Reg. No.Manipul Institute of Manipal UniversityA constituent Institute of Manipal UniversityINSERSTER M.TECH (INDUSTRIAL BIOTECHNOLOGY) END SEMESTER M.TECH (INDUSTRIAL BIOTECHNOLOGY) END SEMESTER M.TECH (INDUSTRIAL BIOTECHNOLOGY) SUBJECT: STATISTICAL DESIGN AND ANALYSIS OF EXPERIMENTS IN BIOTECHNOLOGY [BIO 530] REVISED CREDIT SYSTEMTime: 3 HoursMAX. MARKS: 50Instructions to Candidates: • Answer ANY FIVE FULL the questions. • Missing data may be suitable assumed.Instructions to Candidates: • Answer ANY FIVE FULL the questions. • Missing data may be suitable assumed.Instructions to Candidates: • Answer ANY FIVE FULL the questions. • Missing data may be suitable assumed.IAssume that the refractive index (np) follows the multiple linear equation no = A + BWp+ CW The regression coefficients values are as follows: A = 1.329; B = 0.1469; C = 0.1957. Calculate the value of R ² and ARD.IIWp 0.1 0.15 0.2 0.25 0.3 0.1 0.15 0.2 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02 No 1.3452 1.3532 1.3592 1.3674 1.3741 1.3481 1.3557 1.3628 1.3697 1.3776Assume that you have three factors (X1, X2 and X3) to be optimized for a process (Y, %). First you may ² factorial design. • A 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: • A. Accidentally, you missed one of the responses in the factorial runs. Will it affect the final regression model? Discuss: • Finally you ended up with a regression model (coded) Y = 89.38 - 1.05 x ₁ - 1.97 x ₂ - 7.24 x ₁ ⁴ - 2.18 x ₁ x ₂																
Manipal Institute of Technology, Manipal (A constituent Institute of Manipal University) (I) SEMESTER M.TECH (INDUSTRIAL BIOTECHNOLOGY) END SEMESTER EXAMINATIONS, MAY 2016 SUBJECT: STATISTICAL DESIGN AND ANALYSIS OF EXPERIMENTS IN BIDTECHNOLOGY [BIO 530] REVISED CREDIT SYSTEM Time: 3 Hours Max: MARKS: 50 Missing data may be suitable assumed. Missing data may be suitable ass					Re	g. No.										
II SEMESTER M.TECH (INDUSTRIA BIOTECHNOLOGY) END SEMESTER EXAMINATIONS, MAY 2016SUBJECT: STATISTICAL DESIGN AND ANALYSIS OF EXPERIMENTS IN BIOTECHNOLOGY [BIO 530] REVISED CREDIT SYSTEMTime: 3 HoursMAX. MARKS: 50Instructions to Candidates: • Answer ANY FIVE FULL the questions. • Missing data may be suitable assumed.1MAX. MARKS: 50Instructions to Candidates: • Answer ANY FIVE FULL the questions. • Missing data may be suitable assumed.1MAX. MARKS: 50Imme: 3 HoursMAX. MARKS: 50Instructions to Candidates: • Answer ANY FIVE FULL the questions. • Missing data may be suitable assumed.1Maxume that the refractive index (no) follows the multiple linear equation np = A + BWp+ CW4. The regression coefficients values are as follows: A = 1.329; B = 0.1469; C = 0.1957. Calculate the value of R ² and ARD.1Wp 0.1 0.15 0.2 0.25 0.3 0.1 0.15 0.2 0.02 0.02 0.02 0.02 0.02 0.02 0.02 0.02May to a not a the value of R ² and ARD.1May to a not a significant 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? JUSTIY; ii. Accidentally, you mised one of the responses in the factorial runs. Will it affect the final regression model? Discuss: ii. Because of various limitations, you were unable to keep the exact value of each of the three factors are: Xi= 23.1% ; Xi = 11.7%. Determine the response at these optimum values:Vuiriable Xi Xi Xi Xi <th>हा</th> <th>Ma</th> <th>nipa</th> <th>l Ins A Const</th> <th>titute ituent In</th> <th>e of T stitute o</th> <th>ech of Mani</th> <th>nolog</th> <th>gy, N versitv)</th> <th>/Ia</th> <th>nij</th> <th>pa</th> <th>I KN MARINA</th> <th>OWLEDG</th> <th>E IS POWER</th> <th>)</th>	हा	Ma	nipa	l Ins A Const	titute ituent In	e of T stitute o	ech of Mani	nolo g	gy, N versitv)	/Ia	nij	pa	I KN MARINA	OWLEDG	E IS POWER)
END SEMESTER EXAMINATIONS, MAY 2016SUBJECT: STATISTICAL DESIGN AND ANALYSIS OF EXPERIMENTS IN BIOTECHNOLOGY [BIO 530] REVISED CREDIT SYSTEMTime: 3 HoursMAX. MARKS: 50Instructions to Candidates: 	BY LIF	E	II SEM	IESTER	M.TECH	I (INDU	STRIA	L BIOTE	ECHNO	LOC	SY)			TTUT	EOT	
MAX. MARKS: 50Instructions to Candidates: \diamond Answer ANY FIVE FULL the questions. \diamond Missing data may be suitable assumed.1Assume that the refractive index (np) follows the multiple linear equation np = 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.1Wr00.10.10.150.10.		SUBJI	ECT: ST	END SE ATISTIC	EMESTE Cal des Biote(Revis	R EXAN Sign An Chnol(Ed Cre	INATI ID AN DGY [E	ONS, M ALYSIS BIO 530 YSTEM	IAY 201 OF EX 	6 (PEF	RIME	ΞΝΤ	rs in			
