Vidya Jyothi Institute of Technology

(An Autonomous Institution)
(Accredited by NAAC & NBA, Approved by AICTE New Delhi & Permanently Affiliated to JNTUH)
Aziznagar Gate, C.B. Post, Hyderabad-500 075

DEPARTMENT OF MECHANICAL ENGINEERING

REGULATION: R18

BATCH: 2018-2022

ACADEMIC YEAR: 2021 - 2022

PROGRAM: B.TECH (MECHANICAL ENGINEERING)

YEAR/SEM: IV/I

COURSE NAME: OPERATION RESEARCH

COURSE CODE: A27334

NAME OF THE FACULTY: K.RAJESH KUMAR

DESIGNATION: Associate Professor

HOD

Vidya Jyothi Institute of Technology

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Aziznagar Gate, C.B. Post, Hyderabad-500 075

DEPARTMENT OF MECHANICAL ENGINEERING

REGULATION: R15

BATCH: 2017-2021

ACADEMIC YEAR: 2020 - 2021

PROGRAM: B.TECH (MECHANICAL ENGINEERING)

YEAR/SEM: IV/I

COURSE NAME: OPERATION RESEARCH

COURSE CODE: A17334

NAME OF THE FACULTY: K.RAJESH KUMAR

DESIGNATION: Associate Professor

HOD

Vidya Jyothi Institute of Technology

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Azizmagar Gate, C.B. Post, Hyderabad-500 075

DEPARTMENT OF MECHANICAL ENGINEERING

REGULATION: R15

BATCH: 2016-2020

ACADEMIC YEAR: 2019 - 2020

PROGRAM: B.TECH (MECHANICAL ENGINEERING)

YEAR/SEM: IV/I

COURSE NAME: OPERATION RESEARCH

COURSE CODE: A17334

NAME OF THE FACULTY: K.RAJESH KUMAR

DESIGNATION: Associate Professor

HOD

COURSE FILE INDEX

1. SYLLABUS

UNIT	TOPICS(R18)	Total No. of Hours
I	**Development** – Definition– Characteristics and Phases – Types of models – Operations Research models – applications. **Allocation:** Linear Programming Problem - Formulation – Graphical solution – Simplex method –Artificial variables techniques: Two–phase method, Big-M method; Duality Principle.	12
II	**Transportation Problem:** Formulation – Optimal solution, unbalanced transportation problem – Degeneracy. **Assignment Problem:** Formulation – Optimal solution - Variants of Assignment Problem; Traveling Salesman problem. **Sequencing:** Introduction – Flow –Shop sequencing – n jobs through two machines – n jobs through three machines –two jobs through 'm' machines	12
III	**Replacement:** Introduction – Replacement of items that deteriorate with time – when money value is not counted and counted – Replacement of items that fail completely- Group Replacement. **Waiting Lines:** Introduction –Terminology-Single Channel – Poisson arrivals and Exponential Service times – with infinite population and finite population models.	12
IV	**Theory of Games:** Introduction –Terminology– Solution of games with saddle points and without saddle points- 2 x 2 games –m x 2 & 2 x n games - graphical method – m x n games - dominance principle. **Inventory:** Introduction – Single item, Deterministic models – Types - Purchase inventory models with one price break and multiple price breaks – Stochastic models – demand discrete variable or continuous variable – Single Period model with no setup cost.	14
V	**Dynamic Programming:** Introduction – Terminology- Bellman's Principle of Optimality – Applications of dynamic programming- shortest path problem – budget allocation. **Network Scheduling:** Critical path method, Programme evaluation and review technique, crashing of networks, resource leveling.	14
	Total Hours	64

COURSE PRE-REQUISITES: Basic Mathematics, Concepts of Matrices and Trigonometry

UNIT	TOPICS(R15)	Total No. of Hours
I	**Development** – Definition– Characteristics and Phases – Types of models – Operations Research models – applications. **Allocation:** Linear Programming Problem - Formulation – Graphical solution – Simplex method –Artificial variables techniques: Two–phase method, Big-M method; Duality Principle.	12
II	**Transportation Problem:** Formulation – Optimal solution, unbalanced transportation problem – Degeneracy. **Assignment Problem:** Formulation – Optimal solution - Variants of Assignment Problem; Traveling Salesman problem. **Sequencing:** Introduction – Flow –Shop sequencing – n jobs through two machines – n jobs through three machines –two jobs through 'm' machines	10
III	**Theory of Games:** Introduction –Terminology– Solution of games with saddle points and without saddle points- 2 x 2 games –m x 2 & 2 x n games - graphical method – m x n games - dominance principle. **Sequencing:** Introduction – Flow –Shop sequencing – n jobs through two machines – n jobs through three machines –two jobs through 'm' machines **Waiting Lines:** Introduction –Terminology-Single Channel – Poisson arrivals and Exponential Service times – with infinite population and finite population models.	16
IV	**Replacement:** Introduction – Replacement of items that deteriorate with time – when money value is not counted and counted – Replacement of items that fail completely- Group Replacement. **Inventory:** Introduction – Single item, Deterministic models – Types - Purchase inventory models with one price break and multiple price breaks – Stochastic models – demand discrete variable or continuous variable – Single Period model with no setup cost.	12
V	**Non linear Programming:** Kuhn Tucker conditions – Hessian Matrix for optimality condition. **Simulation:** Definition – Types of simulation models – phases of simulation – applications of simulation – inventory and Queuing problems – Advantages and Disadvantages – Brief introduction of simulation languages.	14
	Total Hours	64

COURSE PRE-REQUISITES: Basic Mathematics, Concepts of Matrices and Trigonometry

2. TEXT BOOKS & OTHER REFERENCES

S. NO.	TITLES(R18)
TEXT BOOKS:	
1	Operations Research, Wagner, PHI Publications
2	Operations Research, ACS Kumar, Yesdee Publications
REFERENCE BOOKS:	
1	Operations Research, A.M. Natarajan, P. Balasubramaniam, A. Tamilarasi, Pearson
2	Operation Research, J.K. Sharma, Mac Milan Publications.
3	Operations Research: Methods and Problems, Maurice Saseini, Arhur Yaspan and Lawrence Friedman, Literary Licensing Publishers
4	Introduction to O.R, Hillier & Libermann, TMH
	Web References: http://nptel.ac.in/courses/112105135/26 https://ocw.mit.edu/courses

S. NO.	TITLES(R15)
TEXT BOOKS:	
1	Hamdy, A. Taha, Operations Research-An Introduction, Sixth Edition, Prentice Hall of India Pvt. Ltd., 1997.
2	S.D. Sharma, Operations Research, Kedarnath, Ramnath & Co., Meerut,2009
3	V.K. Kapoor, Operations Research, S. Chand Publishers, New Delhi, 2004
REFERENCE BOOKS:	
1	Harvey M. Wagner, Principles of Operations Research, Second Edition, Prentice Hall of India Ltd., 1980.
2	R. Paneer Selvam, Operations Research, Second Edition, PHI Learning Pvt. Ltd., New Delhi, 2008.
3	Nita H. Shah, Ravi M. Gor, Hardik Soni, Operations Research, PHI Learning Private Limited, 2013
	Web References: http://nptel.ac.in/courses/112105135/26 https://ocw.mit.edu/courses

3. TIME TABLE

VIDYA JYOTHI INSTITUTE OF TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

ACADEMIC YEAR 2020-21 B.TECH IV-I SEM

TIME TABLE FOR ONLINE CLASSES SECTIONS A

DAY	TIMINGS	COURSE NAME	FACULTY NAME
MON	9.30 - 10.30AM	Operation Research	Dr.V.V.Satyanarayana
	10.45 - 11.45 AM	Computer Aided Design / Computer Aided Manufacturing	Dr.G.Sreeram Reddy
	12.00 - 1.00 PM	Mechanical Measurement & Instruementation	Mr.S.Prasad Kumar
	2.00 - 3.00 PM	Unconventional Machining Process (Fast Track)	Mr.S.Sampath
TUE	9.30 - 10.30AM	Mechanical Measurement & Instruementation	Mr.S.Prasad Kumar
	10.45 - 11.45 AM	Robotics Engineering	Ms.P.Pavani
	12.00 - 1.00 PM	Power Plant Engineering	Mrs.J.Emeema
	2.00 - 3.00 PM	Unconventional Machining Process (Fast Track)	Mr.S.Sampath
WED	9.30 - 10.30AM	Operation Research	Dr.V.V.Satyanarayana
	10.45 - 11.45 AM	Computer Aided Design / Computer Aided Manufacturing	Dr.G.Sreeram Reddy
	12.00 - 1.00 PM	Mechanical Measurement & Instruementation	Mr.S.Prasad Kumar
	2.00 - 3.00 PM	Unconventional Machining Process (Fast Track)	Mr.S.Sampath
THU	9.30 - 10.30AM	Power Plant Engineering	Mrs.J.Emeema
	10.45 - 11.45 AM	Robotics Engineering	Ms.P.Pavani
	12.00 - 1.00 PM	****** Open Elective ******	
FRI	9.30 - 10.30AM	Operation Research	Dr.V.V.Satyanarayana
	10.45 - 11.45 AM	Computer Aided Design / Computer Aided Manufacturing	Dr.G.Sreeram Reddy
	12.00 - 1.00 PM	****** Open Elective*****	
SAT	9.30 - 10.30AM	Mechanical Measurement & Instruementation	Mr.S.Prasad Kumar
	10.45 - 11.45 AM	Robotics Engineering	Ms.P.Pavani
	12.00 - 1.00 PM	Power Plant Engineering	Mrs.J.Emeema
		MMI lab	Mr.S.Prasad Kumar/P Chandra Kumar
		CAD/CAM lab	Dr.G.Sreeram Reddy/Madi Bhoopal Reddy

