| Reg. No. | | | | | | | | | | |
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# MANIPAL INSTITUTE OF TECHNOLOGY
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**VII SEMESTER B.TECH (BIOTECHNOLOGY)**
**END SEMESTER EXAMINATIONS, NOV/DEC 2017**
**SUBJECT:** BIOSTATISTICS & ANALYTICAL TECHNIQUES [BIO 4103]
**REVISED CREDIT SYSTEM (16/11/2017)**

Time: 3 Hours MAX. MARKS: 50

**Instructions to Candidates:**

- Answer **ALL** the questions.
- Missing data may be suitable assumed.

**1A.** Assume that the refractive index **($n_D$)** follows the multiple linear equation $n_D = A + BW_p + CW_s$. The regression coefficients values are as follows: A = 1.329; B = 0.1469; C = 0.1957. Calculate the value of $R^2$. **5**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **$W_P$** | 0.1 | 0.15 | 0.2 | 0.25 | 0.3 | 0.1 | 0.15 | 0.2 | 0.25 | 0.3 |
| **$W_s$** | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 |
| **$n_D$** | 1.3452 | 1.3532 | 1.3592 | 1.3674 | 1.3741 | 1.3481 | 1.3557 | 1.3628 | 1.3697 | 1.3776 |

**1B.** Sucrose concentration in a fermentation broth is measured using HPLC. Chromatogram peak areas are measured for five standard sucrose solutions to calibrate the instrument. Measurements are performed in triplicate with results as follows: **5**

| Sucrose concentration (g/L) | Peak area |
|---|---|
| 6 | 55.55, 57.01,57.95 |
| 12 | 110.66,114.76,113.05 |
| 18 | 168.9,169.44,173.55 |
| 24 | 233.66,233.89,230.67 |
| 30 | 300.45,304.56,301.11 |

i. Find an equation for sucrose concentration as a function of peak area using simple linear regression.

ii. A sample containing sucrose gives a peak area of 209.86, what is the sucrose concentration?

**2A** The concentration of a drug in a tablet of 100 mg dosage was measured by two methods. Construct the stem-leaf plot and Box-Whisker plot for the data. Determine the mean, mode, standard deviation. Which method do you recommend? Why? **6**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Method 1 (mM)** | 68 | 22 | 36 | 32 | 42 | 24 | 28 | 38 |
| **Method 2 (mM)** | 36 | 38 | 39 | 40 | 36 | 34 | 33 | 32 |

**2B** The following output was obtained from a computer program that performed a two-factor ANOVA on a factorial experiment. Fill in the blanks in the ANOVA table. **4**

| Source | DF | SS | MS | F |
|---|---|---|---|---|
| **A** | 1 | -- | 0.0002 | -- |
| **B** | -- | 180.378 | -- | -- |
| **Interaction** | 3 | 8.479 | -- | -- |
| **Error** | 8 | 158.797 | -- | |
| **Total** | 15 | 347.653 | | |

**3A** An engineer is investigating the yield (Y) of a process. Two variables ($X_1$ & $X_2$) are of interest. Each variable can be run at a low and high level, and he decides to run a $2^2$ design with five center points. The resulting yields are: Yield at the factorial points (in standard order): 63.1, 87.8, 50, 76.3 and the yield at the center points: 80.5, 76.8, 79.2, 77.5, 78.4. Fit this data into a regression model $Y = A + BX_1 + CX_2$ by least square regression method. **5**

**3B** The following table shows a Plackett-Burman design for seven variables ($X_1$ to $X_7$) at high (H) and low (L) levels in a fermentation medium. Determine the main effect of each variable and find out the most influential variables among them: **5**

| Trial | Variables | | | | | | | Yield |
|---|---|---|---|---|---|---|---|---|
| | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ | $X_7$ | |
| **1** | H | H | H | L | H | L | L | 10 |
| **2** | L | H | H | H | L | H | L | 60 |
| **3** | L | L | H | H | H | L | H | 12 |
| **4** | H | L | L | H | H | H | L | 8 |
| **5** | L | H | L | L | H | H | H | 60 |
| **6** | H | L | H | L | L | H | H | 9 |
| **7** | H | H | L | H | L | L | H | 10 |
| **8** | L | L | L | L | L | L | L | 14 |

**4A** You are interested in optimizing the enzyme activity by checking different combinations of two factors namely, pH ($2 \leq pH \leq 7$) and temperature ($20 \leq T \leq 40$ °C). A first order model in coded variables has been fit to yield data from $2^2$ designs. The design and the resulting enzyme activity (IU) at the factorial points (in standard order): 3.93, 4, 4.09, 4.15, and IU at the center points: 4.03, 4.05, 4.07, 4.02, 4.06. The model is $Y= 4.04 + 0.0325\ X_1 + 0.0775\ X_2$. **5**

i. Is there any curvature in the model?
ii. After checking curvature, how do you proceed to the optimization?

**4B** CCD was suggested for the optimization of pH and temperature for the production of carboxymethyl cellulase synthesized by a fungal system. List all the experimental runs that are needed in CCD, in coded and uncoded forms. **5**

| Variable | pH | Temp (°C) |
|---|---|---|
| **Low** | 5 | 20 |
| **High** | 7 | 30 |

**5A** The Beer-Lambert law relates the absorbance A of solution to the concentration C of a species in solution. Measurements of A are made at various concentrations. **5**

| Concentration (mM) | 1 | 1.2 | 1.5 | 1.7 | 2 |
|---|---|---|---|---|---|
| **Absorbance @ 600 nm** | 0.99 | 1.13 | 1.52 | 1.73 | 1.96 |

i. Let $A = B_o+B_1C$ be the equation of the least-squares line for predicting absorbance and concentration. Compute the values of $B_o$ and $B_1$.
ii. Let $A = B_1C$ be the equation of the least-squares line for predicting absorbance and concentration. Compute the value of $B_1$.
iii. If the standard error of the $B_o$ and $B_1$ for the first model are 0.09 and 0.06 and the $t_{crit}$ value is 3.18 and if the standard error of the $B_o$ for the second model is 0.012 and the $t_{crit}$ value is 2.78, which model do you select?

**5B** The following XRD data has been observed for the ZnO nanoparticles. Calculate the average crystallite size in nm using Debye-Scherrer equation. Assume that $\lambda$= 1.54056 Å and C =0.98 **5**

| Peak no. | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| **2θ (°)** | 31.80 | 34.44 | 36.29 | 47.57 | 56.61 | 67.96 | 69.07 |
| **FWHM (°)** | 0.152 | 0.192 | 0.238 | 0.309 | 0.217 | 0.370 | 0.401 |