มหาวิทยาลัยสงขลานครินทร์
คณะวิศวกรรมศาสตร์

สอบปลายภาค ภาคการศึกษาที่ **2** ประจำปีการศึกษา **2546**
วันที่ 23 กุมภาพันธ์ 2547 เวลา 9:00 – 12:00 น.
วิชา **216-462 พลังงานทดแทน** (Renewable Energy) ห้อง R300

คำชี้แจง

1. ข้อสอบมี 6 ข้อ จำนวนหน้าทั้งหมด 11 หน้า (ไม่รวมหน้าคำชี้แจง) ข้อสอบแต่ละข้อคะแนนไม่เท่ากัน ให้ทำทุกข้อโดยแสดงวิธีทำลงในกระดาษข้อสอบให้ชัดเจน
2. หากเนื้อที่ในการทำข้อสอบแต่ละข้อไม่พอ อนุญาตให้ทำต่อด้านหลังของกระดาษข้อสอบ
3. อนุญาตให้นำเอกสาร, Lecture note, Dictionary และหนังสือที่เป็นประโยชน์ในการทำข้อสอบเข้าห้องสอบได้
4. สามารถนำเครื่องคิดเลขเข้าห้องสอบได้ (ไม่จำกัดชนิดและรุ่น)
5. อนุญาตให้ทำข้อสอบโดยการเขียนด้วยดินสอ

อ.ฐานันดร์ศักดิ์ เทพญา
ผู้ออกข้อสอบ

ข้อ	คะแนนเต็ม	คะแนนที่ได้
1	20	
2	15	
3	10	
4	15	
5	15	
6	15	
รวมคะแนน	90	
	คิดเป็น 45%	

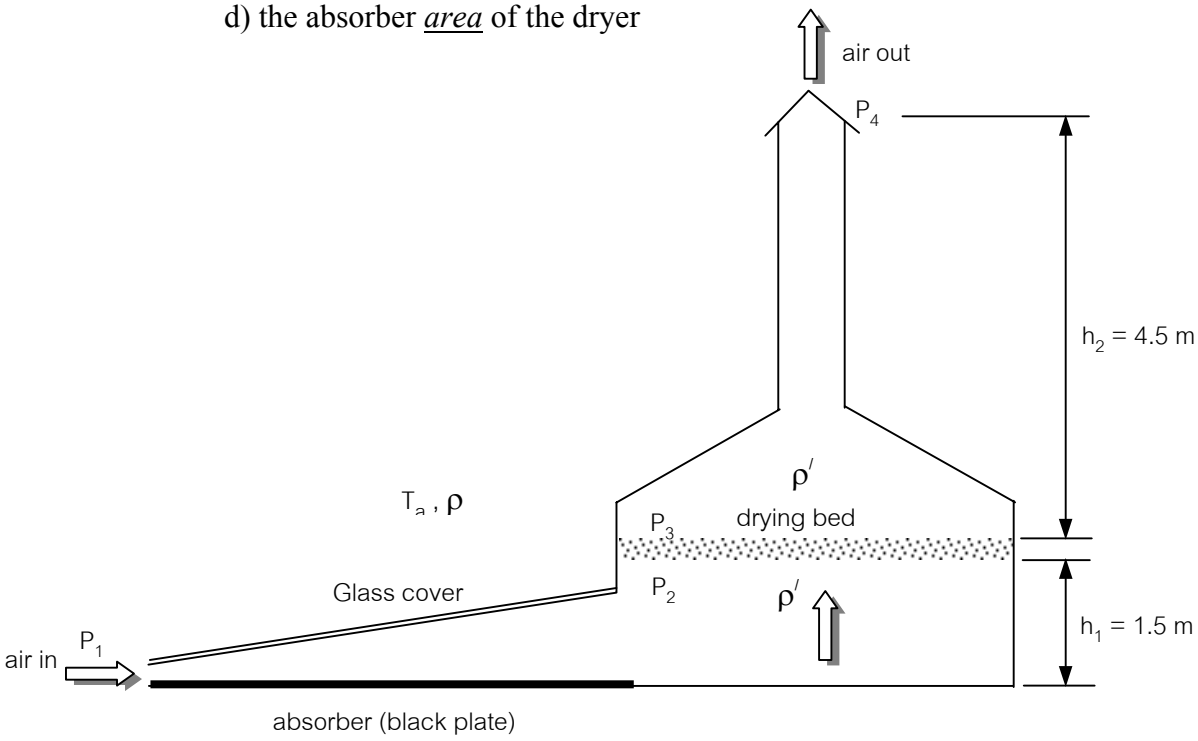
ชื่อ-สกุล.....รหัสนักศึกษา.....