HOD

VIDYA JYOTHI INSTITUTE OF TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

ACADEMIC YEAR 2020-21 B.TECH IV-I SEM

TIME TABLE FOR ONLINE CLASSES SECTIONS B

DAY	TIMINGS	COURSE NAME	FACULTY NAME
MON	9.30 - 10.30AM	Mechanical Measurement & Instruementation	Dr. Dareddy Ramana Reddy
	10.45 - 11.45 AM	Robotics Engineering	G.Ambika
	12.00 - 1.00 PM	Power Plant Engineering	Mr.Mohammed Amoodi
TUE	9.30 - 10.30AM	Operation Research	Dr.V.V.Satyanarayana
	10.45 - 11.45 AM	Computer Aided Design / Computer Aided Manufacturing	Mr.T.Pavan Kumar
	12.00 - 1.00 PM	Mechanical Measurement & Instruementation	Dr. Dareddy Ramana Reddy
WED	9.30 - 10.30AM	Mechanical Measurement & Instruementation	Dr. Dareddy Ramana Reddy
	10.45 - 11.45 AM	Robotics Engineering	G.Ambika
	12.00 - 1.00 PM	Power Plant Engineering	Mr.Mohammed Amoodi
THU	9.30 - 10.30AM	Operation Research	Dr.V.V.Satyanarayana
	10.45 - 11.45 AM	Computer Aided Design / Computer Aided Manufacturing	Mr.T.Pavan Kumar
	12.00 - 1.00 PM	****** Open Elective ******	
FRI	9.30 - 10.30AM	Mechanical Measurement & Instruementation	Dr. Dareddy Ramana Reddy
	10.45 - 11.45 AM	Robotics Engineering	G.Ambika
	12.00 - 1.00 PM	****** Open Elective*****	
SAT	9.30 - 10.30AM	Operation Research	Dr.V.V.Satyanarayana
	10.45 - 11.45 AM	Computer Aided Design / Computer Aided Manufacturing	Mr.T.Pavan Kumar
	12.00 - 1.00 PM	Mechanical Measurement & Instruementation	Dr. Dareddy Ramana Reddy
		MMI lab	Dr. Dareddy Ramana Reddy/P Raghuram Reddy
		CAD/CAM lab	Mr.T.Pavan Kumar/P.Raghuram Reddy

HOD

VIDYA JYOTHI INSTITUTE OF TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

ACADEMIC YEAR 2020-21 B.TECH IV-I SEM

TIME TABLE FOR ONLINE CLASSES SECTIONS C

DAY	TIMINGS	COURSE NAME	FACULTY NAME
MON	9.30 - 10.30AM	Operation Research	Mr.K.Rajesh
	10.45 - 11.45 AM	Computer Aided Design / Computer Aided Manufacturing	Dr.M.Naveen Kumar
	12.00 - 1.00 PM	Mechanical Measurement & Instruementation	Mr.S.Venkatesh
TUE	9.30 - 10.30AM	Mechanical Measurement & Instruementation	Mr.S.Venkatesh
	10.45 - 11.45 AM	Robotics Engineering	Mr.J.Jagadesh Kumar
	12.00 - 1.00 PM	Power Plant Engineering	Mrs.C.L.Sindhuja
WED	9.30 - 10.30AM	Operation Research	Mr.K.Rajesh
	10.45 - 11.45 AM	Computer Aided Design / Computer Aided Manufacturing	Dr.M.Naveen Kumar
	12.00 - 1.00 PM	Mechanical Measurement & Instruementation	Mr.S.Venkatesh
THU	9.30 - 10.30AM	Power Plant Engineering	Mrs.C.L.Sindhuja
	10.45 - 11.45 AM	Robotics Engineering	Mr.J.Jagadesh Kumar
	12.00 - 1.00 PM	****** Open Elective ******	
FRI	9.30 - 10.30AM	Operation Research	Mr.K.Rajesh
	10.45 - 11.45 AM	Computer Aided Design / Computer Aided Manufacturing	Dr.M.Naveen Kumar
	12.00 - 1.00 PM	****** Open Elective*****	
SAT	9.30 - 10.30AM	Mechanical Measurement & Instruementation	Mr.S.Venkatesh
	10.45 - 11.45 AM	Robotics Engineering	Mr.J.Jagadesh Kumar
	12.00 - 1.00 PM	Power Plant Engineering	Mrs.C.L.Sindhuja
		Mechanical Measurement & Instruementation lab	Mr.S.Venkatesh/S.Ramakrishna
		CAD/CAM lab	Dr.M.Naveen Kumar/Shaik Ismail

HOD

VIDYA JYOTHI INSTITUTE OF TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

ACADEMIC YEAR 2020-21 B.TECH IV-I SEM

TIME TABLE FOR ONLINE CLASSES SECTIONS D

DAY	TIMINGS	COURSE NAME	FACULTY NAME
MON	9.30 - 10.30AM	Mechanical Measurement & Instruementation	G.Sowmya
	10.45 - 11.45 AM	Robotics Engineering	Ch.Rakesh
	12.00 - 1.00 PM	Power Plant Engineering	Mrs.C.L.Sindhuja
TUE	9.30 - 10.30AM	Operation Research	Mr.Abul Hassan
	10.45 - 11.45 AM	Computer Aided Design / Computer Aided Manufacturing	Dr.M.Naveen Kumar
	12.00 - 1.00 PM	Mechanical Measurement & Instruementation	G.Sowmya
WED	9.30 - 10.30AM	Power Plant Engineering	Mrs.C.L.Sindhuja
	10.45 - 11.45 AM	Robotics Engineering	Ch.Rakesh
	12.00 - 1.00 PM	Mechanical Measurement & Instruementation	G.Sowmya
THU	9.30 - 10.30AM	Operation Research	Mr.Abul Hassan
	10.45 - 11.45 AM	Computer Aided Design / Computer Aided Manufacturing	Dr.M.Naveen Kumar
	12.00 - 1.00 PM	****** Open Elective ******	
FRI	9.30 - 10.30AM	Mechanical Measurement & Instruementation	G.Sowmya
	10.45 - 11.45 AM	Robotics Engineering	Mr.J.Jagadesh Kumar
	12.00 - 1.00 PM	****** Open Elective*****	
SAT	9.30 - 10.30AM	Operation Research	Mr.Abul Hassan
	10.45 - 11.45 AM	Computer Aided Design / Computer Aided Manufacturing	Dr.M.Naveen Kumar
	12.00 - 1.00 PM	Power Plant Engineering	Mrs.C.L.Sindhuja
		Mechanical Measurement & Instruementation lab	G.Sowmya/shaik saidulu
		CAD/CAM lab	T. Virajee/Syeda Saniya Fatima

HOD

VIDYA JYOTHI INSTITUTE OF TECHNOLOGY
MECHANICAL ENGINEERING DEPARTMENT

TIMETABLE 2019-2020

IV B.Tech I Sem **SECTION-A** **w.e.f. 22-07-2019**

TIME/ DAY	9.00-9.55	9.55-10.50	10.50-11.45	11.45-12.30	12.30-01.25	01.25-02.20	02.20-03.15	03.15-04.05
MON	CAD/INST.LAB			BREAK LUCH	PPE	OR		TECHNICAL SEMINAR
TUE	PPE	ROB	MMI		CAD/INST.LAB			TECHNICAL SEMINAR
WED	MMI	OR	CAD/CAM		PDP LAB			SPORTS
THU	OR	OE			CAD/CAM	ROB		LIBRARY
FRI	ROB	OE			CAD/CAM	MMI	PPE	T & P
SAT	CAD/CAM	OR	PPE		ROB	MMI	MPR	T & P

SL.NO	SUBJECT	FACULTY
1	MECHANICAL MEASUREMENTS & INSTRUMENTATION	Mr. S. Prasad Kumar
2	POWER PLANT ENGINEERING	Mrs. J.Emeema
3	CAD/CAM	Dr Dileep Kumar Sahu
4	OPERATIONS RESEARCH	Mr. Ch. Rakesh
5	ROBOTICS	Mr. J.Jagadesh Kumar
6	PRODUCTION DRAWING PRACTICE LAB(PD LAB)	Mr. Praveen Kumar
7	CAD/CAM LAB	CL Sindhuja/Mr.J.Pradeep
8	MECHANICAL INSTRUMENTS LAB(MI LAB)	Mr.S.Prasad Kumar/Mrs CL.Sindhuja
9	MINI PROJECT REVIEW(MPR)	Mrs. J.Emeema
10	OPEN ELECTIVE (OPTIMIZATION TECHNIQUES)	Dr.V.V Satyanarayana
11	TECHNICAL SEMINAR	Mr.J.Jagadesh Kumar
12	LIBRARY/SPORTS	Mr. Ch. Rakesh

H.O.D

VIDYA JYOTHI INSTITUTE OF TECHNOLOGY
MECHANICAL ENGINEERING DEPARTMENT
TIMETABLE 2019-2020

IV B.Tech I Sem **SECTION-B** **w.e.f. 22-07-2019**

TIME/ DAY	9.00-9.55	9.55-10.50	10.50-11.45	11.45-12.30	12.30-01.25	01.25-02.20	02.20-03.15	03.15-04.05
MON	PDP LAB			BREAK LUCH	OR	CAD/CAM	PPE	TECHNICAL SEMINAR
TUE	CAD/INS LAB				ROB	PPE	OR	TECHNICAL SEMINAR
WED	PPE	ROB	CAD/CAM		MMI	OR	OR	LIBRARY
THU	CAD/CAM	O.E			MMI	ROB	ROB	SPORTS
FRI	MMI	O.E			CAD/INS. LAB			T & P
SAT	ROB	MMI	CAD/CAM		PPE	OR	MPR	T & P

SL.NO	SUBJECT	FACULTY
1	MECHANICAL MEASUREMENTS & INSTRUMENTATION	Dr.B Ravinder Reddy
2	POWER PLANT ENGINEERING	Mr. Amoodi
3	CAD/CAM	Dr.G.Sreeram Reddy
4	OPERATIONS RESEARCH	Mr. Ch. Rakesh
5	ROBOTICS	Ms.P.Pavani
6	PRODUCTION DRAWING PRACTICE LAB(PD LAB)	Mr. PRAVEEN KUMAR
7	CAD/CAM LAB	Dr.G.Sreeram Reddy/Mr.T.Pavan
8	MECHANICAL INSTRUMENTS LAB(MI LAB)	Mr. Rakesh/Mr.Chandra
9	MINI PROJECT REVIEW(MPR)	Mr.Amoodi
10	OPEN ELECTIVE (MSE)	Mrs.T.Virajee
11	TECHNICAL SEMINAR	Mrs CL.Sindhuja
12	LIBRARY/SPORTS	Mr.Amoodi

H.O.D

VIDYA JYOTHI INSTITUTE OF TECHNOLOGY
MECHANICAL ENGINEERING DEPARTMENT
TIMETABLE 2019-2020

IV B.Tech I Sem **SECTION-C** **w.e.f. 22-07-2019**

TIME/ DAY	9.00-9.55	9.55-10.50	10.50-11.45	11.45-12.30	12.30-01.25	01.25-02.20	02.20-03.15	03.15-04.05
MON	ROBO	OR	MMI	BREAK LUCH	CAD/INS LAB			SPORTS
TUE	OR	PPE	CAD/CAM		ROBO	ROBO	MMI	LIBRARY
WED	OR	PPE	ROBO		CAD/INS LAB			TECHNICAL SEMINAR
THU	CAD/CAM	O.E			PDP LAB			TECHNICAL SEMINAR
FRI	MMI	O.E			OR	PPE	CAD/CAM	T & P
SAT	PPE	ROBO	MMI		OR	CAD/CAM	MPR	T & P

