



ELIZADE UNIVERSITY, ILARA-MOKIN,
ONDO STATE, NIGERIA
DEPARTMENT OF
MECHANICAL ENGINEERING

SECOND SEMESTER EXAMINATIONS

2017/2018 ACADEMIC SESSION

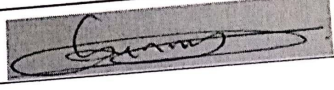
COURSE: MEE518 – Turbomachinery (3 Units)

CLASS: 500 Level Mechanical Engineering

TIME ALLOWED: 2 Hours 30 minutes

INSTRUCTIONS: Attempt any FOUR (4) questions

Date: July/August, 2018


HOD'S SIGNATURE

Question 1

(a) Identify the different kinds of turbomachine based on the throughflow or flow path classification, stating their differences. **(6 marks)**

(b) These data were gathered from the performance test of a pump
 $T_a=25^\circ\text{C}$; $p_a=2.5\text{ kPa}$; $P_m=894\text{ W}$; $p_d=155\text{ kPa}$; $p_c=149.0\text{ kPa}$; $\eta_e=0.890$; $D=10\text{ cm}$; $d=5\text{ cm}$.
At $T_a=25^\circ\text{C}$, $\rho_{H_2O}=997\text{ kgm}^3$ and kinematic viscosity = $0.904 \times 10^{-6}\text{ m}^2\text{s}^{-1}$.
Determine the single point performance characteristics of this pump. **(9 marks)**

Question 2

(a) Explain the forms of similarities that must be achieved to undertake data extrapolation in dimensional analysis. **(6 marks)**

(b) A fan is tested over the following range
 $0 \leq Q \leq 110\text{ m}^3\text{s}^{-1}$; $0 \leq \Delta p_T \leq 1300\text{ Pa}$; $0 \leq P \leq 100\text{ kW}$,
with the design point performance (BEP) of $Q=80\text{ m}^3\text{s}^{-1}$; $\Delta p_T=1000\text{ Pa}$; and $P=90\text{ kW}$. The fan diameter is $D=1.2\text{ m}$, the speed is $N=103\text{ s}^{-1}$ (980 rpm) and the air density is $\rho=1.2\text{ kgm}^3$.
What would be the BEP performance of this fan design at a different size and speed? For example, suppose
 $D=30\text{ inches}=2.5\text{ ft}$,
 $N=1800\text{ rpm}=188.5\text{ s}^{-1}$,
 $\rho=0.0023\text{ slugft}^3$. **(9 marks)**

Question 3

(a) Explain what you understand by cavitation and list the undesirable effects of cavitation (6 marks)

(b) A particular type of fan has, at its BEP, $\phi = 0.455$ and $\psi = 0.055$. What size (D) and speed (N) would be required for a fan of this type to deliver 20,000 cfm at 1 in.wg total pressure? What are the specific speed, N_s , and specific diameter, D_s , of the fan "sized" above. Take 1 in.wg to be 5.204 lb/ft² and note that cfm means cubic feet per minute. (9 marks)

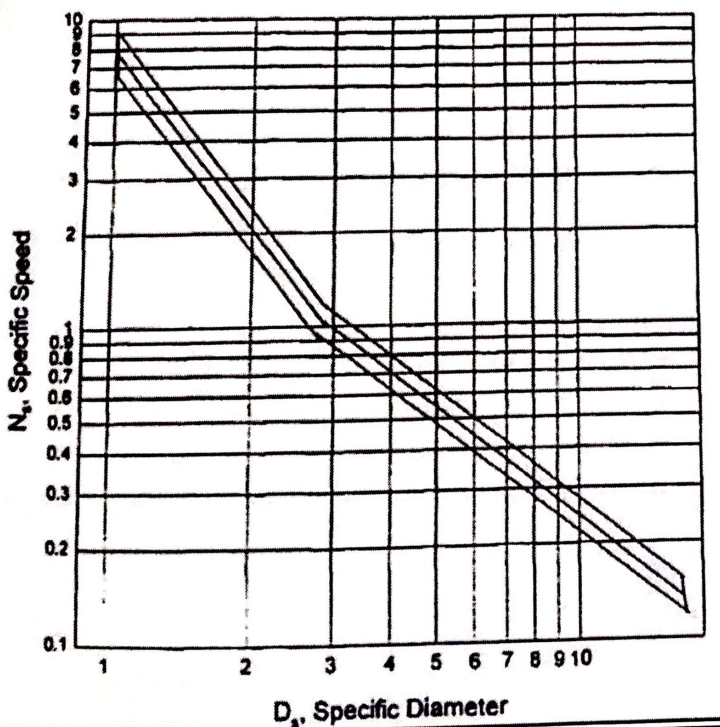
Question 4

(a) What is the Net Positive Suction Head? Mention **four factors** on which the actual efficiency of a turbomachine depends. (6 marks)

(b) A water slide in an amusement park requires a pump to deliver 0.5 m³/s of water against a head of 50 m. For best economy, an AC induction motor with either two poles or four poles will be directly-coupled to the pump. Specify which motor to use and the type of pump required and estimate the pump size, power requirement, and required NPSH. Assume motor slip of 50 rpm, so that the pump speed, N , will be either 3550 rpm with a 2-pole motor or 1750 rpm with a 4-pole motor (9 marks)

Question 5

(a) Identify the three broad flow regions on which the Cordier diagram below may be classified (6 marks)



Question 3

- (a) Explain what you understand by cavitation and list the undesirable effects of cavitation (6 marks)
- (b) A particular type of fan has, at its BEP, $\phi = 0.455$ and $\psi = 0.055$. What size (D) and speed (N) would be required for a fan of this type to deliver 20,000 cfm at 1 in.wg total pressure? What are the specific speed, N_s , and specific diameter, D_s , of the fan "sized" above. Take 1 in.wg to be 5.204 lb/ft² and note that cfm means cubic feet per minute. (9 marks)

Question 4

- (a) What is the Net Positive Suction Head? Mention four factors on which the actual efficiency of a turbomachine depends. (6 marks)
- (b) A water slide in an amusement park requires a pump to deliver 0.5 m³/s of water against a head of 50 m. For best economy, an AC induction motor with either two poles or four poles will be directly-coupled to the pump. Specify which motor to use and the type of pump required and estimate the pump size, power requirement, and required NPSH. Assume motor slip of 50 rpm, so that the pump speed, N , will be either 3550 rpm with a 2-pole motor or 1750 rpm with a 4-pole motor (9 marks)

Question 5

- (a) Identify the three broad flow regions on which the Cordier diagram below may be classified (6 marks)