รหัสนักศึกษา.....

SOLAR ENERY APPICATIONS : solar drying (20 points)

1. A simple solar dryer as shown in figure below was used for bean drying. If we would like to dry the *300 kg* of bean with the initial moisture content of *26%* (dry basis) down to *15%* of final moisture content within *4 days* (day time drying start from *9:00 AM* to *3:00 PM*). The outside air was naturally drawn into the dryer and was heated up by the black plate absorber to the temperature about 47^oC before entering the drying bed and exit at temperature of 31.5^oC. The ambient temperature (around the dryer) is 32^oC and the relative humidity is *70%*. Assume the heat of vaporization in bean is approximately *2,800 kJ/kg*, the total solar irradiation is *17 MJ/m^2-day*, bean density is *650 kg/m^3*, the density of the air inside solar dryer is slightly constant, ρ', air pressure gradient constant is *C = 0.03 m/Pa-min*, and the collector efficiency is *30%*.

   Determine : a) the <u>*volume air flow rate*</u> for drying the bean in this solar dryer.
   b) the <u>*pressure drop*</u> between the drying bed
   c) the <u>*thickness*</u> of the drying bed (bean thickness)
   d) the absorber <u>*area*</u> of the dryer



รหัสนักศึกษา.....

รหัสนักศึกษา.....

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SOLAR ENERY APPICATIONS : concentrating solar collector (15 points)

2. A compound parabolic concentrating solar collector (CPCs), with concentrating ratio, *CR = 10* and length *10 m*, has an absorbed radiation per unit area of aperture of *450 W/m^2*. The receiver is a cylindrical tube painted flat black and used to absorb the solar radiation. The receiver has a diameter of *55 mm* with a wall thickness of *5 mm*. It is made of stainless steel (*k = 16 W/m ^oC*). The collector is designed to heat a fluid entering the absorber at 150^{o}C at a flow rate of *0.05 kg/s*. The fluid has C_p *= 2.98 kJ/kg ^oC*. The heat transfer coefficient inside tube is *300 W/m^2 ^oC* and the overall loss coefficient is *9.8 W/m^2 ^oC*. If the ambient temperature is *25^{o}C*, *calculate the useful gain* and the *exit fluid temperature*.

รหัสนักศึกษา.....

รหัสนักศึกษา.....

PHOTOVOLTAIC CELL (PV CELL) : calculate the module parameters (10 points)

3. Determine the following parameters of a photovoltaic module under the operating condition of G = 675 W/m^2, and T_a = 33^{o}C.

   (a) Short-circuit current, $I_{SC}(G)$

   (b) Solar cell temperature, T_C

   (c) Open-circuit voltage, V_{OC}

   (d) Fill Factor (*FF*) and the maximum electrical power , $P_{max}(G, T_C)$.

   The PV module was formed by 36 solar cells in series. The manufacturer's values under standard condition are : I_{SC} = 2.5 A ; V_{OC} = 22.5 V ; P_{max} = 42.5 W ; and NOCT = 45^{o}C.

รหัสนักศึกษา.....

