MUZAFFARPUR INSTITUTE OF TECHNOLOGY, Muzaffarpur

COURSE FILE

OF

Operational Research

(021723)

Faculty Name:

Mr. Shobhit Gusain

ASSISTANT PROFESSOR, DEPARTMENT OF MECHANICAL ENGINEERING

Content

VISION OF THE DEPARTMENT

To strengthen the region through imparting superior quality technical education and research; which enables the fulfillment of industrial challenge and establish itself as a Centre of Excellence in the field of Mechanical Engineering.

MISSION OF DEPARTMENT

- To build an academic environment of teaching and lifelong learning for students to make them competitive in context with advance technological, economical and ecological changes.
- To enable the students to enhance their technical skills and communications through research, innovation and consultancy projects.
- To share and explore the accomplishments through didactic, enlightenment, R & D programs with technical institution in India and abroad.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

After 4 to 5 years of graduation a BE (ME) graduate would be able to :

- Use core competence acquired in various areas of Mechanical engineering to solve techno managerial issues for creating innovative products that leads to better livelihoods and economy of resources.
- To establish themselves as effective collaborators and innovators to address technical, managerial and social challenges.
- To equip students for their professional development through lifelong learning and career advancement along with their organizational growth.
- To serve as a driving force for proactive changes in industry, society and nation.

PROGRAMME OUTCOMES (PO)

Students who complete the B.E. degree in ME will have :

- An ability to apply the knowledge of mathematics, basic sciences and engineering concepts to solve the complex engineering problems.
- The ability to conduct experiments and to critically analyze and interpret the experimental data to reach at substantial outcomes.

- An ability to design systems, components, or processes to meet appropriate needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability.
- An ability to identify, formulates, and solves the complex engineering problems.
- An ability to function on multi-disciplinary teams that leads the multi-disciplinary projects.
- An understanding of professional and ethical responsibility.
- An ability to communicate effectively with written, oral, and visual means.
- An ability to understand the impact of engineering solutions in a global, environmental, economical and societal context.
- An ability to recognize the need to engage in life-long learning.
- An ability to attain knowledge of contemporary issues.
- An ability to use the techniques, skills, and modern tools necessary for Mechanical engineering practice.
- Possess ability to estimate costs, estimate quantities and evaluate materials for design and manufacturing purposes.

COURSE OBJECTIVE AND COURSE OUTCOMES:

Institute / College Name :	MUZAFFARPUR INSTITUE OF TECHNOLOGY		
Program Name	**B.E. MECHANICAL**		
Course Code	021723		
Course Name	Operation Research		
Lecture / Tutorial (per week):	3/0	**Course Credits**	3
Course Coordinator Name	MR. SHOBHIT GUSAIN		

Course objective:

On completion of this course you should be able to:

- 1. Define and formulate linear programming problems and appreciate their limitations.
- 2. Solve linear programming problems using appropriate techniques and optimization solvers, interpret the results obtained and translate solutions into directives for action.
- 3. Conduct and interpret post-optimal and sensitivity analysis and explain the primal-dual relationship.
- 4. Develop mathematical skills to analyse and solve integer programming and network models arising from a wide range of applications.
- 5. Effectively communicate ideas, explain procedures and interpret results and solutions in written and electronic forms to different audiences.

MAPPING OF COs AND POs

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	3	3	-	-	-	-	-	1	2	2
CO2	3	3	3	2	1	-	-	-	-	1	-	2
CO3	3	2	2	3	-	-	-	-	-	3	-	2
CO4	3	3	4	2	-	-	2	1	-	1	1	2
CO5	3	3	2	2	-	-	2	1	-	2	1	3

Correlation level: 1- slight (Low) 2- moderate (Medium) 3-substantial (High)

SYLLABUS

Topics	No of lectures	Weightage
Scope and application of operation research.	2	7%
Linear programming, graphical and simplex method.	5	15%
Transportation and assignment models.	4	15%
Simulation and Monte-Carlo techniques.	2	10%
Queuing theory (single and double channel)	4	12%
CPM and PERT and CPM-crashing networks	5	15%
Dynamic programming. Sequencing model (n jobs-2 machines), Replacement problems and Reliability theory,	6	9%
Inventory models with probabilistic demands and area, quantity constraints, Game theory (competitive strategies).	4	10%
Non-Linear Programming (Kuhn and Tucker condition).	3	6%

GATE Syllabus of Design of Machine Elements:

Linear programming, simplex method, transportation, assignment, network flow models, simple queuing models, PERT and CPM.