SL.NO	SUBJECT	FACULTY
1	MECHANICAL MEASUREMENTS & INSTRUMENTATION	Mr.Venkatesh
2	POWER PLANT ENGINEERING	Mrs. CL.Sindhuja
3	CAD/CAM	Mr.M.Naveen Kumar
4	OPERATIONS RESEARCH	Mr. K.Rajesh
5	ROBOTICS	Mr. J. Jagadesh Kumar
6	PRODUCTION DRAWING PRACTICE LAB(PD LAB)	Ms.P.Pavani
7	CAD/CAM LAB	Mr.M.Naveen Kumar/Mrs.T.Virajee
8	MECHANICAL INSTRUMENTS LAB(MI LAB)	Mr.Venkatesh/Mr.Amoodi
9	MINI PROJECT REVIEW(MPR)	Mrs.T.Virajee
10	OPEN ELECTIVE (MSE)	Mrs.Sudha Bindhu
11	TECHNICAL SEMINAR	Mrs.Sudha Bindhu
12	LIBRARY/SPORTS	Ms.P.Pavani

H.O.D

VIDYA JYOTHI INSTITUTE OF TECHNOLOGY
MECHANICAL ENGINEERING DEPARTMENT
TIMETABLE 2019-2020

IV B.Tech I Sem **SECTION-D** **w.e.f. 22-07-2019**

TIME/ DAY	9.00-9.55	9.55-10.50	10.50-11.45	11.45-12.30	12.30-01.25	01.25-02.20	02.20-03.15	03.15-04.05
MON	CAD/CAM	MMI	ROBO	BREAK LUCH	CAD/CAM	OR	OR	LIBRARY
TUE	ROBO	PPE	MMI		PDP LAB			SPORTS
WED	CAD/INS LAB				OR	PPE	ROBO	TECHNICAL SEMINAR
THU	CAD/CAM	O.E			CAD/INS LAB			TECHNICAL SEMINAR
FRI	PPE	O.E			ROBO	MMI	OR	T & P
SAT	MMI	ROBO	OR		PPE	CAD/CAM	MPR	T & P

SL.NO	SUBJECT	FACULTY
1	MECHANICAL MEASUREMENTS & INSTRUMENTATION	Mr.S.Venkatesh
2	POWER PLANT ENGINEERING	Mrs.B.Malathi
3	CAD/CAM	Mr.T.Pavan kumar
4	OPERATIONS RESEARCH	Mr.K.Rajesh
5	ROBOTICS	Ms.P.Pavani
6	PRODUCTION DRAWING PRACTICE LAB(PD LAB)	Mr.V.R.Rao
7	CAD/CAM LAB	Mr.T.Pavan/Ms.P.Pavani
8	MECHANICAL INSTRUMENTS LAB(MI LAB)	Mr.Venkatesh/Mr. Chandra Kumar
9	MINI PROJECT REVIEW(MPR)	Mrs.B.Malathi
10	OPEN ELECTIVE (MSE)	Mr.Narendar Reddy
11	TECHNICAL SEMINAR	Mr.K.Rajesh
12	LIBRARY/SPORTS	Ms.P.Pavani

H.O.D

VIDYA JYOTHI INSTITUTE OF TECHNOLOGY
MECHANICAL ENGINEERING DEPARTMENT

IV B.Tech I Sem — **TIMETABLE 2018-19** — **w.e.f. 07/08/2018**

SECTION-A — **ROOM NO: S306**

TIME/ DAY	9.00- 10.00	10.00-11.00	11.00-12.00	12.00-01.00	01.00-01.45	01.45-02.45	02.45-03.45
MON	ROB	PPE	CAD/CAM/INS LAB		LUNCH	CAD/CAM	OR
TUE	CAD/CAM	MMI	ROB	PPE		CAD/CAM/INS LAB	
WED	OR	CAD/CAM	ROB	MMI		PDP LAB	
THU	MMI	PPE	O.E			OR	OR
FRI	PPE	CAD/CAM	O.E			MMI	ROB

SL.NO	SUBJECT	FACULTY
1	MECHANICAL MEASUREMENTS & INSTRUMENTATION	Mr. S. Prasad Kumar
2	POWER PLANT ENGINEERING	Mr. Amoodi
3	CAD/CAM	Mr. M. Naveen Kumar
4	OPERATIONS RESEARCH	Mr. Ch. Rakesh
5	ROBOTICS	Ms. Sowmya
6	PRODUCTION DRAWING PRACTICE LAB	Mr.K Ravi Kumar
7	OPTIMIZATION TECHNIQUES	Dr. V.V. Satyanarayana
8	MAINTENANCE & SAFETY ENGG.	Mrs. Virajee/ Mr. S.Ramakrishna
9	CAD/CAM LAB	Mr. M.Naveen Kumar/Mr.T.Pavan Ku
10	INSTRUMENTATION LAB	Mr. S. Prasad Kumar/Mr.Venkatesh

H.O.D

VIDYA JYOTHI INSTITUTE OF TECHNOLOGY
MECHANICAL ENGINEERING DEPARTMENT

TIMETABLE 2018-19 **w.e.f. 07/08/2018**

IV B.Tech I Sem **SECTION-B** **ROOM NO: S306**

TIME/ DAY	9.00- 10.00	10.00-11.00	11.00-12.00	12.00-01.00	01.00-01.45	01.45-02.45	02.45-03.45
MON	MMI	ROB	PPE	OR	LUNCH	PDP LAB	
TUE	OR	CAD/CAM	CAD/CAM/INS LAB			ROB	PPE
WED	PPE	MMI	CAD/CAM	ROB		OR	OR
THU	ROB	PPE	O.E			MMI	CAD/CAM
FRI	CAD/CAM	MMI	O.E			CAD/CAM/INS LAB	

SL.NO	SUBJECT	FACULTY
1	MECHANICAL MEASUREMENTS & INSTRUMENTATION	Mr. S. Prasad Kumar
2	POWER PLANT ENGINEERING	Mrs. Sindhuja
3	CAD/CAM	Mrs. Virajee
4	OPERATIONS RESEARCH	Mr. Ch. Rakesh
5	ROBOTICS	Mr. J. Jagadesh Kumar
6	PRODUCTION DRAWING PRACTICE LAB	Mr.K.Ravi Kumar
7	OPTIMIZATION TECHNIQUES	Dr. V.V. Satyanarayana
8	MAINTENANCE & SAFETY ENGG.	Mrs. Virajee/ Mr. S.Ramakrishna
9	CAD/CAM LAB	Mrs. Virajee/Mr.Rajesh
10	INSTRUMENTATION LAB	Mr. Ch. Rakesh/Mrs. C.L.Sindhuja

H.O.D

VIDYA JYOTHI INSTITUTE OF TECHNOLOGY
MECHANICAL ENGINEERING DEPARTMENT

IV B.Tech I Sem — **TIMETABLE 2018-19** — **w.e.f. 07/08/2018**

SECTION-C — **ROOM NO: S306**

TIME/ DAY	9.00- 10.00	10.00-11.00	11.00-12.00	12.00-01.00	01.00-01.45	01.45-02.45	02.45-03.45
MON	MMI	OR	PPE	ROB	LUNCH	CAD/CAM/INS LAB	
TUE	PPE	ROB	CAD/CAM	MMI		OR	OR
WED	ROB	MMI	PPE	CAD/CAM		CAD/CAM/INS LAB	
THU	CAD/CAM	PPE	O.E			PDP LAB	
FRI	OR	MMI	O.E			ROB	CAD/CAM

SL.NO	SUBJECT	FACULTY
1	MECHANICAL MEASUREMENTS & INSTRUMENTATION	Mr.Venkatesh
2	POWER PLANT ENGINEERING	Mrs. Malathi
3	CAD/CAM	Mr.M. Naveen Kumar
4	OPERATIONS RESEARCH	Mr. D.R.S. Narsing Rao
5	ROBOTICS	Mr. J. Jagadesh Kumar
6	PRODUCTION DRAWING PRACTICE LAB	Mr. P Raghuram Reddy
7	OPTIMIZATION TECHNIQUES	Dr. V.V. Satyanarayana
8	MAINTENANCE & SAFETY ENGG.	Mrs. Virajee/ Mr. S.Ramakrishna
9	CAD/CAM LAB	Dr. G. Sreeram Reddy/Mr.Pradeep
10	INSTRUMENTATION LAB	Mrs. Ambika/Mr.Venkatesh

H.O.D

VIDYA JYOTHI INSTITUTE OF TECHNOLOGY
MECHANICAL ENGINEERING DEPARTMENT

TIMETABLE 2018-19 **w.e.f. 07/08/2018**

IV B.Tech I Sem **SECTION-D** **ROOM NO: S306**

TIME/ DAY	9.00- 10.00	10.00-11.00	11.00-12.00	12.00-01.00	01.00-01.45	01.45-02.45	02.45-03.45
MON	PPE	MMI	OR	OR	LUNCH	ROB	CAD/CAM
TUE	CAD/CAM	MMI	PPE	OR		PDP LAB	
WED	OR	CAD/CAM	CAD/CAM/INS LAB			PPE	ROB
THU	MMI	ROB	O.E			CAD/CAM/INS LAB	
FRI	ROB	PPE	O.E			CAD/CAM	MMI

SL.NO	SUBJECT	FACULTY
1	MECHANICAL MEASUREMENTS & INSTRUMENTATION	Mrs. Ambika
2	POWER PLANT ENGINEERING	Mrs. Malathi
3	CAD/CAM	Mr. Pavan
4	OPERATIONS RESEARCH	Dr. V.V. Satyanarayana
5	ROBOTICS	Ms. Sowmya
6	PRODUCTION DRAWING PRACTICE LAB	Mr. V.R. Rao
7	OPTIMIZATION TECHNIQUES	Dr. V.V. Satyanarayana
8	MAINTENANCE & SAFETY ENGG.	Mrs. Virajee/ Mr. S.Ramakrishna
9	CAD/CAM LAB	Mr. Pavan/Mr.Pradeep
10	INSTRUMENTATION LAB	Mr. S.M.Amoodi/Mrs.G.Ambika

H.O.D

4.PROGRAM OUTCOMES(PO'S) & PROGRAM SPECIFIC OUTCOMES(PSO'S)

PO's	STATEMENT
PO1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/Development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO'S	STATEMENT
PSO1	Analyze and solve problems of thermal and manufacturing in thecomprehensive design of mechanical engineering components.
PSO2	An ability to design, develop and implement sustainable mechanical engineering solutions in view of environmental issues with social responsibility.

