B.E. MECHANICAL ENGINEERING 3RD YEAR 2ND SEM. EXAMINATION, 2018

Subject: **MECHANICAL MEASUREMENT AND INDUSTRIAL STATISTICS**

Time: Three hours | Full Marks: 100

Different parts of the same question should be answered together.

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

CO1 [10]	*Answer any **one (1) from (a) and (b) in this block*** [1] (a) What do you mean by Process Capability Index (PCI) ? Write the expressions for different PCI. Explain its significance with reference to process performance. [2+2+6] (b) Mention the different functional elements of a generalized measurement system. What is the function of a transducer element ? What do you mean by 'uncertainty' in measurement ? [4+2+4]
CO2 [20]	*Answer any **one (1) from (a) and (b) in this block*** [2] (a) Describe the platform scale used for measuring large force. [8] Explain the principle of strain measurement used in electrical resistance strain gauge. Derive the expression for Gauge Factor for electrical resistance strain gauge. [4+8] (b) Explain the steps to be taken to improve the sensitivity of equal arm analytical balance. Differentiate between accuracy and precision with suitable example. [6+4] Certain quantity of plastic material having density 1550 Kg/m^3 weighed on a standard equal arm balance. Equilibrium condition is obtained by brass weights of 170 gm where the ambient air is at temperature 21°C and at pressure 101.36 kPa. The density of brass weight is 8370 Kg/m^3. Calculate the true weight of plastic material and the percentage error that would result if balance readings are taken without correction of buoyancy effect of air. Given, Universal gas constant (R) = 0.287 $\frac{KJ}{KgK}$ [10]
CO3 [40]	*Answer any **two (2) from (a), (b) and (c) in this block:*** [3](a) What do you mean by 'Null Hypothesis' and 'Alternate Hypothesis' ? What are the errors involved in testing of hypothesis ? [4+4] The following experimental data shows the tensile strength (in kg/mm^2) of 10 specimens of certain material: 27.8, 25.5, 24.2, 24.3, 26.4, 25.6, 24.6, 26.8, 25.4, 23.6 Can it be concluded that the standard deviation in tensile strength of the material is more than 2.5 kg/mm^2 with α = 5% ? Determine the 95% confidence interval of the standard deviation of true tensile strength of the material. [12] (b) Show that $\lambda(t) = \frac{f(t)}{R(t)}$, The notations bear the usual meanings. [6] The times to failure of 10 components are as follows (in days): 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. [8+6]

(c) Prove that MTTF = $\int_0^{\infty} R(t)dt$. [6]

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 imperfect switching device. [14]

CO4 [30]

Answer any two (2) from (a), (b) and (c) in this block:

[4](a) What are 'main effect' and 'interaction' with reference to factorial experiments. [4]

Perform analysis of variance and estimate percent contribution of main effects and interaction for the data given in the following table. The values in the table show the observed data of the response variable: [11]

	B1	B2	B3
A1	30, 32, 34	38, 40	44, 48
A2	24, 26	36, 37	30, 28, 32

Assume level of significance as 5%

(b) Use Chi-square test to justify whether the following data fits into the nonlinear model, $Y = aX^b$. [15]

X	24	35	42	56	60	72
Y	30	45	65	96	156	206

Assume level of significance as 5%.

(c) It is necessary to determine the uncertainty in estimating the mass of a cylindrical solid object with hemispherical ends attached on both ends. [15]
The various dimensions and densities are estimated as follows:
Length = 30.0 ± 0.10 cm, Density of cylindrical portion = 3.5 ± 0.10 gm/cc,
Radius = 4.00 ± 0.05 cm, Density of hemispherical portions = 2.5 ± 0.05 gm/cc
Calculate the total mass of the body and its overall uncertainty.

Course Outcomes:

The students of the course should be able to –
CO1: Interpret the basic concepts of measurement systems and statistics. (K2)
CO2: Employ fundamental concepts of measurement applicable for designing of engineering systems. (K2)
CO3: Apply statistical concepts to solve problems related to measurement, engineering and management. (K3)
CO4: Compare performance of engineering and measurement systems using statistical techniques. (K4)