Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

II SEMESTER M.TECH (INDUSTRIAL BIOTECHNOLOGY)
END SEMESTER EXAMINATIONS, MAY 2016
SUBJECT: **STATISTICAL DESIGN AND ANALYSIS OF EXPERIMENTS IN BIOTECHNOLOGY** [BIO 530]
REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ANY FIVE FULL** 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 = 1.329; B = 0.1469; C = 0.1957. Calculate the value of R^2 and ARD.

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

2 (10)

Assume that you have three factors (X_1, X_2 and X_3) to be optimized for a process (Y, %). First you run 2^3 factorial design.

i. At the end of ANOVA you have found out that one of these four factors is not significant. Will it corroborate the concept of hidden replication in DoE? Justify:

ii. Accidentally, you missed one of the responses in the factorial runs. Will it affect the final regression model? Discuss:

iii. Because of various limitations, you were unable to keep the exact value of each of the three factors during experimentation. Will it affect the final regression model? Discuss:

iv. Finally you ended up with a regression model (coded) $Y = 89.38 - 1.05\ x_1 - 1.97\ x_2 - 7.24\ x_1^2 - 2.18\ x_1x_2 - 11.72\ x_2^2$. Your friend says that the optimum value of the two significant factors are: X_1= 23.1% ; X_2 = 11.7%. Determine the response at these optimum values:

Variable	**X_1**	**X_2**	**X_3**
Low	21.2	9.8	15.5
High	25.2	13.8	30.5

3 (10)

A chemical engineer is investigating the yield (Y) of a process. Three process variables (X_1,X_2 and X_3) are of interest. Each variable can be run at a low and high level, and the engineer decides to run a 2^3 design with four center points. The design and the resulting yields are as follows: Yield at the factorial points (in standard order): 32, 46, 57, 65, 36, 48, 57, 68 and Yield at the center points: 50, 44, 53, 56. Fit this data into a regression model $Y = A + BX_1 + CX_2 + DX_3$ by least square regression method.

4 (10)

An engineer is interested in the effects of three process variables (A,B & C) on a response (R). Two levels of each factor are chosen and three replicates of a 2^3 factorial design are run.

	The results are as follows: Factor: A, B, C; Response (R): Trial 1, Trial 2, Trial 3 -1 -1 -1 22 31 25 1 -1 -1 32 43 29 -1 1 -1 35 34 50 1 1 -1 55 47 46 -1 -1 1 44 45 38 1 -1 1 40 37 36 -1 1 1 60 50 54 1 1 1 39 41 47 i. Estimate the factors effects. Which effects appear to be large? ii. Write down a regression model for predicting the response on the results of this experiment? iii. Construct main effect and interaction plots. iv. Based on the analysis, what coded factor levels of A, B and C would you recommend?	
5A.	The following output was obtained from a computer program that performed a two-factor ANOVA on a factorial experiment: Two way ANOVA Source: DF, SS, MS, F, F_{crit} A: 1, ?, 0.0002, ?, ? B: ?, 180.378, ?, ?, Interaction: 3, 8.479, ?, ?, Error: 8, 158.797, ?, Total: 15, 347.653, i. Fill in the blanks in the ANOVA table. ii. How many levels were used for factor B?	**5**
5B.	You are interested in optimizing the yield of a process by checking different combinations of two factors namely, time ($30 \leq t \leq 40$min) and temperature ($150 \leq T \leq 160$°F). A first order model in coded variables has been fit to yield data from 2^2 designs. The design and the resulting yields are as follows: Yield at the factorial points (in standard order): 39.3, 40, 40.9, 41.5, and Yield at the center points: 40.3, 40.5, 40.7, 40.2, 40.6. The model is $Y= 40.44 + 0.775X_1+0.325\ X_2$. i. Is there any curvature in the model? ii. After checking curvature, how do you proceed to the optimization?	**5**
6A	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. **Variable**: **A**, **B**, **C** **Low**: 130, 800, 30 **High**: 170, 1200, 50	**5**
6B	You have been given a regression model. How will you check the following? i. Errors are normally distributed ii. Errors have the same variance iii. Errors are independent iv. Errors have a mean of zero	**5**