PO's	STATEMENT
PO1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO2	**Problem Analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO3	**Design/Development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
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PO11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in team, to manage projects and in multidisciplinary environments.
PO12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PSO'S	STATEMENT
PSO1	An ability to analyze and solve manufacturing engineering problems and employing reverse engineering techniques for the design of mechanical engineering components.
PSO2	An ability to design, develop and implement sustainable mechanical engineering solutions in view of environmental issues with social responsibility.

5. COURSE OBJECTIVES & COURSE OUTCOMES (CO'S)

R18

Course Outcomes:

At the end of the course, the students should be able to:

CO1	Model the real life situations with mathematical models. Understand the concept of linear programming.
CO2	Solve transportation and assignment and sequencing problems.
CO3	Understand the various waiting lines and replacement concepts.
CO4	Identify and apply game theory and inventory models.
CO5	Apply dynamic programming and network scheduling models.

R15

Course Outcomes:

At the end of the course, the students should be able to:

CO1	Model the real life situations with mathematical models. Understand the concept of linear programming.
CO2	Solve transportation and assignment problems.
CO3	Formulate the sequencing of jobs on machines. Understand the various replacement concepts.
CO4	Identify and apply various inventory models.
CO5	Apply queuing and dynamic programming models.

6. MAPPING OF COURSE OUTCOMES (CO'S) WITH PROGRAM OUTCOMES (PO'S) & PROGRAM SPECIFIC OUTCOMES (PSO'S)

R18

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	3	3	3	2	3		2	2		3			2
CO2	3	3	3	3	2	2		2	3		3			2
CO3	3	3	3	3	2	3		2	3		3			
CO4	3	3	3	3	2			2	2		3			2
CO5	3	3	3	3	2			2	2		2			3
Avg.	**3**	**3**	**3**	**3**	**2**	**1.6**		**2**	**2.4**		**2.8**			**1.8**

Note: Low-1, Medium-2, High-3

R15

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PSO 1	PSO 2
CO1	3	3	3	3	2	3		2	2		3			2
CO2	3	3	3	3	2	3		2	3		3			2
CO3	3	3	3	3	2	3		2			2			2
CO4	3	3	3	3	2			2	3		3			
CO5	3	3	3	3	2			2	3		3			3
Avg.	3	3	3	3	2	1.5		2	1.2		1.8			1.5

Note: Low-1, Medium-2, High-3

7. ACADEMIC CALENDAR

Vidya Jyothi Institute of Technology (Autonomous)

(Accredited by NAAC & NBA, Approved By A.I.C.T.E., New Delhi, Permanently Affiliated to JNTU, Hyderabad)
(Aziz Nagar, C.B.Post, Hyderabad -500075)

B.Tech II, III & IV Year Academic Calendar for the Academic Year 2021-22

FIRST SEMESTER		**Commencement of Class Work 20.09.2021**	
	FROM	**TO**	**DURATION**
I Spell of Instructions	20.09.2021	13.11.2021	8 Weeks
I Mid Examinations	15.11.2021	20.11.2021	1 Week
II Spell of Instructions	22.11.2021	15.01.2021	8 Weeks
II Mid Examinations	17.01.2021	20.01.2022	4 Days
Practical Examinations	21.01.2022	25.01.2022	4 Days
End Semester Examinations	27.01.2022	12.02.2022	2 Weeks 3 Days
SECOND SEMESTER		**Commencement of Class Work 14.02.2022**	
I Spell of Instructions	14.02.2022	09.04.2022	8 Weeks
I Mid Examinations	11.04.2022	16.04.2022	4 Days
II Spell of Instructions	18.04.2022	11.06.2022	8 Weeks
II Mid Examinations	13.06.2022	16.06.2022	4 Days
Practical Examinations	17.06.2022	21.06.2022	4 Days
End Semester Examinations	22.06.2022	09.07.2022	2 Weeks 4 Days
Commencement of class work for B. Tech., II,III & IV Year I Semester will be from: 11.07.2022			

DEAN EXAMS.

DIRECTOR

Vidya Jyothi Institute of Technology (Autonomous)

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II, III & IV B. Tech I Semester Academic Calendar for the Academic year 2020-21

Department of Mechanical Engineering

II/III/IV YEAR I SEMESTER		**Commencement of Class Work 13.07.2020**	
I Spell of Instruction	13-07-2020	19-09-2020	10 Weeks
Mini Projects	Aug 2020 (I Review),Sep 2020(I Review)		
I Mid Examinations	21-09-2020	26-09-2020	1 Week
II Spell of Instruction	28-09-2020	16-10-2020	3 Weeks
Dussehra Holidays	17-10-2020	25-10-2020	9 Days
II Spell of Instruction Continuation	26-10-2020	14-11-2020	3 Weeks
Events organized(STTP)	Jan 2021		
Internships	Jan 2021 Mar 2021		
II Mid Examinations	16-11-2020	21-11-2020	1 Week
Preparation & Practical Examination	23-11-2020	28-11-2020	1 Week
III Mid Examinations	01-12-2020	03-12-2020	3 days
End Semesiter Examinations	04-12-2020	19-12-2020	2 Weeks
II/III/IV YEAR II SEMESTER		**Commencement of Class Work 30-03-2021**	
I Spell of Instruction	30-03-2021	12-06-2021	11 Weeks
Major Projects	April-2021 (I Review) May- 2021(II Review) June- 2021(III Review) July -2021 (Final Review)		
I Mid Examinations	14-06-2021	22-06-2021	8 Days
II Spell of Instruction	23-06-2021	14-08-2021	8 Weeks
II Mid Examinations	16-08-2021	19-08-2021	4 Days
Preparation & Practical Examination	20-08-2021	24-08-2021	4 Days
Betterment Examinations	25-08-2021	28-08-2021	4 Days
End Semester Examinations	30-08-2021	18-09-2021	3Weeks

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II/III/IV B.Tech I & II Semester Academic Calendar for the Academic Year 2019-20

II/III/IV YEAR I SEMESTER		**Commencement of Class Work 17.06.2019**	
	From	**To**	**Duration**
I Spell of Instruction	17.06.2019	10.08.2019	8 WEEKS
I Mid Examinations	13.08.2019	17.08.2019	4 DAYS
II Spell of Instruction	19.08.2019	05.10.2019	7 WEEKS
Dussehra Holidays	07.10.2019	12.10.2019	1 WEEK
II Spell of Instruction Continuation	14.10.2019	19.10.2019	1 WEEK
II Mid Examinations	21.10.2019	24.10.2019	4 DAYS
Practical Examinations	25.10.2019	29.10.2019	4 DAYS
Betterment Examinations	30.10.2019	01.11.2019	3 DAYS
End Semester Examinations	02.11.2019	18.11.2019	2 WEEKS
Supplementary Examinations	19.11.2019	04.12.2019	2 WEEKS
II/III/IV YEAR II SEMESTER		**Commencement of Class Work 02.12.2019**	
I Spell of Instruction	02.12.2019	10.01.2020	6 WEEKS
Pongal Holidays	11.01.2020	15.01.2020	5 DAYS
Technical/Sports fest	16.01.2020	18.01.2020	3 DAYS
I Spell of Instruction Continuation	20.01.2020	01.02.2020	2 WEEKS
I Mid Examinations	03.02.2020	08.02.2020	1 WEEK
II Spell of Instruction	10.02.2020	04.04.2020	8 WEEKS
II Mid Examinations	06.04.2020	09.04.2020	4 DAYS
Practical Examinations	13.04.2020	17.04.2020	4 DAYS
Betterment Examinations	18.04.2020	22.04.2020	4 DAYS
End Semester Examinations	23.04.2020	08.05.2020	2 WEEKS
Supplementary Examinations	11.05.2020	23.05.2020	2 WEEKS
Commencement of classes will be from			

DIRECTOR

8. TEACHING SCHEDULE

Lecture No. as per period	Topic(R18)
UNIT-I	**DEVELOPMENT AND ALLOCATION**
LH1	Development-definition
LH2	Characteristics & Phases
LH3	Types of operation Research Models
LH4	Applications & Allocations
LH5	Allocation: Linear Programming Problem
LH6	Formulation
LH7	Graphical Solution
LH8	Simplex Method-
LH9	Artificial variable techniques
LH10	Big-M Method-
LH11	Two Phase Method
LH12	Duality Principle
UNIT-II	**TRANSPORTATION & ASSIGNMENT PROBLEM AND SEQUENCING**
LH13	**Transportation Problem**: Formulation
LH14	Optimal solution: Northwest Corner Method
LH15	Row Minima Method, Column Minima Method
LH16	Least Cost Method,Vogel's approximation Method
LH17	Vogel's approximation Method Unbalanced Problem
LH18	Degeneracy & Modified Distribution Method
LH19	Unbalanced Problem
LH20	**Assignment Problem:** Formulation
LH21	Optimal solution: Variants of assignment problem
LH22	**Travelling Salesmen Problem**-Transshipment Problem
LH23	**Sequencing**: Introduction, Flow- Shop Sequencing

LH24	n jobs through two machines
LH25	n jobs through three machines
LH26	Two jobs through" m " machines
UNIT-III	**REPLACEMENT AND WAITING LINES THEORY**
LH27	**Replacement:** Introduction
LH28	Replacement of items that deteriorate with time
LH29	When money value is counted
LH30	When money value is not counted
LH31	Replacement of items that fail completely
LH32	Group replacement
LH33	**Waiting Lines:** Introduction-Single Channel
LH34	Poisson arrivals exponential service times
LH35	Infinite population models
LH36	finite population models
LH37	Multi channels- Poisson arrivals, Exponential service times
LH38	Infinite population single channel Poisson arrivals
UNIT-IV	**THEORY OF GAMES AND INVENTORY**
LH39	**Theory of Games**: Introduction; Terminology
LH40	Solution of Games without saddle points
LH41	Solution of games with saddle points
LH42	Rectangular games with saddle points
LH43	Dominance Principle
LH44	mX2 games,
LH45	2Xn games
LH46	Graphical Method