PHOTOVOLTAIC CELL (PV CELL) : system sizing calculation (15 points)

4. Calculate the *total daily energy load* in watt-hours, *the number of solar cell panels* (40 Wp per panel and each panel produces 150 Wh per day) and *choose the battery capacity enough for 7 days* by using a *24 V system* for a small household utilization (also *draw the array of PV panels*). And calculate the *collector area of PV panels* if the insolation at a site installation is *17 MJ/m^2-day*. Assume *5% for bettery-to-load wire losses, 80% of battery efficiency*, *5% for PV array-to-battery wire losses*, and *PV cell efficiency is 15%.*

Household appliances are : *six 18 W* lamps used *5 hours* per day
: *one 20 W* television used *3 hours* per day
: *one 25 W* fan used *5 hours* per day
: *one 60 W* refrigerator used *all day* (compressor on *50%* of the time)
: *one 600 W* electric pot used *45 minutes* per day

รหัสนักศึกษา.....

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WIND ENERGY : estimate wind energy potential (15 points)

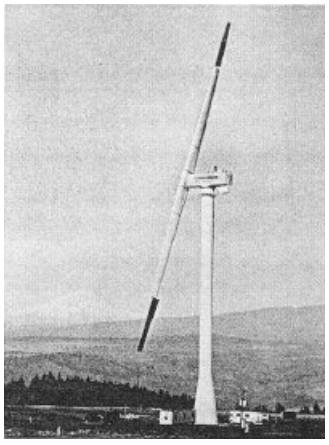
5. The Wiebull parameters at a given site of wind station are $c = 6.5$ *m/s* and $k = 2.1$. Estimate the *number of hours per year* that ; **(a)** the wind speed will be *between 5 m/s* and *8 m/s* , and **(b)** the wind speed *greater than or equal 12 m/s*. **(c)** Calculate *the total wind energy available per year* for the wind speed *between 5 m/s* and *8 m/s on one square meter of swept area* of wind turbine. (Assume to use the average air density of *1.27 kg/m*^{3}.)

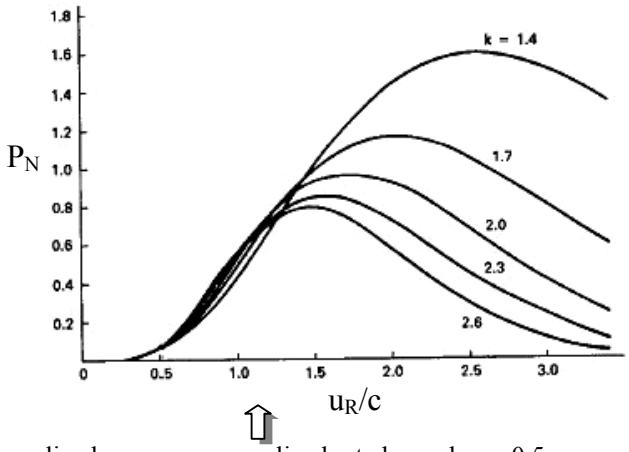
รหัสนักศึกษา.....

WIND ENERGY : the average power and yearly production values from wind turbine (15 points)

6. If you plan to build wind machine of the same size as MOD-2 which has a *rated power* of *2,000 kW* at a *rated wind speed* of *11 m/s* at hub height. A 50 m tower installed wind turbine (MOD-2 Model) at your potential wind farm site are characterized by the Weibull parameters $c = 8\ m/s$ and $k = 2.0$. Assume that $u_C = 0.5u_R$, and $u_F = 2u_R$.

MOD-2 ⇨
Wind machine





Normalized power vs normalized rated speed $u_c = 0.5u_R$, $u_F = 2u_R$

(a) What is the *optimum rated wind speed*?

(b) What is the *capacity factor* of your optimized turbine?

(c) What are the *average power* and *yearly energy production* values for your optimized turbine?

รหัสนักศึกษา.....