MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

II SEMESTER M.TECH (INDUSTRIAL BIOTECHNOLOGY)

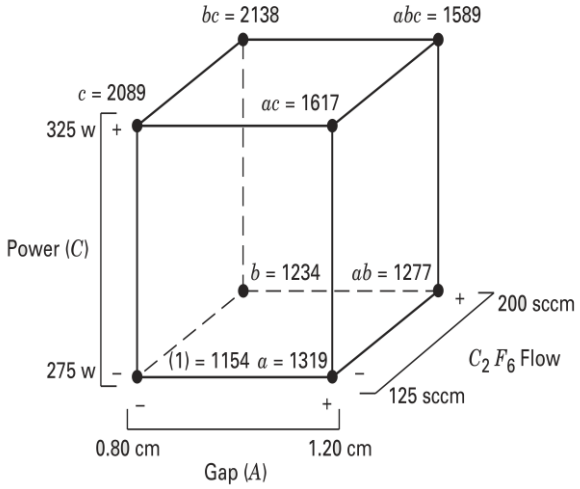
END-SEMESTER EXAMINATION, 29/06/22 (02:00-05:00PM)

SUBJECT: STATISTICAL DESIGN AND ANALYSIS OF EXPERIMENTS IN BIOTECHNOLOGY (BIO 5011)

REVISED CREDIT SYSTEM

ANSWER ALL QUESTIONS

TIME: 3 HOURS **MAX. MARKS: 50**

Q. NO		MARKS	CO	BTL
1A	Give a graphical representation of the fitting the model y = mx + e to the data y_1, y_2, y_3 and x_1, x_2, x_3.	**3**	1	4
1B	For the given set of data (for response), 28,30,32,35,26,50,34,29,48,13,31,37,98,44,43 and 56, find out mean, median, mode, trimmed mean, trimmed median of 5%, range, minimum, maximum, standard deviation, variance, and IQR of the data (with and without outliers). Construct a dot plot and Box-whisker plot.	**4**	1	4
1C	Suppose that you want to investigate the factors that potentially affect purification and extraction of crude enzyme from the fermenter. What would you use as a response variable in this experiment? How would you measure the response? List all of the potential sourses of variability that could impact the response. Write down the problem statement, factors screened and optimized for the response.	**3**	1	4
2A	A 2^3 factorial design was used to develop a nitride etch process on a single-wafer plasma etching tool. The design factors are the gap between the electrodes, the gas flow and the RF power applied to the cathode. The response variable is the etch rate for silicon nitride (A/m). The etch rate data are shown geometrically in Figure 2A. Estimate the main effect for ***a, b, c, ab, ac, bc and abc***. Construct the main effect plot for variable ***a, b, c and all possible two-way interaction plots***. 	**5**	2	2,3
2B	Determine the coefficient and construct the regression equation of $Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_1X_2 + b_5X_1X_3 + b_6X_2X_3 + b_7X_1X_2X_3$ for **2A**.	**2**	2	3
2C	Starting with a 16-run 2^4 design, show how two three level factors can be incorporated in this experiment. How many two-level factors can be included if we want some information on two-factor interactions?	**3**	2	4
3A	Genetic theory states that children having one parent of blood type A and the other of blood type B will always be of one of three types, A, AB, B and that the proportion of three types will on an average be as 1 : 2 : 1. A report states that out of 300 children	**3**	3	4, 5

<table>
<tr><td></td><td>having one A parent and B parent, 30 per cent were found to be types A, 45 per cent per cent type AB and remainder type B. Test the hypothesis by chi-square test and degree of freedom (Tabulated value of chi-square at 5 per cent level of significance is 5.991.).</td><td></td><td></td><td></td></tr>
<tr><td>3B</td><td>Construct the ANOVA table for the data of a, b, c, ab, ac, bc and abc. given in Question No: 2A. The assumptions for ANOVA table are, total degree of freedom is 15 and degree of freedom for error is equal to 8. The SSE is 18,020.5000.</td><td>4</td><td>3</td><td>3</td></tr>
<tr><td>3C</td><td>Outline the analysis of variance table for a $2^2 3^2$ factorial design. Discuss how this design may be confounded in blocks.</td><td>3</td><td>3</td><td>3</td></tr>
<tr><td>4A</td><td>A chemical engineer is investigating the yield of a process. Three process variables are of interest: temperature, pressure, and catalyst concentration. Engineer decides to run a 2^3 design with four center points. The resulting yields are 32, 46, 57, 65, 36, 48, 57, 50, 44, 53, 56. Suppose that the engineer decides to fit a main effects only model, say $Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3$</td><td>4</td><td>4</td><td>3</td></tr>
<tr><td>4B</td><td>The luciferase enzyme in fireflies catalyzes the modification of luciferin, consuming both luciferin and ATP, and producing light. A series of experiments are performed in which 5 μM luciferase enzyme is mixed with various concentrations of substrate S0, and the relative reaction rates are measured in terms of light emission rates (RLU), measured using a photomultiplier tube:
<table>
<tr><td>S0 (μM)</td><td>5</td><td>10</td><td>20</td><td>40</td><td>80</td><td>200</td><td>500</td><td>1000</td></tr>
<tr><td>RR (RLU)</td><td>3554</td><td>6262</td><td>10115</td><td>14611</td><td>18786</td><td>22672</td><td>24718</td><td>25484</td></tr>
</table>
From the data, estimate the Vmax (in RLU) and K_m (in μM) by least square analysis.</td><td>4</td><td>4</td><td>3</td></tr>
<tr><td>4C</td><td>Determine R-square and ARD for Q.NO.4B.</td><td>2</td><td>4</td><td>2</td></tr>
<tr><td>5A</td><td>You studied the effects of three factors of interest on the yield of a chemical reaction using a full factorial design plus three center points. You found that curvature was important, and want to augment the design with star points and three more center points to make it a full central composite design
<table>
<tr><td>Variable coding</td><td>Low (-1)</td><td>Center point (0)</td><td>High (+1)</td></tr>
<tr><td>X1</td><td>130</td><td>150</td><td>170</td></tr>
<tr><td>X2</td><td>800</td><td>1000</td><td>1200</td></tr>
<tr><td>X3</td><td>30</td><td>40</td><td>50</td></tr>
</table>
List the additional runs that are needed to be included to the table, in both coded and uncoded form. The star point level for the design is 1.68. If you have severe budget constraints, write down the whole CCD in three factors, using coded factors. Then put a check in front of each run that would still be required for the small composite design. How many runs would be saved?</td><td>4</td><td>5</td><td>4</td></tr>
<tr><td>5B</td><td>An experimental study to determine the effects of six factors on the response of enzyme activity. Call these factors A, B, C, D, E, and F. i). If a full factorial design is used, how many runs are needed? ii). Construct a two-level resolution IV design requiring 16 runs. iii).What effects are confounded with the main effects A, with the BD interaction?</td><td>3</td><td>5</td><td>3</td></tr>
<tr><td>5C</td><td>Construct a 2^{6-2} fractional factorial design with high resolution possible. What are the generators of your design? What us defining relation of your design? What is confounded with the main effect 3 of your design? What is confounded with 1x2 interaction?</td><td>3</td><td>5</td><td>2</td></tr>
<tr><td colspan="5">CO: Course Outcome; BLOOM TAXONOMY LEVEL: 1-Remember, 2-Understand, 3-Apply, 4-Analyze, 5-Evaluate, 6-Create</td></tr>
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