LH47	**Inventory:** Introduction, Single Item, Deterministic models
LH48	Purchase inventory models with one price break
LH49	Purchase inventory models with multiple price breaks
LH50	Shortages Models Instantaneous production
LH51	Stochastic Models Instantaneous
LH52	Demand discrete variable Demand, Single period Model no set up cost
LH53	Demand continuous variable
LH54	Single period Model no set up cost
UNIT-V	**DYNAMIC PROGRAMMING AND NETWORK SCHEDULING**
LH55	**Dynamic Programming**: Introduction, Terminology
LH56	Bellman's principle of optimality,
LH57	Application of dynamic programming Shortest path problem,
LH58	Shortest path problem
LH59	budget allocations
LH60	**Network scheduling:** Critical path method
LH61	Program evaluation
LH62	Review technique
LH63	Crashing of networks
LH64	Resource leveling

Lecture No. as per period	Topic(R15)
UNIT-I	**DEVELOPMENT AND ALLOCATION**
LH1	Development-definition
LH2	Characteristics & Phases
LH3	Types of operation Research Models
LH4	Applications & Allocations
LH5	Allocation: Linear Programming Problem
LH6	Formulation
LH7	Graphical Solution
LH8	Simplex Method-
LH9	Artificial variable techniques
LH10	Big-M Method-
LH11	Two Phase Method
LH12	Duality Principle
UNIT-II	**TRANSPORTATION & ASSIGNMENT PROBLEM SEQUENCING**
LH13	**Transportation Problem**: Formulation
LH14	Optimal solution: Northwest Corner Method
LH15	Row Minima Method, Column Minima Method
LH16	Least Cost Method,Vogel's approximation Method
LH17	Vogel's approximation Method Unbalanced Problem
LH18	Degeneracy & Modified Distribution Method
LH19	**Assignment Problem:** Formulation
LH20	**Travelling Salesmen Problem**-Transshipment Problem
UNIT-III	**THEORY OF GAMES, SEQUENCING AND WAITING LINES THEORY**
LH21	**Theory of Games**: Introduction; Terminology

LH22	Solution of Games without saddle points
LH23	Solution of games with saddle points
LH24	Rectangular games with saddle points
LH25	Dominance Principle, mX2 games
LH26	2Xn games & GRAPHICAL METHOD
LH27	**Waiting Lines:** Introduction-Single Channel
LH28	Poisson arrivals exponential service times
LH29	Infinite population models
LH30	finite population models
LH31	Multi channels- Poisson arrivals, Exponential service times
LH32	Infinite population single channel Poisson arrivals
LH33	**Sequencing**: Introduction, Flow- Shop Sequencing
LH34	n jobs through two machines
LH35	n jobs through three machines
LH36	Two jobs through" m " machines
UNIT-IV	**REPLACEMENT AND INVENTORY**
LH37	**Replacement:** Introduction
LH38	Replacement of items that deteriorate with time
LH39	When money value is counted
LH40	When money value is not counted
LH41	Replacement of items that fail completely
LH42	Group replacement
LH43	**Inventory:** Introduction, Single Item,
LH44	Deterministic models

LH45	Purchase inventory models with one price break
LH46	Purchase inventory models with multiple price breaks
LH47	Shortages Models Instantaneous production
LH48	Stochastic Models Instantaneous
LH49	Demand discrete variable Demand
LH50	Single period Model no set up cost
LH51	Demand continuous variable
LH52	Single period Model no set up cost
UNIT-V	
LH55	**Non linear Programming:** Introduction, Terminology
LH56	Kuhn Tucker conditions
LH57	Problems on Kuhn Tucker conditions
LH58	Hessian Matrix for optimality condition.
LH59	Problems on Hessian Matrix
LH60	**Simulations:** Definition , Types of simulation models ,Phases of simulation
LH61	Applications of simulation
LH62	Inventory and Queuing problems
LH63	Advantages and Disadvantage
LH64	Brief introduction of simulation languages

9. ASSIGNMENT QUESTIONS

A.Y.2021-22

ASSIGNMENT I

Q.No	Questions	Bloom's Taxonomy Level	Course Outcomes
Q.1	Solve Graphically Maximize Z=10x+15y Subjected to constraint x+2y≤4 and x,y≥0	**L2**	CO1
Q.2	In the following IBF's of transportation problem of C_{11} is sent with one unit, find the solution 6 | 10 | 15 (2) 4 | 6 | 16 (4) 12 | 5 (8) | 8 (1)	**L3**	CO1
Q.3	A and B toss one rupee coin each and if the coins match A wins otherwise B wins. The matching of heads has double premium.	**L2**	CO2
Q.4	Reduce the distance travelled by salesman one iteration. $\begin{array}{c\|ccccc} & \mathbf{A} & \mathbf{B} & \mathbf{C} & \mathbf{D} & \mathbf{E} \\ \mathbf{A} & \infty & \mathbf{0} & \mathbf{2} & \mathbf{0} & \mathbf{0} \\ \mathbf{B} & \mathbf{0} & \infty & \mathbf{1} & \mathbf{0} & \mathbf{0} \\ \mathbf{C} & \mathbf{2} & \mathbf{1} & \infty & \mathbf{3} & \mathbf{0} \\ \mathbf{D} & \mathbf{0} & \mathbf{0} & \mathbf{3} & \infty & \mathbf{4} \\ \mathbf{E} & \mathbf{0} & \mathbf{0} & \mathbf{0} & \mathbf{4} & \infty \end{array}$	**L3**	CO2
Q.5	Write the Dual form of LPP Maximize Z=10x1+15x2 Subjected to constraints 2x1+5x2≤7 3x1+4x2≥8 x1+x2=10 and x1& x2≥0	**L4**	CO3

A.Y.2021-22

ASSIGNMENT II

<table>
<tr><th>Q.No</th><th>Questions</th><th>Bloom's Taxonomy Level</th><th>Course Outcomes</th></tr>
<tr><td>Q.1</td><td>If the saddle point is 7 find the value of p and q in the given game pay off matrix.
$\begin{bmatrix} 2 & 6 & 5 \\ 10 & 7 & q \\ 5 & p & 8 \end{bmatrix}$</td><td>L4</td><td>CO3</td></tr>
<tr><td>Q.2</td><td>In a queuing system with usual notations if arrival rate is 10 per hour and service rate is 12 per hour, what is the idle time of server in 8 hours shift.</td><td>L2</td><td>CO4</td></tr>
<tr><td>Q.3</td><td>There are four job state processed on two machines A & B in that order. What is the difference of processing time making span with two types of your choice?
<table><tr><td>A</td><td>10</td><td>8</td><td>20</td><td>7</td></tr><tr><td>B</td><td>12</td><td>15</td><td>4</td><td>7</td></tr></table></td><td>L3</td><td>CO4</td></tr>
<tr><td>Q.4</td><td>In an inventory control Harris Model find the change in EOQ if the annual demand is doubled.</td><td>L2</td><td>CO4</td></tr>
<tr><td>Q.5.</td><td>Find the Khun tucker conditions
Maximize $Z=10x^2+5y^2$
$2x+3y=10$</td><td>L3</td><td>CO5</td></tr>
</table>

A.Y.2020-21

ASSIGNMENT I

<table>
<tr><th>Q.No</th><th>Questions</th><th>Bloom's Taxonomy Level</th><th>Course Outcomes</th></tr>
<tr><td>Q.1</td><td>Maximize $Z=3x_1+2x_2$
subjected to the constraints
$-2x_1+x_2\leq 1$,
$x_1 \leq 2$,
$x_1+x_2\leq 3$
and $x_1, x_2 \geq 0$
Solve by Graphical Method</td><td>L3</td><td>CO1</td></tr>
<tr><td>Q.2</td><td>Maximize $Z=3x_1+4x_2$
subjected to the constraints
$3x_1+x_2\leq 6$,
$x_1+x_2\leq 4$,
$x_1, x_2 \geq 0$
Solve by Simplex Method</td><td>L2</td><td>CO1</td></tr>
<tr><td>Q.3</td><td>Obtain the Feasible solution for the given transportation cost matrix using: Least Cost Cell Method
<table>
<tr><th></th><th>A</th><th>B</th><th>C</th><th>availability</th></tr>
<tr><td>1</td><td>50</td><td>30</td><td>220</td><td>1</td></tr>
<tr><td>2</td><td>90</td><td>45</td><td>170</td><td>3</td></tr>
<tr><td>3</td><td>250</td><td>200</td><td>50</td><td>4</td></tr>
<tr><td>Requirement</td><td>4</td><td>2</td><td>2</td><td></td></tr>
</table></td><td>L2</td><td>CO2</td></tr>
<tr><td>Q.4</td><td>Obtain the initial solution to the following transportation problem VAM method
<table>
<tr><th></th><th>D1</th><th>D2</th><th>D3</th><th>D4</th><th>Availability</th></tr>
<tr><td>S1</td><td>2</td><td>3</td><td>11</td><td>7</td><td>6</td></tr>
<tr><td>S2</td><td>1</td><td>5</td><td>6</td><td>1</td><td>4</td></tr>
<tr><td>S3</td><td>5</td><td>8</td><td>15</td><td>9</td><td>10</td></tr>
<tr><td>Demand</td><td>8</td><td>6</td><td>3</td><td>3</td><td></td></tr>
</table></td><td>L3</td><td>CO3</td></tr>
<tr><td>Q.5</td><td>Solve the game using dominance property
$A=\begin{bmatrix} 5 & 20 & -10 \\ 10 & 6 & 2 \\ 20 & 15 & 18 \end{bmatrix}$</td><td>L4</td><td>CO3</td></tr>
</table>

