant Systems. [06 points]

b) Sketch a winter air conditioning system consisting of air preheater, air washer and air reheater. Part of the recirculated air is admitted (يتم إدخاله) as return air before the air washer and the rest is by- passed after the air washer. Now if given inside air conditions 26°C db & 50% RH. Outside air conditions 4°C db & 70% RH. Fresh air 1700 $m^3$/hr, temperature of air leaving air preheater 10°C, relative humidity of air leaving air washer 95%, temperature difference between supply air and circulated (return & by-pass) air 7°C. Equal masses of fresh air, return air and by-pass air are used. **Calculate:** 1- Capacity of air preheater. 2- Capacity of air reheater. 3- Internal heating load. 4- Make-up water in L/h. [10 points]

## Question Number (2)

**[16 points]**

a) What is meant by the heat storage effect? Illustrate with detailed sketch the concept of the heat storage effect. [04 points]

b) The sensible heat gain of a hall is 24 kW, and the latent heat gain of which hall is 6 kW, that hall is to be maintained at 26 °C dry-bulb temp. and 50% relative humidity. 1000 L/s of outdoor air at 36 °C dry-bulb temp. and 24 °C wet-bulb temp. is to be mixed with 2000 L/s of return air. Part of the air mixture passes through a cooling coil and the rest to be by-passed around the cooling coil. Assuming that the air leaves the cooling coil at 90% RH. Find the capacity of the cooling coil. [12 points]



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## Question Number (3)

**[28 points]**

a) Explain the theory of operation of the cooling tower and explain the meaning of the other operational Aspects such as (Makeup Water, Blow down, Control, and Limit). [06 points]

b) A 600 $m^2$ rectangular theatre hall lies in the top floor of a building is to be conditioned. The one side (20 m long) is facing north and separates the hall from unconditioned spaces, while other sides are outside walls. Space height is 5 m. The hall has ten windows (with 0.8 m x 2.5 m height and 6 mm single glass having dark colour, medium weave shading) on each of the outside walls. All walls are constructed from 100 mm face brick + air space or insulation + 100 mm block. Ceiling is constructed from 100 mm heavy weight concrete + 50 mm insulation has suspended ceiling and assume mass inside the insulation. The hall could be occupied by 500 persons (Assume Seated – very light work). Lighting is unvented and unsuspended fluorescent lamps 20 W/$m^2$ and works from 10:00 AM till 10:00 PM and equipment load could be assumed 10 W/$m^2$. Indoor air is at 24°C and 50% relative humidity (RH) and outdoor air is assumed to be 40°C and 50% RH. **Calculate** the space total cooling load assuming ventilation rate of 2.5 L/s per person. Base your calculations on 21 August, 15:00 O'clock and 32° north latitude. [22 points]

## Question Number (4)

**[15 points]**

a) What are the **steps required** to design the air duct system? **Explain** the static regain method that used to air duct system design. [06 points]

b) An air duct supplies outdoor air from a fan section to a place with dimensions of 42 m by 15 m. The duct is to be designed as a low velocity system (maximum 7.5 m/s). The duct starts at the midpoint of the short side of the place and travels in a false ceiling along the place centreline to the opposite side. There are 10 ceiling grilles with 4 m spacing and each has airflow of 0.8 $m^3$/s and the first grille starts 1 m inside the space. Make a complete design of the rectangular duct system and find the fan static and total pressures required. Sketch the duct system and show all dimensions of each section, velocities, and the points of changes of area. [09 points]

