

EEL4936/6936 – Power Plant Engineering

Homework #4: Prime Movers

Due: 03/02/09

#1. A steam turbine stage, the design where pressure drops only across the fixed nozzle and not across the moving buckets is;

- A. Reaction Turbine
- B. Impulse Turbine

ANSWER: B

#2. A turbine installation where there are two LP turbines connected on a common shaft driving one generator is known as a;

- A. Tandem compound turbine
- B. Cross compound turbine

ANSWER: A

#3. The valve that is used to control steam flow to the HP section turbine for control during full load operation is known as the;

- A. The Governor Valve
- B. The Intercept Valve
- C. The Stop Valve
- D. The Throttle Valve

ANSWER: A

#4. Purpose of the Turbine turning gear is to rotate the turbine during shutdown and startup to;

- A. Prevent bowing of turbine rotor due to weight of rotor
- B. Build up oil film in journal bearings
- C. Prevent bowing of turbine rotor due to uneven heating
- D. Check for rotor rotation direction.

ANSWER: C

#5. The type of turbine control that refers to the sequential opening of the steam control (governor) valve (partial arc admission) is;

- A. Throttle control
- B. Governing control
- C. Variable pressure control

ANSWER: B

#6. The four parts of the Brayton combustion cycle are;

ANSWER:
COMPRESSION
COMBUSTION
EXPANSION
EXHAUST

#7. Using the following formula for compressor efficiency for a combustion turbine generator;

$$\eta_{\text{comp}} = \frac{h_{2s} - h_1}{h_2 - h_1}$$

Determine Compressor efficiency if;

H1 = 250 BTU/lbm
H2 = 1250 BTU/lbm
H2S = 1000 BTU/lbm

- A. 0.75
- B. 1.00
- C. 1.25
- D. 1.33

ANSWER: A

$$\begin{aligned} n_{\text{comp}} &= (H_2 - H_1) / (H_2 - H_1) \\ &= (1000 - 250) / (1250 - 250) \\ &= 0.75 \text{ or } 75\% \end{aligned}$$

#8. Given the formula for Hydroturbine power below, What is the power developed (in HP) by a hydroturbine if the net head of water is 250 feet, turbine discharge flow is 1000 ft³/s, and turbine efficiency is 0.8?

$$P = (H * Q * n) / 8.81$$

Where Turbine output (HP)

H = net head (ft)

Q = turbine discharge (ft³/s)

N = turbine efficiency

- A. 10,700 HP
- B. 18,100 HP
- C. 22,700 HP
- D. 27,200 HP

ANSWER: C

$$P = (H * Q * n) / 8.81$$

$$= (250 \text{ ft}) * (1000 \text{ ft}^3/\text{s}) * (0.8) / 8.81$$

$$= 22700 \text{ HP}$$

#9. Using the table shown below; If the power developed by a turbine with a head of 200 feet is 20,000 HP and the head is reduced to 100 feet, what is the new HP developed by the hydroturbine?

TABLE 3.5.1 Proportionality Laws*

Constant head	Constant runner and diameter	Variable runner, diameter, and head
$P \propto D^2$	$P \propto H^{3/2}$	$P \propto D^2 H^{3/2}$
$n \propto \frac{1}{D}$	$n \propto H^{1/2}$	$n \propto \frac{H^{1/2}}{D}$
$Q \propto D^2$	$Q \propto H^{1/2}$	$Q \propto D^2 H^{1/2}$

* P = turbine output, hp (kW)

D = runner discharge diameter, ft (m)

n = turbine rotating speed, rpm

Q = turbine discharge, ft³/s (m³/s)

H = net head, ft (m)

- A. 4,400 HP
- B. 7,070 HP
- C. 11,300 HP
- D. 20,000 HP

ANSWER B:

$$(P_1/P_2) = (H_1/H_2)^{3/2} \text{ Solving for } P_2$$

$$P_2 = P_1 * (H_1/H_2)^{-3/2}$$

$$P_2 = 20,000 \text{ HP} * (200\text{ft}/100\text{ft})^{-3/2}$$

$$= 7070 \text{ HP}$$

#10. For a four stroke Gas or Oil reciprocating engine it takes how many shaft revolutions to complete on full cycle?

- A. one
- B. two
- C. three
- D. four

ANSWER B.

- 1 B
- 2 A
- 3 A
- 4 C
- 5 B

6 ANSWER:
COMPRESSION
COMBUSTION
EXPANSION
EXHAUST

- 7 A
- 8 C
- 9 B
- 10 B