A.Y.2020-21

ASSIGNMENT II

<table>
<tr><th>Q.No</th><th>Questions</th><th>Bloom's Taxonomy Level</th><th>Course Outcomes</th></tr>
<tr><td>Q.1</td><td>A commodity is to be supplied at the rate of 200 units per day. Ordering cost is Rs.50 and the holding cost is Rs.2 per day. The delay in supply includes a penalty of Rs.10 per unit per delay of one day. Find the optimal policy and the re-order cycle period.</td><td>L2</td><td>CO3</td></tr>
<tr><td>Q.2</td><td>Find the sequence that minimizes the total time required in performing the following jobs on three machines in the order A-B-C as shown in the below table. Also find the total elapsed time.
<table>
<tr><th>Machine/Job</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th></tr>
<tr><td>A</td><td>8</td><td>3</td><td>7</td><td>2</td><td>5</td><td>1</td></tr>
<tr><td>B</td><td>3</td><td>4</td><td>5</td><td>2</td><td>1</td><td>6</td></tr>
<tr><td>C</td><td>8</td><td>7</td><td>6</td><td>9</td><td>10</td><td>9</td></tr>
</table></td><td>L4</td><td>CO3</td></tr>
<tr><td>Q.3</td><td>The maintenance cost and resale value per year of a machine whose purchase price is Rs.7000 is given below:
<table>
<tr><td>Year</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td></tr>
<tr><td>Maintenance cost in Rs.</td><td>900</td><td>1200</td><td>1600</td><td>2100</td><td>2800</td><td>3700</td><td>4700</td><td>5900</td></tr>
<tr><td>Resale value in Rs.</td><td>4000</td><td>2000</td><td>1200</td><td>600</td><td>500</td><td>400</td><td>400</td><td>400</td></tr>
</table></td><td>L2</td><td>CO4</td></tr>
<tr><td>Q.4</td><td>The annual consumption of an item is 2000 units. The ordering cost is Rs.100 per order. The carrying cost is Rs.0.80 per unit, per year. Assuming working days as 200, lead time as 20 days, and safety stock as 100 units, calculate i) EOQ, ii) The number of orders per year.</td><td>L4</td><td>CO4</td></tr>
<tr><td>Q.5.</td><td>What are the different Phases of Project Management?</td><td>L3</td><td>CO5</td></tr>
</table>

10. MID QUESTION PAPERS I & II

Vidya Jyothi Institute of Technology (Autonomous)

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(Aziz Nagar, C.B.Post, Hyderabad -500075)

IV B. Tech I Semester Mid-I Examination, November-2021

Subject: Operation Research **Branch: MECH**
Time: 90 Minutes **Max Marks: 20**

Bloom's Level:

Remember	L1
Understand	L2
Apply	L3
Analyze	L4
Evaluate	L5
Create	L6

Q. No.	PART-A	B L	CO	PO	Marks
	ANSWER ALL THE QUESTIONS (2Q x 3M = 6M)				
1	What do you mean by Slack variables, Artificial variables in Linear Programming Problems?	L2	CO1	PO3	3
2	What do you understand by Assignment Problem?	L1	CO2	PO2	3
	PART-B				
	ANSWER ALL THE QUESTIONS (2Q x 7M=14M)				
3. i)	Solve graphically Maximize $P = 50 X_1 + 100 X_2$ subjected to constraints $2X_1+5X_2 \leq 16$ $X_1+ X_2 \leq 5$ and $X_1, X_2 \geq 0$	L2	CO1	PO3	7
	(OR)				
ii)	Solve the given LPP by using Big-M Method Maximize $Z = x_1 + 4x_2$ subject to the constraints: $3x_1 + x_2 \leq 3$ $2x_1 + 3x_2 \leq 6$ $4x_1 + 5x_2 \geq 20$ and $x_1, x_2 \geq 0$	L3	CO1	PO3	7

4 i)	Obtain an initial basic feasible solution to the following transportation problem using Vogel's Approximation method.	L4	CO2	PO2	7

Units	**W1**	**W2**	**W3**	**W4**	**Availability**
A	**5**	**1**	**3**	**3**	**34**
B	**3**	**3**	**5**	**4**	**15**
C	**6**	**4**	**4**	**3**	**12**
D	**4**	**1**	**4**	**2**	**19**
Demand	**21**	**25**	**17**	**17**	

(OR)

ii)	Solve the following Travelling Sales men Problem:	L4	CO2	PO4	7

	A	B	C	D
A	∞	46	16	40
B	41	∞	50	40
C	82	32	∞	60
D	40	40	36	∞

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IV B. Tech I Semester Mid-II Examination, January-2022

Subject: Operation Research **Branch:Mechanical**

Time: 90 Minutes **Max Marks: 20**

Bloom's Level:

Remember	L1
Understand	L2
Apply	L3
Analyze	L4
Evaluate	L5
Create	L6

Q. No.	PART-A	B L	CO	PO	Marks
	ANSWER ALL THE QUESTIONS (3Q x 2M = 6M)				
1	What are the categories into which the replacements of items are classified?	L2	CO3	PO2, PO4, PO6	2M
2	Explain the term balking in queuing theory.	L2	CO4	PO3, PO5, PO6	2M
3	Define the terms: a. Node b. Activity	L1	CO4	PO3, PO4, PO5	2M
	PART-B				
	ANSWER ALL THE QUESTIONS (5+5+4=14M)				
3. i)	The arrival rate of customers at a banking counter follows a Poisson distribution with a mean of 45 per hour. The service rate of the counter clerk also follows Poisson distribution with a mean of 60 per hour. (a)What is the probability of having 0 customers in the system(P_0)? (b)What is the probability of having 10 customers in the System? (c)Find Length of queue, Length of system, Average waiting time in the system and average waiting time in the queue?	L4	CO3	PO2, PO3, PO4, PO5	5M

(OR)

ii) The maintenance cost and resale value per year of a machine whose purchase price is Rs. 7000 is given below:

Year	1	2	3	4	5	6	7	8
Maintenance cost in Rs.	900	1200	1600	2100	2800	3700	4700	5900
Resale value in Rs.	4000	2000	1200	600	500	400	400	400

When should the machine be replaced? — L5 — CO3 — PO2, PO3, PO6, PO8

4 . i) Use graphical method to solve the following pay-off matrix:

$$A=\begin{pmatrix} 3 & 5 \\ -1 & 6 \\ 4 & 1 \\ 2 & 2 \end{pmatrix}$$

L4 — CO4 — PO2, PO5, PO6, PO8

(OR)

ii) The annual demand of an item in the stores of a foundry is 9000 units. Its annual carrying cost is 15% of the purchase price per year, where purchase price is Rs.20 per unit. The ordering cost is Rs.15 per order. Presently the order size is the average monthly demand of the item. Find EOQ and compare its cost with the present ordering system and find the corresponding cost advantage. — L5 — CO4 — PO3, PO4, PO6, PO8 — 5M

5. i) What is the application of Dynamic Programming? — L2 — CO4 — PO2, PO3, PO6, PO8

(OR)

ii) What are the phases of Project Management? — L2 — CO4 — PO3, PO4, PO6, PO8 — 4M

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IV B. Tech I Semester Mid-I Examination, November-2021

Subject: Operation Research **Branch: MECH**

Time: 90 Minutes **Max Marks: 20**

Bloom's Level:

Remember	L1
Understand	L2
Apply	L3
Analyze	L4
Evaluate	L5
Create	L6

Q. No.	PART-A	B L	CO	PO	Marks
ANSWER ALL THE QUESTIONS	**(2Q x 3M = 6M)**				
1	What do you mean by Slack variables, Artificial variables in Linear Programming Problems?	L2	CO1	PO3	3
2	What do you understand by Assignment Problem?	L1	CO2	PO2	3
PART-B					
ANSWER ALL THE QUESTIONS	**(2Q x 7M=14M)**				
3. i)	Solve graphically Maximize $P = 50 X_1 + 100 X_2$ subjected to constraints $2X_1+5X_2 \leq 16$ $X_1+ X_2 \leq 5$ and $X_1, X_2 \geq 0$	L2	CO1	PO3	7
(OR)					
ii)	Solve the given LPP by using Big-M Method Maximize $Z = x_1 + 4x_2$ subject to the constraints: $3x_1 + x_2 \leq 3$ $2x_1 + 3x_2 \leq 6$ $4x_1 + 5x_2 \geq 20$ and $x_1, x_2 \geq 0$	L3	CO1	PO3	7

4 i)	Obtain an initial basic feasible solution to the following transportation problem using Vogel's Approximation method.	L4	CO2	PO2	7

Units	**W1**	**W2**	**W3**	**W4**	**Availability**
A	**5**	**1**	**3**	**3**	**34**
B	**3**	**3**	**5**	**4**	**15**
C	**6**	**4**	**4**	**3**	**12**
D	**4**	**1**	**4**	**2**	**19**
Demand	**21**	**25**	**17**	**17**	

(OR)

ii)	Solve the following Travelling Sales men Problem:	L4	CO2	PO4	7

	A	B	C	D
A	∞	46	16	40
B	41	∞	50	40
C	82	32	∞	60
D	40	40	36	∞

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IV B.Tech I Semester II Mid Examination, February-2021

Subject Name: Operation Research **BRANCH: Mechanical**

Time: 1 Hour **Max Marks:20**

Bloom's Level:

Remember	L1
Understand	L2
Apply	L3
Analyze	L4
Evaluate	L5
Create	L6

<table>
<tr><th colspan="2">ANSWER ALL THE QUESTIONS</th><th>Bloom's Level</th><th>Marks</th></tr>
<tr><td>.a)</td><td>In a machine shop 6 different products are being manufactured each requiring time on two different machines A and B are given in the table below:
<table>
<tr><th>Product</th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th></tr>
<tr><td>Machine-A</td><td>30</td><td>120</td><td>50</td><td>20</td><td>90</td><td>110</td></tr>
<tr><td>Machine-B</td><td>80</td><td>100</td><td>90</td><td>60</td><td>30</td><td>80</td></tr>
</table>
Find an optimal sequence of processing of different product in order to minimize the total manufactured time for all product. Find total ideal time for two machines and elapsed time.</td><td>L2</td><td>6M</td></tr>
<tr><td colspan="4">[OR]</td></tr>
<tr><td>b)</td><td>In a railway marshalling yard, goods trains arrive at a rate of 30 trains per day. Assuming that inter arrival time and service time distribution follows an exponential distribution with an average of 30 minutes, calculate the following:
i) The mean queue size.
ii) The probability that queue size exceeds 10.
If the input of the train increases to an average of 33 per day, what will be</td><td>L3</td><td>6M</td></tr>
</table>

	the changes in i) and ii)?		
2.a)	The maintenance cost and resale value per year of a machine whose purchase price is Rs.7000 is given below: When should the machine be replaced?	L4	7M
	[OR]		
b)	The annual consumption of an item is 2000 units. The ordering cost is Rs.100 per order. The carrying cost is Rs.0.80 per unit, per year. Assuming working days as 200, lead time as20 days, and safety stock as 100 units, calculate i) EOQ, ii) The number of orders per year.	L3	7M
3.a)	What are the advantages and disadvantages of Simulation?	L2	7M
	[OR]		
b)	Maximize Z= 3.6x1-0.4 x12+1.6x2-0.2x22 subjected to the constraints $2x1+x2 \leq 10$ and $x1, x2 \geq 0$ Solve by using Kuhn tucker condition	L4	7M

Year	1	2	3	4	5	6	7	8
Maintenance cost(Rs.)	900	1200	1600	2100	2800	3700	4700	5900
Resale Value (Rs.)	4000	2000	1200	600	500	400	400	400

11. RUBRICS FOR MID EVALUATION

RUBRICS FOR MID EXAMINATION EVALUATION

Criteria of Evaluation	Poor (1)	Satisfactory (2)	Good (3)	Very Good (4)	Excellent (5)
Interpretation	Answer reflects that the question was not understood at all.	Answer reflects that the question was somewhat understood	Answer reflects that the Question was understood to a reasonable level	Answer reflects that the Question was understood to an appreciable level	Answer reflects that the Question was completely understood
Presentation	No proper presentation	Presentation was marginal with issues in legibility and grammar	Presentation was clear but with grammatical errors	Presentation was explicitly good and clear with minor grammatical errors	Presentation was excellent and clear with no grammatical errors
Solution	Solution has more errors	Solution has moderate amount of errors	Solution was complete but with minor errors	Solution was complete but with no clear mention of entire procedure	Solution was accurate/ complete with clear mention of the entire procedure.

