

II B.Tech I Semester Supplementary Examinations, November 2006
PRIME MOVERS AND MECHANICAL MEASUREMENTS
(Instrumentation & Control Engineering)

Time: 3 hours

Max Marks: 80

Answer any FIVE Questions
All Questions carry equal marks

1. (a) Which of the following turbines require complete initial conversion of total energy into the kinetic energy. Explain why.
 - i. Kaplan turbine
 - ii. Francis turbine
 - iii. Pelton wheel
- (b) A reaction turbine works at 450 rpm under a head of 115m. The diameter of the inlet, is 1.2m and the flow area is 0.4 sq m. At inlet the absolute and the relative velocities make angles of 20 degrees and 60 degrees respectively with the tangential velocity. Determine the power developed and the hydraulic efficiency. Assume the velocity of whirl at the outlet to be zero. [5+11]
2. (a) Explain
 - i. Mechanical efficiency
 - ii. volumetric efficiency
 - iii. Manometric efficiency
 - iv. Over all efficiency
- (b) The discharge of a centrifugal pump is $0.38 \text{ m}^3 / \text{sec}$ and runs at a speed of 500rpm. The head developed is 15 m. The width of the impeller at outlet is 5cm and the diameter is 75 cm. The manometric efficiency is 0.8. Estimate the blade angle at outlet. [8+8]
3. (a) Differentiate mountings and accessories of a boiler. List out various mountings and accessories that are normally employed in a boiler installation.
- (b) Explain the principle of operation of a fusible plug with a neat sketch. [8+8]
4. (a) Distinguish between the operational features of an impulse and reaction turbine.
- (b) A single stage impulse turbine 1 m in diameter rotates at 3000 rpm. Steam is supplied from the nozzles with a velocity of 300 m/sec and nozzle angle is 20° . The blades are equiangular. Assuming the friction loss in the blade passage is 33% of the kinetic energy corresponding to the relative velocity at inlet to the blade, find the power developed by the turbine. Axial thrust on the bearing of the turbine is 150 N. [6+10]
5. (a) What are different methods to improve the performance of gas turbine plant?

- (b) Derive the optimum pressure ratio for maximum thermal efficiency of the gas turbine? [8+8]
6. Give the principle of photoelectric pulse counting. List the different devices work on the principle of photoelectric pulse counting and explain with a neat sketch magnetic pulse counting? [16]
7. (a) Explain in detail about gyroscopes.
(b) Differentiate between bonded and un-bonded strain gauge transducers used in load measurement. [8+8]
8. (a) Sketch the schematic arrangement of an oscilloscope for frequency and phase measurements and explain its working principle.
(b) An oscilloscope displays a sine wave and the distance between the first and fourth peaks is found to be 5.4cm. If the time base setting is 20×10^{-03} make calculations for the periodic time and frequency of the sine wave. [8+8]

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1. (a) Explain the working of Francis turbine. Derive the equation for power developed by the runner.
(b) A Pelton wheel has a mean bucket speed of 12m/ sec and is supplied with water at the rate of 750 litres /sec under a head of 35 m. If the buckets deflect the jet through an angle of 160 degrees, find the power and the efficiency of the turbine. Take the coefficient of velocity as 0.98. [10+6]
2. (a) Explain
 - i. Mechanical efficiency
 - ii. volumetric efficiency
 - iii. Manometric efficiency
 - iv. Over all efficiency(b) The discharge of a centrifugal pump is $0.38 \text{ m}^3 / \text{sec}$ and runs at a speed of 500rpm. The head developed is 15 m. The width of the impeller at out let is 5cm and the diameter is 75 cm. The manometric efficiency is 0.8. Estimate the blade angle at outlet. [8+8]
3. What are high-pressure boilers? How do they differ in construction and working principle from ordinary boilers? Explain the advantages gained by employing forced circulation in these high-pressure boilers. [16]
4. (a) Explain why rankine cycle is used instead of carnot cycle in steam power plants.
(b) In a regenerative cycle steam at 35 bar and 300° is expanded isentropically to 0.06 bar. When the pressure reaches 3 bar, some of the expanding steam is bled to heat the feed water. Assuming that the feed water is heated to the saturation temperature at 3 bar by the bled steam, calculate the proportion of bled steam to steam leaving the boiler, the cycle efficiency and the specific steam consumption. [10+6]
5. (a) What are the advantages and disadvantages of reheating gas turbine power cycle?
(b) Show that the thermal efficiency of a gas turbine power cycle depends only on pressure ratio. [6+10]
6. Suppose that a rotameter uses a cylindrical float 25mm high and 25mm in diameter and of proper density to give density compensation. If the coefficient $C_c=0.5$ and

the maximum inside diameter of the metering tube is 50mm, what flow rate in kg/m can the rotameter accommodate. [16]