MUZAFFARPUR INSTITUTE OF TECHNOLOGY

B.Tech. 7th (Seventh) Semester, Mechanical Engineering, (2015 Batch) Faculty time table

7th Semester Mechanical								ROOM NO-47
Day/ time	**9:00-10:00**	**10:00-11:00**	**11:00-12:00**	**12:00-13:00**	**13:00-14:00**	**14:00-15:00**	**15:00-16:00**	**16:00-17:00**
MON					**B R E A K**			
TUE				**Operation Research**				
WED			**Operation Research**					
THU			**Operation Research**			**Operation Research(Tut.)**	**Operation Research (Tut.)**	
FRI						**Operation Research(Tut.)**		
SAT								

STUDENT LIST:

S.NO.	Roll No	Name
1	15M01	ASHISH CHAURASIA
2	15M02	RAJ KAMAL
3	15M03	VIVEK KUMAR
4	15M04	RAM BHADRA JHA
5	15M05	RITU RAJ
6	15M06	SUMIT KUMAR
7	15M07	PAWAN KUMAR PIYUSH
8	15M08	HIMANSHU KUMAR
9	15M09	ANMOL
10	15M10	MADHU PRIYA
11	15M11	SANJAN KUMAR YADAV
12	15M12	PRAVEEN KUMAR
13	15M13	VIKASH KUMAR KESHRI
14	15M14	AHSAN SOHAIL
15	15M15	MUKESH KUMAR ROY
16	15M16	SAJAN KUMAR
17	15M17	SUMAN KUMAR SINHA
18	15M18	RITESH KUMAR
19	15M19	SHANUR RAHMAN WAHID
20	15M20	MD AFTAB ALAM
21	15M21	DHEERAJ KUMAR
22	15M23	SAROJ KUMAR PASWAN
23	15M24	MAYANK
24	15M25	ASHOK DAS
25	15M26	ALOKRAJ
26	15M28	ASHIWANI KUMAR
27	15M29	NEHAL ANSARI
28	15M30	DHARMENDRA KUMAR
29	15M31	ASHVANI KUMAR
30	15M32	DHANANJAY KUMAR
31	15M33	RAHUL KUMAR
32	15M34	RANJAN KUMAR
33	15M35	ANURAG KUMAR RAVI
34	15M36	RAVI RAJ
35	15M37	ANKIT AKASH
36	15M38	PRAMENDRA KUMAR
37	15M39	RAMESH KUMAR
38	15M40	GANGA RAM MANDAL

39	15M41	ROHIT KUMAR
40	15M42	UJJWAL KASHYAP
41	15M44	NISHANT KIRAN
42	15M46	AMAN KUMAR JHA
43	15M47	NITISH KUMAR
44	15M48	NAVEEN KUMAR
45	15M49	DHANANJAY KUMAR CHOUDHARY
46	15M50	AAKASH KUMAR
47	15M51	DEEPAK KUMAR
48	15M52	SURANJAN KUMAR
49	15M53	MONU KUMAR
50	15M54	SANJEEV KUMAR ADITYA
51	15M55	ISHA SHARMA
52	15M56	NEETU GUPTA
53	15M57	AMIT KUMAR
54	15M58	MERAJ AHMED
55	15M59	MANISH KUMAR SINGH
56	15M60	ABHINANDAN KUMAR
57	15M61	RAM KUMAR MAHTO
58	15M62	ROHIT RAJ
59	15M63	VIKAS KUMAR SAXENA
60	15M64	SUMIT KUMAR
61	15M65	PRAKASH KUMAR
62	15M66	ANAND MOHAN DEO
63	15M67	ADITYA KUMAR
64	16(LE)M01	ADITYA KUMAR
65	16(LE)M02	SHAKTI KUMAR
66	16(LE)M03	ROHIT KUMAR
67	16(LE)M04	KUMARI PRIYA RANJAN
68	16(LE)M05	KAMLESH KUMAR
69	16(LE)M06	KUMAR PRATIK VISHWAS
70	16(LE)M07	VIKRANT KUMAR
71	16(LE)M08	NIRBHAY KUMAR
72	16(LE)M09	RAUSHAN KUMAR SINGH
73	16(LE)M10	HIMANSHU CHANDRA

Reference Books:

