

B.E. MECHANICAL ENGINEERING (PART TIME) 3RD YEAR 2ND SEM. EXAMINATION, 2018**MECHANICAL MEASUREMENT AND INDUSTRIAL STATISTICS****Time: Three hours****Full Marks: 100****Answer any FIVE questions****(Tables of z , t , F and χ^2 distributions can be used)**

- 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): (i) Same mean but different SD
(ii) Different mean but same SD (iii) Different mean and different SD (2+6)
- 1b) A manufacturing process has the following data regarding the process:
Process mean = 60 unit; Process standard deviation = 6 unit; Production specification = 55 ± 16 unit
Calculate rejection percentage of products. (12)
- 2a) What do you mean by process capability index ? Write down the expressions for process capability indices.
Explain its significance with reference to process performance. (4+2+6)
- 2b) Calculate process capability indices and comment on the performance of the process for the problem given in Question (1b). (8)
- 3a) Define the term 'Reliability' and mention its mathematical expression.
Show that $\lambda(t) = \frac{f(t)}{R(t)}$, the notations bear the usual meanings, (4+8)
- 3b) Prove that $\int_0^\infty R(t)dt$, the notations bear the usual meanings, (8)
- 4a) What do you mean by 'shape parameter' and 'characteristic life' of a component ? (6)
- 4b) The times to failure of 10 components are as follows (in days):
1050, 805, 1350, 980, 1075, 1285, 870, 1220, 1390, 1090
Assume two parameter Weibull distribution and estimate the values of failure parameters using analytical method. Calculate the reliability of the component for a specified time period of 850 days. (10+4)

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- 5a) Two components having same and constant failure rate ' λ ' are connected to form a standby system with 1-operating unit and 2-standby unit. Derive the expression for system reliability and MTTF for the system. Assume perfect switching device. (14)
- 5b) By drawing a rough sketch of Weibull graph paper, explain how to determine the failure parameters using this graph paper. (6)
- 6a) What are the functional elements of a measurement system. Explain the function of transducer element with appropriate example. (4+4)
- 6b) Explain the principle of strain measurement using electrical resistance strain gauge. Derive the expression for Gauge Factor for electrical resistance strain gauge. (4+8)
- 7a) Prove that the change in output voltage (de) under optimal sensitivity for a Ballast Circuit can expressed as:
- $$de = \frac{GF}{4} \varepsilon E \quad (12)$$
- where, GF = Gauge Factor; ε = Strain induced, E = Source voltage of Ballast Circuit
- 7b) An electrical resistance strain gauge is bonded to a beam which is 20 cm long and has a cross sectional area of 4 square cm. The unstrained resistance and Gauge Factor of the strain gauge are 220 Ω and 2.2 respectively. On application of load, the resistance of the gauge changes by 0.018 Ω . If the modulus of elasticity for the beam material is 208 GPa, calculate (i) The change in length of the beam (ii) The force applied to the beam. (8)
- 8) Write short notes on the followings (any four) : (4 x 5)
- Accuracy of a measuring device
 - Precision of a measuring device
 - Median rank
 - Static sensitivity
 - k-out of-m system* configuration
 - Hysteresis effect in a measuring device
 - Parallel system configuration