*End of questions.....*

*Best of Luck* *Dr. Ahmed Mostafa Khaira*

Tanta University

**Mechanical Power Engineering Dept.**
Total Marks: 75 marks
**Final Exam**

Faculty of Engineering

**Course Title:** Elective Course (2),
New and Renewable Energy طاقة جديدة ومتجددة
**Date:** 14th June, 2023(Final Exam)

**Course Code: MEP 3217**
**Allowed Time:** 3 hrs.

**Year:** 3rd, Mechanical Power Engineering
**No. of Pages:** 3 pages

**أجب عن الأسئلة الأتية داعماً إجابتك بالرسومات التوضيحية كلما أمكن ذلك :**

**السؤال الأول: (١٥ درجة)**

**أ- ضع علامة (✔) امام العبارة الصحيحة وعلامة (✘) امام العبارة الخطأ مع تصويب الخطأ (١٠ درجات)**

١- أعلى شدة للاشعاع الشمسي الواصل للارض تقع في مدى الأشعة تحت الحمراء. ( )
٢- قيمة زاوية إنحراف الشمس Declination تساوي صفر في مارس وأغسطس. ( )
٣- في حالة السطح المائل تكون زاوية السقوط هي نفسها زاوية السمت للرأسي للشمس. ( )
٤- تتبع مركزات طبق القطع المكافئ Parabolic-Dish الشمس عن طريق الدوران حول محور واحد. ( )
٥- الإشعاع الشمسي داخل الغلاف الجوي يشبه إشعاع الجسم الأسود. ( )
٦- يتم امتصاص أشعة أكس و أشعة جاما بواسطة بخار الماء وثاني أكسيد الكربون. ( )
٧- قيمة نسبة كتله الهواء عندما تكون زاوية السمت الرأسي للشمس 60 درجة تساوى 0.5 . ( )
٨- تزداد كفاءة الطلاء المميز للسطح الماص كلما زادت نسبة الامتصاصية إلى الانبعاثية للسطح الماص. ( )
٩- يرجع اللون الأحمر للشمس عند شروق الشمس وغروبها إلى تشتت الإشعاع الشمسي scattering. ( )
١٠- مجمعات الأنابيب المفرغة ETC هو نوع من المجمعات الشمسية المركزة. ( )

**B)** Find the amount of **daily** solar energy received on a square meter of a horizontal surface at the top of the atmosphere, where the Latitude is 30° N on December 21. (Hsc = 1353 W/m²) **[5]**

**السؤال الثاني: (١٨ درجة)**

أ- ما هي طاقة الكتلة الحيوية Biomass Energy؟ وما طرق الاستفادة منها؟ **(٥ درجات)**
ب- وضح مستعيناً بالرسم تأثير العوامل الأتية على أداء الخلايا الشمسية: شدة الإشعاع الشمسى - درجة الحرارة المحيطة. **(٤ درجات)**

**C)** The architect who designed a compound (Fig. Q.2C) in the New Administrative Capital (30° N and 31.7° E) claims that ratio of separation distance (d) to building height (H) of 2.8 would assure no shading all over the year between 8 am and 4 pm. **Examine whether this claim is valid or not. [9]**

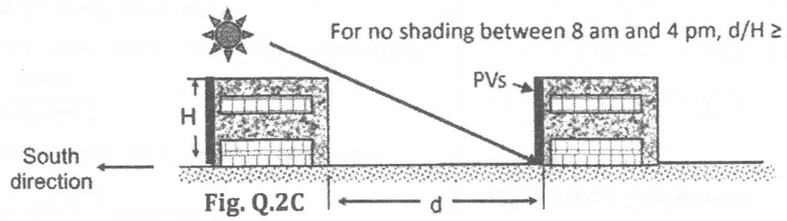

Fig. Q.2C

**السؤال الثالث: (٢٠ درجة)**

أ- أذكر طرق التبريد بالطاقة الشمسية. **(٤ درجات)**
ب- وضح بالرسم فقط مع كتابة البيانات. **(٤ درجات)**
- تركيب جهاز البيرانوميتر Pyranometer
- توزيع الطيف الشمسي خارج وداخل الغلاف الجوي


P.T.O >>>>

**C)** To meet the growing energy demand using clean energy technologies, a solar chimney power plant (SCPP) is proposed to be established in Port Safaga on the red sea coast (26.73° N and 33.94° E) at a mountainous site. The solar collector of the SCPP consists of two isosceles trapezoidal surface areas with a chimney at its apex as indicated in the figure (Fig. Q.3C) having two slope angles S1 and S2 of 30° and 45°, respectively. The base sides of trapezoid are 315 m and 105 m and the chimney width is 28 m. Due to the topography of the site, the SCPP collector is facing east. **For site and project evaluation, estimate the following:**

i. The sunrise, sunset, and day length times.
ii. The direct beam solar radiation normal to the sun's rays
iii. The beam and total incident radiation on the collector at 11:00 am on 21st. July (ground reflectance 0.3).
iv. The power output, if the overall efficiency of the SCPP is 0.05%.