Instructions to Candidates: \diamond Answer ANY FIVE FULL the questions. \diamond Missing data may be suitable assumed.1 $n_D = A + BW_p + CW_s$. The regression coefficients values are as follows: $A = 1.329$; $B = 0.1469$; $C = 0.1957$. Calculate the value of R^2 and ARD. $\overline{W_P}$ 0.10.1469; $C = 0.1957$. Calculate the value of R^2 and ARD. $\overline{W_P}$ 0.10.150.20.250.30.10.150.20.250.30.10.150.20.220.30.10.150.20.220.30.10.160.010.010.010.010.020.020.020.020.020.020.020.020.020.020.020.031.34521.35321.35921.36741.37411.34811.35571.36281.36971.3776Assume that you have three factors (X1, X2 and X3) to be optimized for a process (Y, %).First you run 2³ factorial design.i.A 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	Tim	ie: 3 H	lours							MA	AX.	MA	RKS:	50		
 Answer ANY FIVE FULL the questions. Missing data may be suitable assumed. 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 R² and ARD. Wr 0.1 0.15 0.2 0.25 0.3 0.1 0.15 0.2 0.25 0.3 Ws 0.00 0.01 0.01 0.01 0.00 0.02 0.02 0.02					Instru	ctions to	Candi	idates:								
1Assume that the refractive index (np) follows the multiple linear equation np = A + BWp+ CWs. The regression coefficients values are as follows: A = 1.329; B = 0.1469; C = 0.1957. Calculate the value of R ² and ARD.We0.10.150.20.250.30.10.150.20.250.3Ws0.010.010.010.010.010.020.020.020.020.020.02np1.34521.35321.35921.36741.37411.34811.35571.36281.36971.3776Assume that you have three factors (X1, X2 and X3) 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 ₁ x 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:VariableX1X2X3Mathematical engineer is investigating the yield (Y) of a process. Three process variables (X1, 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 <b< td=""><th></th><td></td><td>AnswMissi</td><td>er ANY ng data n</td><td>FIVE FU</td><td>LL the class</td><td>juestior umed.</td><td>18.</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></b<>			AnswMissi	er ANY ng data n	FIVE FU	LL the class	juestior umed.	18.								
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	Assume that the refractive index (n _D) follows the multiple linear equat $n_D = A + BW_p + CW_s$. The regression coefficients values are as follows: A = 1.329; I 0.1469: C = 0.1957. Calculate the value of R ² and ARD												uation); B =	10		
Ws 0.010.010.010.010.020.020.020.020.02no1.34521.35321.35921.36741.37411.34811.35571.36281.36971.3776Assume that you have three factors (X1, X2 and X3) to be optimized for a process (Y, %). First you run 2³ 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 ₁ x 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 	T	WP	0.1	0.15	0.2	0.25	0.3	0.1	0.1	5	0.2	2	0.25		0.3	
Imp1.34521.35321.35921.36741.37411.34811.35571.36281.36971.3776Assume that you have three factors (X1, X2 and X3) to be optimized for a process (Y, %). First you run 2³ 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 ₁ x 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:VariableX1X2X3 LowA 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 2³ 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.104An engineer is interested in the effects of three process variables (R). Two levels of each factor are chosen and three replicates of a 2³ factorial design are run.11		Ws	0.01	0.01	0.01	0.01	0.01	0.02	0.0	2	0.02	2	0.02		0.02	
Assume that you have three factors (X1, X2 and X3) 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 ₁ x 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 X1 X2 X3 Low 21.2 9.8 15.5 High 25.2 13.8 30.5 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 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.		n _D	1.3452	1.3532	1.3592	1.3674	1.3741	1.3481	1.355	7 1	.3623	8	1.3697	1.	.3776	
Variable A_1 A_2 A_3 Low 21.2 9.8 15.5 High 25.2 13.8 30.5 A chemical engineer is investigating the yield (Y) of a process. Three process variables $(X_1, X_2 \text{ and } X_3)$ 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.104An 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.10	2	 Assume that you have three factors (X1, X2 and X3) to be optimized for a process (Y, %). First you run 2³ factorial design. 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: Accidentally, you missed one of the responses in the factorial runs. Will it affect the final regression model? Discuss: 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: Finally you ended up with a regression model (coded) Y = 89.38 - 1.05 x₁ - 1.97 x₂ - 7.24 x₁² - 2.18 x₁x₂ - 11.72 x₂². Your friend says that the optimum value of the two significant factors are: X₁ = 23.1%; X₂ = 11.7%. Determine the response at these optimum values: 										10				