1. Rader, D. J. 2010, Deterministic Operations Research: Models and Methods in Linear Optimization, J. Wiley & Sons

2. Taha, H. A. 2007, Operations Research, 8th edn, Pearson

3. Taylor, B. W. III 2013, Introduction to Management Science, 11th edn, Prentice Hall

4. Schrage, L. 1997, Optimization Modeling with LINDO, 5th edn, Thomson

5. Winston, W. L. 2004, Operations Research: Applications and Algorithms, 4th edn, Thomson

6. Williams, H. P. 2013, Model Building in Mathematical Programming, 5th edn, Wiley

7. Hillier, F. S. and Lieberman, G. J. 2010, Introduction to Operations Research, 9th edn, McGraw-Hill.

COURSE PLAN

Lecture Number	**Date of Lecture**	**Topics**
1-2		**Introduction**
		Scope and application of operation research
3-4		**Linear programming**
		Linear Programming, graphical and simplex method.
5-7		**Transportation model**
		North West Corner rule and Vogel's Approximation method for finding basic feasible solution, Stepping Stone and uv method for optimum solution
8-12		**Assignment models.**

		Variables and constraints, Hungarian method
13-16		**Simulation and Monte-Carlo techniques.**
		Simulation and Monte-Carlo techniques.
17-20		**Queuing theory (single and double channel).**
		Different models in Queuing theory, Single and double channel Queuing
21-28		**CPM and PERT**
		CPM, PERT, Crashing
29-35		**Dynamic modelling**
		Dynamic programming. Sequencing model (n jobs-2 machines), Replacement problems and Reliability theory, Inventory models with probabilistic demands and area, quantity constraints, Game theory (competitive strategies).
36-38		**Non-Linear Programming**
		Kuhn and Tucker condition in Non-Linear Programming

Assignment 1

1. A company has three operational departments (weaving, processing and packing) with capacity to produce three different types of clothes namely suitings, shirtings and woolens yielding a profit of Rs. 2, Rs. 4 and Rs. 3 per metre, respectively. One metre suitin requires 3 minutes in weaving 2 minutes in processing and 1 minute in packing. One metre of shirting requires 4 minutes in weaving, 1 minute in processing and 3 minutes in packing while one metre of woollen requires 3 minutes in each department. In a week, total run time of each department is 60, 40 and 80 hours for weaving, processing and packing departments, respectively. Formulate as LPP to maximize the profit.
2. A company has factories at A, B and C which supply warehouses at D, E and F. Weekly factory capacities are 200, 160 and 90 units respectively. Weekly warehouse requirements (demands) are 180, 120 and 150 units respectively. Unit shipping costs (in Emalangeni) are as follows:

Factory	D	E	F	Capacity
A	16	20	12	**200**
B	14	8	18	**160**
C	26	24	16	**90**
Demand	**180**	**120**	**150**	**450**

Determine the optimum distribution for this company to minimize shipping costs.

3. Suppose a queueing system has two servers, with mean of 1 hour, and exponential service times with mean of 1 hour per customer. Suppose a customer has just arrived at 12.00 noon.
   1). What is the probability that the next arrival will come before 1.00 pm (between 1.00 pm and 2.00 pm, after 2.00 pm)?
   2). Suppose no customer arrives before 1.00 pm. What is the probability that the next arrival will come between 1.00 pm and 2.00 pm?
   3). What is the probability that the number of arrivals between 1.00 pm and 2.00 pm will be zero (one, more than one?
   4). Suppose that both servers are serving customers at 1.00 pm. What is the probability that neither customer will have service completed before 1.01 pm (before 1.10 pm, before 2 pm)?

UNIVERSITY QUESTION PAPERS:

Code : 021723

B.Tech.7th Semester Special Examination,2016

Operation Research

Time : 3 hours *Full Marks : 70*

Instructions :

*(i) There are **Nine** questions in this paper.*

*(ii) Attempt **Five** questions in all.*

*(iii) **Questions No.1 is Compulsory.***

(iv) The marks are indicated in the right hand margin.

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1. Answer the following multiple choice questions: (Any Seven) 14

(i) Graphical method, simplex method and transportation method are concerned with
- (a) Value analysis
- (b) linear programming
- (c) Break-even analysis
- (d) queuing theory

(ii) In a transportation problem, there are 4 supply centers and 5 demand centers. The total quantity of supply available is greater than the total demand. The number of allocation, without degeneration during an iteration is

(vi) The Critical path of a network represents;
- (a) Minimum time required for completion of a project
- (b) Maximum time required for completion of a project
- (c) Minimum cost required for completion of a project
- (d) Maximum cost required for completion of a project

(vii) Stimulation is basically a technique which is used for
- (a) Optimization
- (b) Testing alternative
- (c) Cost minimization
- (d) Computerization

