Ref. No.: Ex/ME(M2)/PE/B/T/316G/2024

B.E. MECHANICAL ENGINEERING THIRD YEAR FIRST SEMESTER EXAM 2024

MECHANICAL MEASUREMENT AND INDUSTRIAL STATISTICS

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

(Answer any FIVE question)

(Tables of *z, t, F and Chi-square* distributions may be used)

1a) Define 'process capability'. What are different types of Process Capability Indices ? Explain the significance of process capability indices with reference to process performance. (2+2+6)

1b) A manufacturing process has the following data regarding the process:
Process mean = 154 unit; Process standard deviation = 12 unit; Production specification = 162±28 unit
Perform process capability study on the above process and comment on your conclusions. (10)

2a) Explain the following terms with reference to testing of hypothesis: (12)
Test statistics, Level of significance, p-value, Two tailed test

2b) Explain the steps involved in testing of hypothesis for a single specified variance. (8)

3a) Explain the errors involved in testing of hypothesis. How will you select sample size based on the errors ? (4+6)

3b) The following data shows the cutting speed of a grade of HSS cutting tool (in m/min)
252, 248, 261, 237, 242, 255, 265, 273, 248, 278
Can it be concluded that tensile strength of the material is 260 m/min with $\alpha = 5\%$? Determine the 95% confidence interval of true cutting speed of HSS cutting tool. (10)

4a) Explain any one probability distribution used in test of variance. Mention the expressions for test statistics and confidence interval for testing a single specified variance. (4+4)

4b) The following data shows the tensile strength (in kg/mm^2) of Material-A and Material-B:
Material-A: 37.8, 25.5, 34.2, 36.3, 30.4, 25.6, 29.6, 26.8, 25.4, 40.6, 37.8, 32.7
Material-B: 47.8, 35.2, 42.3, 48.4, 35.6, 29.6, 28.4, 40.6, 47.8, 34.7
Can it be concluded that the variances of two materials are equal with $\alpha = 5\%$? Determine the 95% confidence interval of the ratio true variances of the two materials. (12)

[Turn over

5a) Define the term 'Reliability' mathematically. Show that, $\lambda(t) = \frac{f(t)}{R(t)}$

The notations bear the usual meanings (4+7)

5b) Explain the three parameter Weibull failure law. Deduce the expression for failure rate for this failure law. (4+5)

6a) Explain the significance of Weibull failure parameters. (9)

6b) The times to failure of 10 components are as follows (in days): (11)

1250, 835, 1330, 990, 1055, 1185, 880, 1210, 1395, 1090

Assume two parameter Weibull distribution and use analytical method to estimate the values of failure parameters. Also calculate the reliability and failure rate of the component for a specified time period of 850 days.

7a) Five components having same and constant failure rate 'λ' are connected to form a standby system with 2-operating unit and 3-standby unit. Derive the expression for system reliability and MTTF for the system. Assume perfect switching device. (12)

7b) Derive the expression of system reliability for k - *out of* – m system. (8)