12. LECTURE NOTES

Unit-1

Operation Research

Development : The term operations research (OR) relates to military operations during the second world war. Scientist used various techniques to deal with strategic and tactical problems during the war. After the war military OR group scientist tried to apply OR techniques to civilian problems relating to business, industry and research developments.

Definition : Operation Research (OR) is a scientific approach to problem solving for executive management. The problem involves integrated systems of men, machines and material.

Characteristics : Important Characteristic of OR is that it deals with a problem as a whole.

→ Before arriving a decision it takes into consideration all possible interaction between various parts or departments of an organisation.

→ OR involves a team of experts from different scientific and engineering disciplines.

→ After careful analysis of the problem a suitable mathematical model is prepared, and this model is solved using scientific techniques. The decision or solution is obtained which gives an optimal solution to the problem.

Phases of OR :

- first step is to formation of the problem.
- To make the problem, we have to identify the objective, the decision variables and the constraints involving the variables.

- After that a mathematical model has to be constructed, with an objective function to be optimized and constraints in the form of equalities and inequalities.
- The solution of the model can be obtained by analytic, iterative method depend on the structure of the model.

Types of operation Research models : Models can be classified according to following characteristics :

(i) Iconic models : represents the system as it by scaling it up or down.

✓ It is usually the simplest to conceive and the most specific and concrete.

(ii) Analogue models : Models, in which one set of properties is used to represent another set of properties are called analogue model.

✓ After the problem is solved, the solution is re-interpreted in terms of the original system.

(iii) Symbolic (Mathematical) models : It is one which employs a set of mathematical symbols to represent the decision variables of the system.

✓ These variables are related together by means of a mathematical equation or a set of equation to describe the behaviour of the system.

Applications of OR & Allocations. : Some of the industrial and business problems which can be analysed by OR technique include :

1. **Finance and Accounting :**
   - Investment and portfolio management
   - Auditing
   - Cash flow analysis.
   - Capital budgeting.
2. **Marketing :**
   - Product mix
   - Marketing
   - Planning
   - Sales
   - Allocations
   - Assignments.
   - Advertising
   - Media planning.
3. **Purchasing and Procurement**
   - Optimal buying
   - Re-ordering.
   - Transportaion
   - Replacement
4. **Production**
   - Warehouse
   - Distribution
   - Transportation
   - Production planning
   - Blending
   - Inventory control
   - Maintainence
   - Project Rescheduling
   - Allocation of Resources.
5. **Mangement**
   - Manpower planning
   - Project Management.

Linear Programming Method

It is one of the various techniques of optimization (maximising the gain and minimising the loss). It deals with problems of allocating limited resources to obtain a desired optimal solution, subjected to a set of given conditions (constraints)

→ A linear programming problem (LPP) consists of an objective function which is to be optimized and a set of constraints to be satisfied by the variables.

The G.F. of the problem is;

Maximise (or minimise)

$$Z = c_1x_1 + c_2x_2 + c_3x_3 + \cdots + c_nx_n$$

subjected to the constraints:

$$a_{11}x_1 + a_{12}x_2 + \cdots + a_{1n}x_n \ (\geq, \leq \text{or} =)\ b_1$$
$$a_{21}x_1 + a_{22}x_2 + \cdots + a_{2n}x_n \ (\geq, \leq \text{or} =)\ b_2$$
$$\vdots$$
$$a_{m1}x_1 + a_{m2}x_2 + \cdots + a_{mn}x_n \ (\geq, \leq \text{or} =)\ b_m$$

$$x_1, x_2, x_3 \cdots x_n \geq 0.$$

The objective function is Z and the variables $x_1, x_2 \cdots x_n$ are called decision variables.

Objective functions may correspond to total cost, profit, total quantity to be produced and other similar objectives.

Formulation: Given a situation, describing the availability of resources and conditions and the object to be optimized. To convert onto a mathematical model, the process is called as formulation.

Steps involved:

Step 1. Defining the decision variables and writting the objective function.

Step 2. Expressing the conditions of availability of the resources in the form of their linear inequalities or equalities using the decision variables.

Production Allocation Problem.

A company manufactures three items A, B, and C. These items are processed on three machines M_1, M_2 and M_3. The time required for each product on each machine is given below. Also the total time of availability of each machine is given. The company gets a profit of Rs. 20, Rs. 30 and Rs. 40 per unit of A, B and C respectively. Determine the number of units of each product to be manufactured per day in order that the total profit is maximum.

Machine	Time per unit (Hours)			Availability of the machine hr/day
	A	B	C	
M_1	1	1.5	2	18
M_2	2	1	1	20
M_3	1	2	2	16

Solution:

Consider the decision variables x_1, x_2, x_3 corresponding to the no. of units of A, B and C respectively.

Profits of the products are Rs. 20, Rs 30. & Rs. 40 respectively.

∴ Objective function

$$Z = 20x_1 + 30x_2 + 40x_3$$

which is to be maximised.

considering to Machine M_1, whose availability is 18 Hrs.

$\therefore$ constraint

$$(1)x_1 + (1.5)x_2 + (2)x_3 \leq 18$$

$$\Rightarrow x_1 + 1.5x_2 + 2x_3 \leq 18$$

Similarly for machine M_2

$$(2)x_1 + (1)x_2 + (1)x_3 \leq 20$$

$$\Rightarrow 2x_1 + x_2 + x_3 \leq 20$$

for machine M_3

$$1(x_1) + (2)x_2 + 3(x_3) \leq 16$$

$$\Rightarrow x_1 + 2x_2 + 3x_3 \leq 16$$

As the no. of units cannot assume negative value.

Thus; $x_1 \geq 0, x_2 \geq 0, x_3 \geq 0$.

$\therefore$ LPP of the problem

Maximize $z = 20x_1 + 30x_2 + 40x_3$

Subject to the constraints;

$$x_1 + 1.5x_2 + 2x_3 \leq 18$$

$$2x_1 + x_2 + x_3 \leq 20$$

$$x_1 + 2x_2 + 3x_3 \leq 16$$

$$x_1, x_2, x_3 \geq 0$$

Three articles A, B and C have weight volume and cost as given below: The total weight cannot exceed 2000 units and total volume cannot exceed 2500 units. find the no. of articles to be selected from each type such that the total cost is maximum.

	weight	volume	cost (Rs.)
A	4	9	5
B	8	7	6
C	2	4	3

Let, x_1, x_2, and x_3 are the decision variables corresponding to A, B and C.

Maximise cost;

$$Z = 5x_1 + 6x_2 + 3x_3.$$

Constraints are;

for weight; $4x_1 + 8x_2 + 2x_3 \leq 2000$

for volume; $9x_1 + 7x_2 + 4x_3 \leq 2500$

and the no. of units. $x_1 \geq 0, x_2 \geq 0, x_3 \geq 0$.

∴ LP problem can be written as.

Maximise; $Z = 5x_1 + 6x_2 + 3x_3$

subject to the constraints;

$$4x_1 + 8x_2 + 2x_3 \leq 2000$$
$$9x_1 + 7x_2 + 4x_3 \leq 2500$$
$$x_1, x_2, x_3 \geq 0.$$

Advertising Media selection Problem.

A company wants to work out a plan for advertising its product in three different media; TV, Radio, and Newspaper. The details are given by the following table:

	TV. (Rs)	Radio (Rs.)	Newspaper (Rs.)
Cost of advertising	4000	3000	1000
No. of customers	20000	30000	20000
Impact Rate	0.8	0.6	0.5

The company cannot spend more than Rs. 50000 for advertising. Advertisements should be given atleast once in a T.V. It is required to determine the no. of times the advertisment should be given in each media, so that the rate of exposure is Maximum.

{ Rate exposure = (impact rate) X (no. of customers) }

Solution:

Consider x_1, x_2, and x_3 are the decision variables represents the frequency in TV, Radio and newspaper.

∴ Rate exposure in TV = (0·8) 20000 = 16000

" in Radio = (0·6) 30000 = 18000

" in Newspaper = (0·5) 20000 = 10000

∴ Maximise $Z = 16000x_1 + 18000x_2 + 10000x_3$

Total cost of advertising shouldn't be more than 80,000.

∴ constraint

$$4000x_1 + 3000x_2 + 1000x_3 \leq 80,000.$$

At least one advertisement in TV.

$$\therefore x_1 \geq 1$$

∴ Lp problem of this given problem;

Maximise $Z = 16000x_1 + 18000x_2 + 10000x_3$

Subject to the constraints.

$$4000x_1 + 3000x_2 + 1000x_3 \leq 80,000$$

$$x_1 \geq 1$$

$$x_2, x_3 \geq 0$$

A soft drink plant has two bottling machines A and B manufacturing 1 litre and 2 litre bottles. The following tables gives the manufacturing data:

Machine	1 litre bottle	2 litre bottle
A	100/min	60/min
B	50/min	80/min.

The machine can be run 8hours per day, 5 days per week. Weekly production of the drink cannot exceed 3,00,000 litre and demand for 1 litre and 2 litre bottles are 25,000 and 8000 per week respectively. The manufacturer get a profit of 50 paise on 1 litre bottle and 75 paise on 2 litre bottle. It is required to find the no. of bottles to be manufactured in each type so as to maximize the total profit.

Solution:

Assume x_1 units of 1 litre bottle and x_2 units of 2 litre bottle.

$\therefore$ Total profit on Rs. $(0.5)x_1 + (0.75)x_2$

$\therefore$ Maximised profit

$$Z = 0.5x_1 + 0.75x_2$$

Machines run for 8 hours per day, 5 days per week.