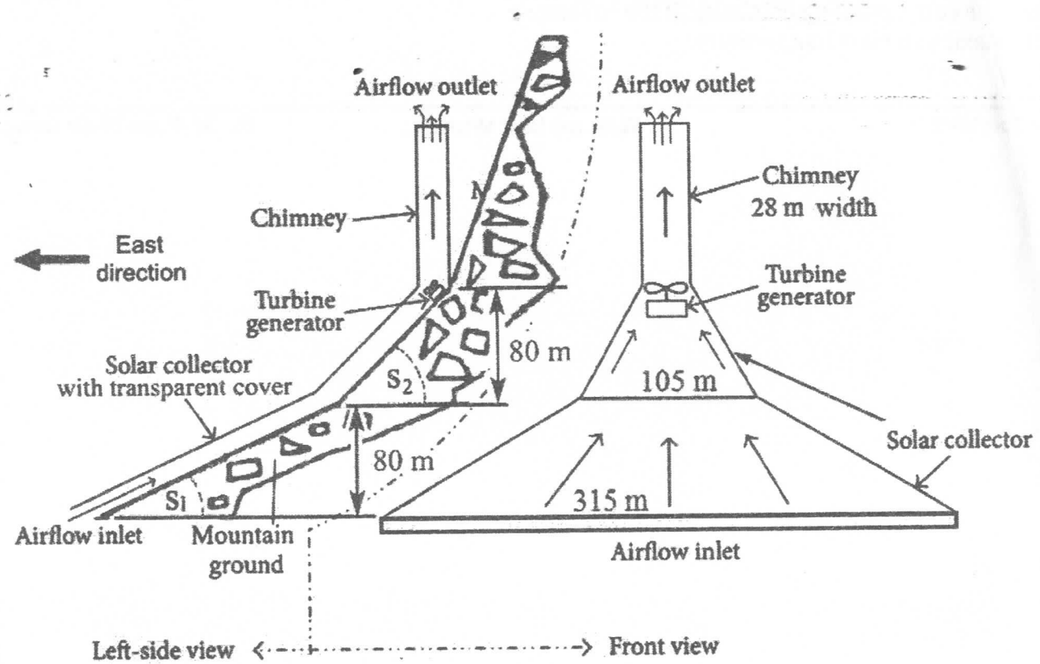

Fig. Q.3C Schematic of the solar chimney power system on sloped surface.

**السؤال الرابع: (٢٢ درجة)**

أ- اذكر الآليات المختلفة للتحكم فى سرعة توربين الرياح. **(٥ درجات)**
ب- **عرف مع الرسم كلاً من:** سرعة القطع Cut-in velocity - سرعة التوقف Cut-out velocity - السرعة القياسية Rated velocity لتربينات الرياح. **(٤ درجات)**

**C)** A single-glazed 2 m² flat-plate collector faces south, tilted 30° from horizontal. The collector is located at 31°N latitude, and on June 21 from 2:00 to 3:00 pm. the average horizontal beam radiation intensity is 820 W/m², the ratio of diffused radiation is 10%, and the ambient temperature is 25°C. **Design data for collector are:**


P.T.O >>>>

# Solar Energy Formula Sheet

**Permitted in New & Renewable Energy**
**Final Exam**

## (I) Solar angles correlations

$$\delta = 23.45\left[\sin\left(\frac{360}{365}(284+\mathrm{n})\right)\right]$$

$$\sin\alpha = \cos z = \sin \mathrm{L}\cdot\sin\delta + \cos \mathrm{L}\cdot\cos\delta\cdot\cos \mathrm{h}$$

$$\sin\phi = \frac{\cos\delta\cdot\sin \mathrm{h}}{\cos\alpha}$$

$$\begin{aligned}\cos i &= \sin \mathrm{L}\cdot\sin\delta\cdot\cos \mathrm{s} - \cos \mathrm{L}\cdot\sin\delta\cdot\sin \mathrm{s}\cdot\cos\psi_s \\ &\quad + \cos \mathrm{L}\cdot\cos\delta\cdot\cos \mathrm{h}\cdot\cos \mathrm{s} \\ &\quad + \sin \mathrm{L}\cdot\cos\delta\cdot\cos \mathrm{h}\cdot\sin \mathrm{s}\cdot\cos\psi_s \\ &\quad + \cos\delta\cdot\sin \mathrm{h}\cdot\sin \mathrm{s}\cdot\sin\psi_s\end{aligned}$$

$$h_{ss}\big|_{\text{in hours}} = \frac{1}{15}\cos^{-1}\left[-\tan \mathrm{L}\cdot\tan\delta\right]$$

$$\text{Day Length} = \frac{2}{15}\cos^{-1}\left[-\tan \mathrm{L}\cdot\tan\delta\right]$$

