

ชื่อ..... นามสกุล..... รหัส.....

PRINCE OF SONGKLA UNIVERSITY

FACULTY OF ENGINEERING

Final examination: Semester-II

Academic year: 2003

Date: 24/02/2004

Time: 13:30-16:30

Subject: 216-436 (Gas Turbine Theory)

Room: 201

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Remark: (49 students)

1. Answer all (5+bonus) questions
2. Allow to bring only 1 sheet of A4 with handwriting
3. Allow to bring a calculator
4. Cheater will be caught and investigated following the faculty rule for examination
5. Total score for this examination is 40%

ข้อที่	คะแนนเต็ม	คะแนนที่ได้
1	9	
2	5	
3	8	
4	6	
5	9	
Bonus	3	
รวม	40	

Wiriya Thongruang

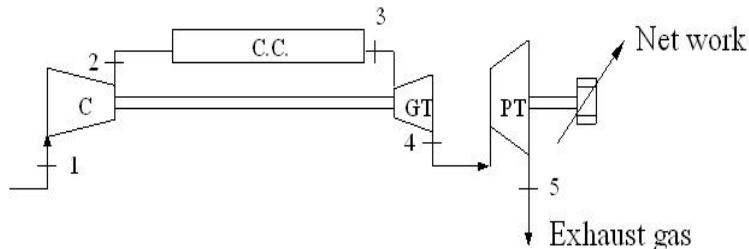
Lecturer

ข้อ 1. (9 คะแนน)

A simple gas turbine with a gas generator system and a power turbine delivering 20 MW (net) is used for a peak load generator. The following data are applicable for this system :

Compressor pressure ratio	11.0
Compressor isentropic efficiency	0.82
Combustion pressure loss	0.4 bar
Combustion efficiency	0.99
Turbine inlet temperature	877°C
Gas generator turbine isentropic efficiency	0.87
Power turbine isentropic efficiency	0.90
Mechanical efficiency of power turbine shaft	0.90
Ambient condition $P_a, T_a$	1 bar, 15°C

$$C_p = 1.07 \text{ kJ/kg.K}, \gamma = 1.3, \text{ LHV} = 43,000 \frac{\text{kJ}}{\text{Kg}}$$



- 1.1) Draw T-S diagram for the system
  - 1.2) Calculate the air mass flow required
  - 1.3) Calculate the specific fuel consumption in the unit of kg/kWh
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**ข้อ 2. (5 คะแนน)**

จงเปรียบเทียบสมบัติและการใช้งานของ turboprop engine และ turbojet engine มาอย่างละ  
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### ข้อ 3. (8 คะแนน)

A simple turbojet engine has the following component performance at the design point where the altitude (level) and speed are 5 km and 300 km/hr, respectively.

Compressor pressure ratio	10.0
Turbine inlet temperature	1200 K
Ram compression	0.3 bar
Isentropic efficiency:	
of compressor,	0.87
of turbine,	0.90
of nozzle,	0.95

Given:

At altitude 5 km  $\rightarrow P_a = 0.54$  bar,  $T_a = 250$  K

$Cp_a$  (air) = 1.005 kJ/kg

$Cp_g$  (gas) = 1.148 kJ/kg

$\gamma$  = 1.3

$R$  = 0.287 kJ/kg K

3.1) Determine that this nozzle is choked or isn't.

3.2) Determine the specific thrust (N.s/kg)

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**ข้อ 4. (6 คะแนน)**

- 4.1) จงแสดงลักษณะไปพัดของกังหัน และคocomเพรสเซอร์ เฉพาะແຕวที่หมุนได้ (rotor blades) ในแต่ละແວມາ 1 คู่ พิจารณาแสดงทิศของการหมุนเดียว
- 4.2) จงแสดงองค์ประกอบของคocomเพรสเซอร์แบบการไหลดตามແກນมา 1 ชุด (stage) พร้อมทั้งแสดงສາມເຫດຢືມຄວາມເງົາທີ່ມີອົງຄົປະກົບຕ່າງໆ (ຄວາມເງົາແລະມູນ) ນາໄໝຄຽບຄ້ວນ
- 4.3) ຈຳເປັນກິດຂອງ the symmetrical blade condition ເກື່ອງກັບຄວາມເງົາແລະມູນຕ່າງໆ
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**ข้อ 5. (9 คะแนน)**

Product of combustion flows through an axial turbine stage with the following properties:

$$T_{01} = 1800 \text{ K}$$

$$P_{01} = 1000 \text{ kPa}$$

$$U = 360 \text{ m/s}$$

$$\alpha_2 = 45^\circ$$

$$\alpha_3 = 5^\circ$$

$$\frac{C_{a3}}{C_{a2}} = 1.0$$

$$\text{Mach number } (M_2) = 1.1$$

(use  $\gamma = 1.3$ ,  $R = 0.287 \text{ kJ/kg.K}$  and velocity triangles given)

Determine the following

5.1)  $C_2$ ,  $C_{a2}$  and  $C_{w2}$

5.2)  $C_{a3}$ ,  $C_{w3}$  and  $C_3$

5.3)  $\Delta T_{os}$  and stage temperature ratio  $\left( \frac{T_{03}}{T_{01}} \right)$

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