Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

II SEMESTER M.TECH (INDUSTRIAL BIOTECHNOLOGY)
END SEMESTER EXAMINATIONS, MAY 2017
SUBJECT: **STATISTICAL DESIGN AND ANALYSIS OF EXPERIMENTS IN BIOTECHNOLOGY [BIO 5253]**
REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

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

1 (10)

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 = 1.3; B = 0.145; C = 0.296. Calculate the value of R^2 and ARD.

W_P	0.25	0.3	0.35	0.4	0.45	0.25	0.3	0.35	0.4	0.45
W_S	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04
n_D	1.3452	1.3532	1.3592	1.3674	1.3741	1.3481	1.3557	1.3628	1.3697	1.3776

2 (10)

A chemical engineer is investigating the yield (Y) of a process. Two process variables (X_1 and X_2) are of interest. Each variable can be run at a low and high level, and the engineer decides to run a 2^2 design with five center points. The design and the resulting yields are as follows: 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.

3 (10)

Your aim is to maximize the chromatographic response function (CRF) in a HPLC method. The factors studied in this study with their levels in the eluent of acetic acid, methanol and citric acid are given below:

Factor	Low	High
Acetic acid (mol/L)	0.004	0.01
% Methanol	70	80
Citric acid (g/L)	2	6

The results of 2^3 full factorial design in standard order is given as:

CRF	10	9.5	11	10.7	9.3	8.8	11.9	11.7

Determine the main effects and interaction effects. Based on the analysis, what coded factor levels of A, B and C would you recommend?

4A. (5)

Explain the following concepts in DOE with an example:

<table>
<tr><td></td><td>a. Hidden replication
b. Free of bias</td><td></td></tr>
<tr><td>4B.</td><td>You are interested in optimizing the enzyme activity of a fermentation process 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) are as follows: 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 $Y= 4.04 + 0.0325\ X_1 + 0.0775\ X_2$.

i. Is there any curvature in the model?
ii. After checking curvature, how do you proceed to the optimization?</td><td>5</td></tr>
<tr><td>5A</td><td>Assume that you have got a second order model equation at the end of response surface methodology. How do you check the following? Support your answers with specific plots as applicable:
i. significance of the model
ii. significance of each terms in the model
iii. normal distribution of errors
iv. independency of errors
v. lack of fit of the model</td><td>5</td></tr>
<tr><td>5B</td><td>You studied the effects of three factors of interest on the yield of a reaction using a full (two-level) factorial design plus three center points. Now you want to make it a full central composite design. List the additional runs that are needed in the table below, in both coded and uncoded form.

<table><tr><th>Variable</th><th>A</th><th>B</th><th>C</th></tr><tr><td>Low</td><td>13.6</td><td>0.8</td><td>6.8</td></tr><tr><td>High</td><td>14.8</td><td>1.6</td><td>7.4</td></tr></table></td><td>5</td></tr>
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