Ref. No.: Ex/ME/T/326C/2019

B.E. MECHANICAL ENGINEERING 3RD YEAR 2ND SEM. EXAMINATION, 2019

MECHANICAL MEASUREMENT AND INDUSTRIAL STATISTICS

Time: Three hours **Full Marks: 100**

Answer any FIVE questions
(Tables of *z, t, F and Chi-square* distributions can be used if required)

1a) Write the expression of probability density function of normal distribution. Draw normal distributions for the following cases (draw at least two distribution in each case): (a) Different mean but same SD (b) Different mean and different SD

b) A manufacturing process has the following data regarding the process: (4+4)
Process mean = 60 unit; Process standard deviation = 4 unit; Production specification = 62±8 unit
Determine process capability indices and the number of rejected items out of a total output of 8000 items. (12)

2a) What do you mean by 'Null Hypothesis' and 'Alternate Hypothesis' ? What are the errors involved in testing of hypothesis ? (8)

b) The following experimental data shows the tensile strength (in kg/mm^2) of 12 specimens of certain material:
26.8, 25.5, 25.2, 24.1, 26.4, 25.6, 24.4, 26.8, 25.4, 23.8, 25.4, 23.6
Can it be concluded that tensile strength of the material is 25 kg/mm^2 ? Determine the 95% confidence interval of true tensile strength of the material. (12)

3a) Define the term 'Reliability' mathematically.
Show that $\lambda(t) = \frac{f(t)}{R(t)}$. The notations bear the usual meanings. (3+8)

b) Explain the significance of Weibull failure parameters. (9)

4a) Explain the exponential failure law. Show that the failure rate remains constant for components following exponential failure law. (3+5)

b) The times to failure of 10 components are as follows (in days): (12)
1250, 835, 1330, 990, 1055, 1185, 880, 1210, 1395, 1090
Assume two parameter Weibull distribution and estimate the values of failure parameters. Also calculate the reliability and failure rate of the component for a specified time period of 1025 days.

[Turn over

5a) Describe the working principle of electrical strain gauge. Derive the expression of 'Gauge Factor'. What do you mean by Temperature Compensation for electrical strain gauge. (4+6+2)

b) Derive the expression for change in output voltage for a strain gauge ballast circuit assuming necessary physical quantities and notations. (8)

5a) Describe the working principle of electrical strain gauge. Derive the expression of 'Gauge Factor'. What do you mean by Temperature Compensation for electrical strain gauge. (4+6+2)

b) Derive the expression for change in output voltage for a strain gauge ballast circuit assuming necessary physical quantities and notations. (8)

6a) Perform analysis of variance and estimate percent contribution of main effects and interaction for the data given in the following table: (14)

	B1	B2	B3
A1	200, 215	246, 254	275, 270
A2	240, 242	262, 260	280, 284

b) Explain the basic principles of Design of Experiment. (6)

7a) Two components having same and constant failure rate 'λ' are connected to form a standby system with 1-operating unit and 1-standby unit. Derive the expression for system reliability and MTTF for the system. (12)

(b) Prove that MTTF = $\int_0^\alpha R(t)dt$. The notations bear usual meanings. (8)

8. Write short notes on the followings (any four): (4 x 5)

a) Testing of hypothesis

b) Uncertainty in measurement

c) Factorial experiments

d) Two tailed test

e) Confidence interval

f) Transducer element

g) Precision and accuracy

h) Robust design