7. (a) Explain the method of measuring force using hydraulic load cell.
(b) Explain the principle and working of seismic displacement sensing accelerometer. [8+8]
8. (a) Explain the working principle of mechanical torsion meter with neat sketch.
(b) A shaft transmits a maximum power of 50kW when running at a constant Speed of 1500rpm. Measurement of torque are made by a pair of strain gauges, which are bonded on to a specially machined portion of the shaft. Each gauge has a nominal resistance of $R = 120\Omega$. Gauge factor $F = 2.0$ are connected electrically to the two arms of a half-activated wheatstone-bridge circuit which is energized with an excitation voltage of 6Volts. If the gauges have a maximum strain of 0.0015, calculate the shaft diameter the modulus of elasticity of the shaft material is 200GN/m^2 . [8+8]

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2. (a) What is a reciprocating pump? Elaborate.
- (b) A single acting reciprocating pump has a plunger diameter of 250mm and stroke of 350 mm. If the speed of the pump is 60 rpm and it delivers $0.2\text{m}^3/\text{sec}$ of water, find the theoretical discharge, coefficient of discharge and the slip. [8+8]
3. Explain the principle of operation of low level, high level and ejector type of jet condensers with the help of neat sketches. [16]
4. The velocity of steam at inlet to a simple impulse turbine is 100 m/sec and the nozzle angle is 20° . The blade speed is 400 m/sec and the blades are symmetrical. Determine the blade angles if the steam is to enter the blades without shock. If the friction effects on the blade are negligible, calculate the tangential force on the blades and the diagram power for a mass flow of 0.75 Kg/sec. What is the axial thrust and the diagram efficiency?
If the relative velocity at the exit is reduced by friction to 80% of that at inlet, What is then the diagram power and the axial thrust? Calculate also the diagram efficiency in this case. [16]
5. (a) Explain the reheating gas turbine power cycle?
- (b) The minimum and maximum temperature limits in a gas turbine plant are 288 K and 1100 K. The pressure limits are 1 bar and 8 bar. Determine
 - i. optimum pressure ratio for maximum work
 - ii. optimum pressure ratio for maximum thermal efficiency? [8+8]

6. A 5cmx2.5cm venturimeter with a coefficient of discharge of 0.98 is to be replaced by an orifice meter having a coefficient of discharge 0.6. If both the meters are to give the same differential mercury manometer reading for a discharge of 10lit per second, and the inlet diameter is to remain 5cm, what should the diameter of orifice be? [16]
7. (a) Explain the method of measuring force using hydraulic load cell.
(b) Explain about response of the seismic instrument to transients. [8+8]
8. (a) What are the electrical dynamometers? Explain in detail?
(b) How should the armature and field resistance of this dynamometer be set when starting it as
 i. motor
 ii. generator. [8+8]

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1. (a) How are the turbines classified ?
(b) A 5 cm dia horizontal jet operating under a head of 33 m strikes a curved blade moving at a velocity of 5m /sec in the direction of the jet. If the deflection angle of the blade is 145 degrees, find the force exerted on the blade by the water. [8+8]
2. (a) What is a reciprocating pump? Elaborate.
(b) A single acting reciprocating pump has a plunger diameter of 250mm and stroke of 350 mm. If the speed of the pump is 60 rpm and it delivers 0.2m³/sec of water, find the theoretical discharge, coefficient of discharge and the slip. [8+8]
3. Explain the working principle of Benson boiler with the help of neat sketch. Also list out its advantages and disadvantages over other boiler plants. [16]
4. (a) Explain the essential differences in the functions of moving blades in the impulse and reaction types of the turbines.
(b) The speed of a single stage impulse turbine is 300rev/min and the blade diameter is 1meter. The nozzle of the turbine is inclined at 20⁰ to the plane of the wheel and the moving blade inlet and exit angles are 35⁰ and 30⁰. Assuming a friction factor (blade velocity coefficient) of 0.8, determine
 - i. The power developed for a steam consumption rate of 9000 kg/hr
 - ii. The blade or diagram efficiency
 - iii. The axial thrustAssume that the steam enters the blades without shock. [6+10]
5. (a) What are the advantages and disadvantages of reheating gas turbine power cycle?
(b) Show that the thermal efficiency of a gas turbine power cycle depends only on pressure ratio. [6+10]
6. List the various methods of flow measurement. What is the significance of term 'Inferential' as applied to flow meters? [16]
7. (a) Write a brief note on various elastic transducers used in force measurement.
(b) Explain the principle and working of a strain gauge accelerometer. [8+8]
8. (a) What are the electrical dynamometers? Explain in detail?

(b) How should the armature and field resistance of this dynamometer be set when starting it as

i. motor

ii. generator.

[8+8]

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