(viii) A project plan is given below

Activity	Time duration(weeks)	Predecessors
A	2	None
B	2	None
C	7	A
D	12	A
E	10	B
F	3	D,E
G	4	C,F

The project duration is
- (a) 21 weeks
- (b) 25 weeks
- (c) 12 weeks

- (a) 3
- (b) 9
- (c) 6
- (d) 0

(iii) If 'a' is the optimistic time, 'b' is the pessimistic time, 'm' is the most likely time of an activity, then expected time of an activity is
- (a) (a+ m+ b)/6
- (b) (a+4m+b)/6
- (c) (a+2m+b)/6
- (d) (a+m+b)/3

(iv) In PERT, the distribution of an activity time is assumed to be
- (a) Normal
- (b) gamma
- (c) beta
- (d) exponential

(v) The ratio of mean arrival time to mean service time is found as 1.2, it indicates the queue would be
- (a) Become explosive
- (b) Not become explosive
- (c) Uncertain
- (d) None of these

- (d) 9 weeks

(ix) Market demand for springs is 8,00,000 per annum. A Company purchase these spring in lot and sell them the cost of making a purchase order is Rs. 1200. Cost of storage of spring is Rs. 120 per annum. The Economic Order Quantity (EOQ) is
- (a) 400
- (b) 2828
- (c) 4000
- (d) 8000

(x) In a M/M/1 queue, the service rate is
- (a) Poisson
- (b) exponential
- (c) linear
- (d) none of these

2. By Simplex Method, find out how many units of product A and B should be made per week. Product A requires 2 kg of raw material and 4 hour of labour. Product B requires 3 kg of raw material and 3 hours of labour. Every week availability of the raw material is 60 kg and labour is of 96 hours. Profit per units of A and B is Rs. 40/- and Rs. 35/- respectively. 14

3. (a) Solve the following transportation problem to obtain feasible solution.

	D_1	D_2	D_3	D_4	Availability
O_1	11	13	17	14	**250**
O_2	16	18	14	10	**300**
O_3	21	24	13	10	**400**
Requirement	**200**	**225**	**275**	**250**	

(b) A departmental head has four subordinates, and four tasks to be performed. The subordinates differ in efficiency and the tasks differ in their intrinsic difficulty. His estimate of the time each man would take to perform each task is given in the matrix below. How should the task be allotted one to a man so as to minimize the total man-hours?

	E	F	G	H
A	18	26	17	11
B	13	28	14	26
C	38	19	18	15
D	19	26	24	10

7+7

4. State Kuhn-Tucker conditions. Use Kuhn-Tucker condition to solve the following NLPP (Nonlinear programming problem).

Maximize $Z = -X_1^2 - X_2^2 - X_3^2 + 4X_1 + 6X_2$ subjected to the constraints

$X_1 + X_2 \leq 2$

$2X_1 + 3X_2 \leq 12$

$X_1 X_2 \geq 0$ 14

5. We have 5 jobs, each of which must go through the 2 machines A and B in the order AB. Processing times in hours are given in the table below. 14

Job	Time of Machine A	Time of Machine B
1	5	2
2	1	6
3	9	7
4	3	8
5	10	4

Determine sequence for the five jobs that will minimize the elapsed time T and total idle time on Machine A and B.

6. A small project is composed of seven activities whose time estimates are in the table below:

Activity	Optimistic time (weeks)	Most Likely time (weeks)	Pessimistic time (weeks)
1-2	1	1	7
1-3	1	4	7
1-4	2	2	8
2-5	1	1	1
3-5	2	5	14
4-6	2	5	8
5-6	3	6	15

(i) *Draw the project network.*

(ii) Find the expected duration and Variance of each activity.

(iii) Determine Critical Path. What is the expected Project length?

(iv) If the project due date is 19weeks, what is the probability of meeting the due data? 14

7. A self-service store employs one cashier at its counter. 8 customers arrive on an average every 5 minutes while the cashier can serve 10 customers in the same time. Assuming Poisson distribution for arrival and exponential distribution for service rate. Determine the following:

(i) Average number of customers in the system.

(ii) Average number of customers in queue (average queue length)

(iii) Average time a customer spends in the system.

(iv) Average time a customer waits before being served.

(v) Probability that there is no customer at the counter.

(vi) Utilization factor.

(vii) Probability that there are more than 2 customers in the system. 14

8. Attempt any 4 14

(i) Distinguish between PERT and CPM.

(ii) What is Gantt Chart? Illustrate with an example.