Reg.No.										

MANIPAL INSTITUTE OF TECHNOLOGY
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V SEM. B.E. (MECHANICAL ENGG.) DEGREE END SEMESTER EXAMINATIONS JUNE 2008

SUBJECT: TURBO MACHINES (MEE-305)
REVISED CREDIT SYSTEM
(09 / 06 / 2008)

Time: 3 Hours. MAX.MARKS: 50

Instructions to Candidates:
- Answer **ANY FIVE FULL** questions.
- Missing data, if any, may be suitably assumed.
- Use of thermodynamics data hand book and steam tables permitted.

1A) Draw the neat sketch of turbine/compressor cascade blades. Mark the following parameters on the sketch:
i) Incidence angle ii) Deviation angle
iii) Stagger angle iv) Camber angle.
v) Chord vi) Pitch (03)

1B) What do you mean by Geometric, Kinematic and Dynamic similarities. Explain each of them. (03)

1C) Define specific speed of the turbo machine from dimensional analysis obtain an expression for the specific speed of the turbine for the specific speed of the turbine after deriving relevant non-dimensional numbers. (04)

2A) The efficiency η of a fan depends on density ρ, viscosity μ of the fluid, angular velocity ω , diameter D of the rotor and discharge Q through the machine. Develop an expression for the efficiency η in terms of non-dimensional parameters. (05)

2B) One fifth scale model of a pump was tested in a laboratory at 1000 rpm. The head developed and the power input at the best efficiency point were found to be 8 m and 30kW respectively. If the prototype

pump has to work against a head of 25m, determine its working speed, the power required to drive it and the ratio of the flow rates handled by the two pumps. (05)

3A) Derive Euler's turbine energy equation in terms of its components of energy transfer and mention the significance of each component. State the assumption made. Draw neat sketch of velocity triangles. (04)

3B) A hydraulic reaction turbine of radial type works under a head of 160 m of water. The rotor inlet blade angle is 119^0 and the diameter of runner is 3.65 m and at the exit the runner diameter is 2.45 m. If the absolute velocity at the wheel outlet is radially directed with the magnitude of 15.5 m/s and the radial velocity at inlet is 10.3 m/s, find the power developed by the runner assuming 80% of available head is converted into work. Flow rate is $110m^3$/sec. Find degree of reaction. (06)

4A) An air compressor has eight stages of equal pressure ratio of 1.35. The flow rate through the compressor and its overall efficiency are 50 kg/s and 82% respectively. If the condition of air at entry are 1 bar and 40^0C, determine (i) the state of air at compressor exit (b) polytropic efficiency(iii) efficiency of each stage and (iv) power required to drive the compressor assuming, η_{mech} = 90% as well as power required in each stage. (06)

4B) Derive an expression for the utilization factor of a turbine in terms of absolute velocities and degree of reaction. Deduce from the same, the maximum utilization factor for an Impulse turbine and 50 % Reaction turbines. (04)

5A) The turbine inlet and condenser conditions in a 3 stage pressure compounded turbine are 40 bar and 400^0 C at inlet and 0.1 bar and 0.87 dryness fraction at outlet. After expansion in the first stage the steam conditions are 12 bar and 250^0 C. After expansion in the second stage steam is at a pressure of 2 bar and a quality of 0.98. Find the work done in each stage and stage efficiency. Also find the overall

efficiency and Reheat factor. (06)

5B) Explain slip in centrifugal compressor with suitable sketch. Using stodola theory find the relation between number of reasons and slip factor. (04)

6A) Why compounding is essential in steam turbines? In a two stage velocity compounded steam turbine the desired condition for maximum utilization factor is given by $\frac{V}{V_1} = \frac{Cos\ \alpha}{4}$ with usual notations and sketch velocity diagrams. (04)

6B) A reservoir with a height of 280 m is connected to the power house of a hydro electric plant through three pipes each of 2.5 km long and with friction factor 0.006, in which the head loss is not to exceed 34 m. It is a requirement that a total shaft output of 18 MW be develop, and to achieve this it is decided to install a number of single-jet pelton wheels, each with dimensionless specific speed not to exceed 0.23 rad. The ratio of bucket speed to jet speed is 0.46, while the wheel speed is to be 650 rpm. If the nozzles have a discharge coefficient of 0.94 and velocity coefficient of 0.96, and assuming that each wheel has an overall efficiency of 87%, find i) The number of pelton wheel required ii) The wheel diameter iii) The jet nozzle diameter and iv) The diameter of the supply pipe. (06)