High 25.2 13.8 30.5 High 25.2 13.8 30.5 A chemical engineer is investigating the yield (Y) of a process. Three process variables (X1,X2 and X3) 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.104An 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.10					varia	bie w	A 1 21.2	9.8	15.5	5						
 A chemical engineer is investigating the yield (Y) of a process. Three process variables (X₁,X₂ and X₃) are of interest. Each variable can be run at a low and high level, and the engineer decides to run a 2³ 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 + BX₁ + CX₂ + DX₃ by least square regression method. 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 2³ factorial design are run. 					Hig	yh	25.2	13.8	30.5	5						
4An 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.10	\$	A chemical engineer is investigating the yield (Y) of a process. Three process variables $(X_1, X_2 \text{ and } X_3)$ 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.											10			
(R). Two levels of each factor are chosen and three replicates of a 2 [°] factorial design are run.	4	An engineer is interested in the effects of three process variables (A,B & C) on a response										10				
	-	(R). 7	Two level	s of each	factor ar	e chosen	and thr	ee replic	ates of a	1 2 ³ f	actor	rial	design	ı are	run.	

	The results are as follows:											
		Factor			Response	e (R)						
	Α	A B C		Trial 1 Trial 2 Tria		13						
	-1	-1	-1	22	31	2	5					
	1	-1	-1	32	43	29)					
	-1	1	-1	35	34	50)					
	1	1	-1	55	47	40	5					
	-1	-1	1	44	45	38	3					
	1	-1	1	40	37	30	5					
	$\begin{array}{ c c c c c c c c c c c c c c c c c c c$											
	$\begin{array}{c c c c c c c c c c c c c c c c c c c $											
	i Fsti	imate the f	actors effe	ects Wh	hich effec	ts annear	to be larg	e?				
	ii Wri	ite down a	regression	n model	for predi	cting the	response (on the res	sults of this			
	exp	eriment?	1051055101	ii iiiouci	ioi picai		response		und of und			
	iii. Construct main effect and interaction plots											
	iv. Based on the analysis, what coded factor levels of A, B and C would vou recommend?											
	The follow	ing output	was obtai	btained from a computer program that performed a two-factor								
	ANOVA on a factorial experiment:											
		~			o way Al	NOVA				_		
	Source			DF	SS		MS	F	F _{crit}	-		
5A.	A			1	?	0	0.0002	?	?	_	5	
	т	B		?	180.37	8	?	?		-		
	In	Interaction		3	8.4/9	7	?	?		-		
		Error	1	8	158.79	/	?			-		
	; D:11	10tal	lia in tha	$13 \qquad 347.033$								
	I. FIII ii Hoy	In the dial	uels wore	ANUVA used for	factor B	7						
	11. 110	w many ic	vers were		Tactor D	•					<u> </u>	
	You are interested in optimizing the yield of a process by checking different combinations of											
	two factors namely, time ($30 \le t \le 40$ min) and temperature ($150 \le T \le 160^{\circ}$ F). A first order											
	model in c	coded vari	ables has	been fit	t to yield	data fr	2^2 des	igns. Tł	ne design and	the	_	
5B.	resulting yi	ields are as	s follows:	Yield at	the facto	orial poir	its (in stan	dard orde	er): 39.3, 40, 4	0.9,	5	
	41.5, and	Yield at	the cen	iter poi	nts: 40.3	3, 40.5,	40.7, 40	0.2, 40.6	. The mode	l is		
	Y=40.44 +	- 0.775X1+	-0.325 X ₂ .									
	i. Is th	here any ci	urvature ir	the mo	del?			•				
	11. Afte	er checkin	g curvatur	e, how o	lo you pr	oceed to	the optimi	zation?			<u> </u>	
	Vou studied the effects of three fectors of interest on the visit of a meeting using a full (the											
	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										_	
6 A	and uncoded form			Variable A P								
			vari	lable	A 120	D		_				
				OW	130	800	30					
			H	igh	170	1200	50					
	You have b	been given	a regressi	on mod	el. How v	vill you o	check the f	ollowing	?			
6R	i. Erro	i. Errors are normally distributed									5	
	ii. Errors have the same variance											
	iii. Erro	ors are ind	ependent									
iv. Errors have a mean of zero												