## (II) Solar radiation correlations

$$H_{on} = H_{sc}\left[1+0.033\cos\left(\frac{360\cdot n}{365}\right)\right]$$

$$H_o = \frac{24}{\pi}H_{on}\left[\cos \mathrm{L}\cdot\cos\delta\cdot\sin \mathrm{h}_{ss} + \left(\frac{2\pi \mathrm{h}_{ss}}{360}\right)\sin \mathrm{L}\sin\delta\right]$$

$$H_t = H_{bn}\cdot\cos i + H_d + H_r$$

$$H_{bn} = A\cdot e^{-B\cdot m} \qquad m = 1/\cos z = 1/\sin\alpha$$

$$H_d = C\cdot H_{bn}\cdot F_{ss} \qquad F_{ss} = 0.5(1+\cos s)$$

$$H_r = \left(H_{Bh}+H_{dh}\right)\rho_g\left(\frac{1-\cos s}{2}\right)$$

ASHRAE Model Coefficients for **average** clear day solar radiation

$$A = 1160 + 75\sin\left[\frac{360}{365}(n-275)\right] \qquad (\mathrm{W/m^2})$$

$$B = 0.174 + 0.035\sin\left[\frac{360}{365}(n-100)\right]$$

$$C = 0.095 + 0.04\sin\left[\frac{360}{365}(n-100)\right]$$

$$R_B = \frac{\cos i}{\cos z} = \frac{\cos(\mathrm{L}-\mathrm{s})\cos\delta\cosh + \sin(\mathrm{L}-\mathrm{s})\sin\delta}{\cos \mathrm{L}\cos\delta\cos \mathrm{h} + \sin \mathrm{L}\sin\delta}$$

$$R = \frac{H_{ti}}{H_{th}} = R_B\frac{H_{Bh}}{H_{th}} + \frac{C\,H_{Bn}}{H_{th}}\left(\frac{1+\cos s}{2}\right) + \rho_g\left(\frac{1-\cos s}{2}\right)$$

## (III) Solar Collectors

**Flat plate collector**

$$\begin{aligned}Q_u &= \dot{m}_w\cdot c_p\cdot(T_{fo}-T_{fi}) \\ &= A_c\left[H_t\cdot\tau_g\cdot\alpha_a - U_L\cdot\left(T_p - T_\infty\right)\right] \\ &= F_R\cdot A_c\left[H_t\cdot\tau_g\cdot\alpha_a - U_L\cdot\left(T_{fi} - T_\infty\right)\right]\end{aligned}$$

$$Q_{u,\max} = A_c\left[H_t\cdot\tau_g\cdot\alpha_a - U_L\cdot\left(T_{fi} - T_\infty\right)\right]$$

Heat removal factor

$$F_R = \frac{Q_u}{Q_{u,\max}} = \frac{\dot{m}_w\,c_p}{A_c U_L}\left(1 - e^{-\frac{A_c U_L F'}{\dot{m}_w c_p}}\right)$$

Maximum absorber plate temperature

$$T_{P\max} = T_\infty + \frac{H_t\cdot\tau_g\cdot\alpha_a}{U_L}$$

Collector-efficiency factor

$$F' = \frac{1/U_L}{W\cdot\left[\frac{1}{U_L[D_o+(\mathrm{W}-\mathrm{D_o})\mathrm{F}]}\right] + \frac{1}{C_b} + \frac{1}{\pi D_i h_{fi}}}$$

where bond conductance $C_b = \dfrac{k_b b}{\gamma}$

fine efficiency $F = \dfrac{\tanh(m L_f)}{m L_f}$

$$m = \sqrt{\frac{U_L}{k_p\delta_p}}$$

fine length $L_f = \dfrac{W - D}{2}$

Collector efficiency

$$\eta_c = \frac{Q_u}{H_t A_c} = F_R\left[\tau_g\cdot\alpha_a - \frac{U_L}{H_t}\cdot\left(T_{fi} - T_\infty\right)\right]$$

| Month | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Day number | n | 31+i | 59+i | 90+i | 120+i | 151+i | 181+i | 212+i | 243+i | 273+i | 304+i | 334+i |



End of Exam

Overall heat loss coefficient, $U_L$ = 6 W/m$^2$ °C
Water inlet temperature = 35 °C. (for water $c_p$ = 4187 J/kg.K)
Mass flow rate through the collector = 0.02 kg/s
Tube inside convection heat transfer coefficient = 1500 W/m$^2$.K
Single glazing with transmissivity $\tau$ = 0.9
Absorber plate is selective with absorptivity $\alpha$ = 0.85
and thickness $\delta$ = 0.8 mm

Copper (k=385 W/m. K) tubes are used for risers, with 10 mm inside diameter, 10.8 mm outside diameter, and distance between risers W= 10 cm.

**Calculate the following:**

i. The useful energy (Qu) of the collector.
ii. The corresponding efficiency of the collector.
iii. Maximum plate temperature.

With my Best Wishes... Dr. M. Osama El-Samadony

End of Questions