$\therefore$ Total time of run/week = 40 hrs = 2400 min.

for machine A

100 units of 1 litre bottle & 60 units of 2 litre bottle.

$$\therefore \frac{x_1}{100} + \frac{x_2}{60} \leq 2400$$

for machine B

50 units of 1 litre bottles and 80 units of 2 litre bottles.

$$\therefore \frac{x_1}{50} + \frac{x_2}{80} \leq 2400$$

weekly production cannot exceed 3,00,000

$$\therefore x_1 + x_2 \leq 300000$$

Demand for the items in the market;

$$x_1 \geq 25000, \quad x_2 \geq 8000$$

$\therefore$ LPP is given as;

Maximise $Z = 0.5x_1 + 0.75x_2$

Subjected to constraints;

$$\frac{x_1}{100} + \frac{x_2}{60} \leq 2400$$

$$\frac{x_1}{50} + \frac{x_2}{80} \leq 2400$$

$$x_1 + x_2 \leq 3,00,000$$

$$x_1 \geq 25000; \quad x_2 \geq 8000.$$

Diet Problem :

In our daily diet, proteins, fats and carbohydrates are required with minimum of 5, 2 and 3 units respectively. we consider the foodstuff consisting of bread, butter and milk. The yields of these nutritional requirements and cost per unit of the food items are given below:

Food	Yield Per Unit			cost per unit of food
	Protein	Fat	Carbohydrate	
Bread	4	1	2	12
Butter	3	2	1	60
Milk	3	2	1	7
Minimum requirement	5	2	3	

It is required to determine the combination of the food items such that the minimum requirement is satisfied and the total cost of the food is minimum.

Solution:

Consider the no. of units of bread, butter and milk consumed are x_1, x_2 and x_3 respectively.

∴ Total cost of the food to be minimised

$$Z = 12x_1 + 60x_2 + 7x_3$$

Minimum requirement of the protein;

$$4x_1 + 3x_2 + 3x_3 \geq 5$$

Similarly for fat

$$x_1 + 2x_2 + 2x_3 \geq 2$$

for carbohydrates;

$$2x_1 + x_2 + x_3 \geq 3$$

∴ Lpp of the problem;

$$Z = 12x_1 + 60x_2 + 7x_3$$

Subjected to constraints: $4x_1 + 3x_2 + 3x_3 \geq 5$; $x_1 + 2x_2 + 2x_3 \geq 2$

$2x_1 + x_2 + x_3 \geq 3$; $x_1, x_2, x_3 \geq 0$.

13. PPT'S MATERIAL

LINEAR PROGRAMMING PROBLEM SOLUTION

METHODS FOR THE SOLUTION OF A LINEAR PROGRAMMING PROBLEM

Linear Programming, is a method of solving the type of problem in which two or more activities are competing to utilize the available limited resources, with a view to optimize the objective function of the problem. The objective may be to maximize the returns or to minimize the costs.

The various methods available to solve the problems are:

- ☐ Graphical Method
- ☐ Simplex Method
- ☐ Big-M Method
- ☐ Duality Principle

Graphical Method:

- ➢ The Graphical methods are used when two decision variables were present in the problem.
- ➢ To deal with more decision variables by graphical method will become complicated, because we have to deal with planes instead of straight lines.

LINEAR PROGRAMMING PROBLEM SOLUTION

Problem.1. A company manufactures two products, *X* and *Y* by using three machines *A*, *B*, and *C*. Machine *A* has 4 hours of capacity available during the coming week. Similarly, the available capacity of machines *B* and *C* during the coming week is 24 hours and 35 hours respectively. One unit of product *X* requires one hour of Machine *A*, 3 hours of machine *B* and 10 hours of machine *C*. Similarly one unit of product *Y* requires 1 hour, 8 hour and 7 hours of machine *A*, *B* and *C* respectively. When one unit of *X* is sold in the market, it yields a profit of Rs. 5/- per product and that of *Y* is Rs. 7/- per unit. Solve the problem by using graphical method to find the optimal product mix.

Solution: The details given in the problem is given in the table below:

Machines	Products (Time required in hours).		Available capacity in hours.
	X	Y	
A	1	1	4
B	3	8	24
C	10	7	35
Profit per unit(in Rs.)	5	7	

LINEAR PROGRAMMING PROBLEM SOLUTION

Let the company manufactures *x* units of *X* and y units of *Y*, and then the L.P. model is: Maximize $Z = 5x + 7y$

subjected to constraints

$1x + 1y \leq 4$

$3x + 8y \leq 24$

$10x + 7y \leq 35$ and

Both *x* and *y* are ≥ 0.

As we cannot draw graph for inequalities, let us

Maximize $Z = 5x + 7y$

subjected to constraints

$1x + 1y = 4$

$3x + 8y = 24$

$10x + 7y = 35$ and both *x* and y are ≥ 0

consider them as equations.

LINEAR PROGRAMMING PROBLEM SOLUTION

Let us take machine *A*. and find the boundary conditions.

If $x = 0$, machine *A* can manufacture $4/1 = 4$ units of *y*.

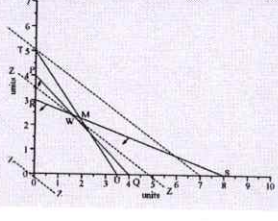
Similarly, if $y = 0$, machine *A* can manufacture $4/1 = 4$ units of *x*.

Similarly for other machines:

Machine *B* When $x = 0$, $y = 24/8 = 3$ and when $y = 0$, $x = 24/3 = 8$

Machine *C* When $x = 0$, $y = 35/10 = 3.5$ and when $y = 0$, $x = 35 / 7 = 5$.

These values we can plot on a graph, taking product *X* on *x*-axis and product *Y* on *y*- axis.



LINEAR PROGRAMMING PROBLEM SOLUTION

Discussion:

- line *PQ* is the boundary line for capacity of machine A, where as line RS for the capacity of machine B and line TU for the capacity of machine C.
- Figure shows the feasible area for all the three machines combined which is the fact because a products *X* and *Y* are complete when they are processed on machine A, B, and C.
- The area covered by all the three lines *PQ*, *RS*, and *TU* form a closed polygon *ROUVW*
- This polygon is the feasible area for the three machines. This means that all the points on the lines of polygon and any point within the polygon satisfies the inequality conditions of all the three machines.
- From the figure it is observed that the co-ordinates of corners of the closed polygon *ROUVW* and substitute the values in the objective function.
- In maximization problem, we select the co-ordinates giving maximum value. And in minimization problem, we select the co-ordinates, which gives minimum value.

LINEAR PROGRAMMING PROBLEM SOLUTION

In the problem the co-ordinates of the corners are:

$R = (0, 3.5)$, $O = (0,0)$, $U = (3.5,0)$, $V = (2.5, 1.5)$ and $W = (1.6,2.4)$.

Substituting these values in objective function:

$Z_{R,3.5} = 5 \times 0 + 7 \times 3.5 =$ Rs. 24.50, at point *R*

$Z_{0,0} = 5 \times 0 + 7 \times 0 =$ Rs. 00.00, at point *O*

$Z_{3.5,0} = 5 \times 3.5 + 7 \times 0 =$ Rs. 17.5 at point *U*

$Z_{2.5,1.5} = 5 \times 2.5 + 7 \times 1.5 =$ Rs. 23.00 at point *V*

$Z_{1.6,2.4} = 5 \times 1.6 + 7 \times 2.4 =$ Rs. 24.80 at point *W*

- Hence the optimal solution for the problem is company has to manufacture 1.6 units of product *X* and 2.4 units of product *Y*, so that it can earn a maximum profit of Rs. 24.80 in the planning period.

LINEAR PROGRAMMING PROBLEM SOLUTION

Problem 2. A manufacturer of furniture makes chairs and tables. Processing of these products is done on two machines A and B. A chair requires 2 hours on machine A and 6 hours on B. A table requires 5 hours on A and 6 hours on B. There are 16 hours of time available on machine A and 30 hours on machine B. At the most 4 chairs are to be manufactured. The manufacturer gets a profit of Rs.50 on a chair and Rs 100 on a table. Determine the number of chairs and tables to be manufactured so as to maximize the profit.

- **Solution:** Let X_1 chairs and X_2 tables be produced.

The total profit is to be maximize $P = 50 X_1 + 100 X_2$

Considering the time taken by X_1 chairs and X_2 tables on machine A we get the constraint $2X_1 + 5X_2 \leq 16$

The next constraint on the time taken on machine B is given by

$6X_1 + 6X_2 \leq 30$

or $X_1 + X_2 \leq 5$ and $X_1 \leq 4$.

Finally the non negativity constraints are $X_1 \geq 0$, $X_2 \geq 0$

LINEAR PROGRAMMING PROBLEM SOLUTION

Hence the LPP can be expressed as:

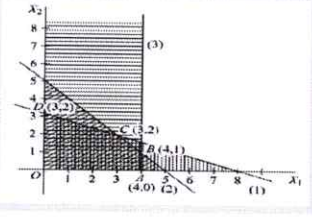
Maximize $P = 50 X_1 + 100 X_2$

subjected to constraints $2X_1 + 5X_2 \leq 16$

$X_1 + X_2 \leq 5$

$X_1 \leq 4$ and $X_1, X_2 \geq 0$

On solving the problem Graphically



14. END SEMESTER EXAMINATION QUESTION PAPERS

Vidya Jyothi Institute of Technology (Autonomous)

(Accredited by NAAC & NBA, Approved By A.I.C.T.E., New Delhi, Permanently Affiliated to JNTU, Hyderabad)
(Aziz Nagar, C.B.Post, Hyderabad -500075)

R15

Subject Code:A17334

B.Tech. IV Year I Semester Examination -NOVEMBER 2019

SUBJECT : OPERATION RESEARCH . **BRANCH :** MECHANICAL ENGINEERING

Time: 3 Hours **Max. Marks:75**

Note: This question paper contains two ***Parts A and B.***
Part A is compulsory which carries 25 Marks. Answer all the questions.
Part B consists of 5 questions. Answer all the questions.

Bloom`s Level:

Remember	L1	Analyze	L4
Understand	L2	Evaluate	L5
Apply	L3	Create	L6

		B. L	25M
	PART - A		
	ANSWER ALL THE QUESTIONS		
1	What is the OR and state the various types OR Models?	L1	2M
2	what are the objectives of Linear programming?-	L2	3M
3	What is a Transportation problem	L3	2M
4	What is the Degeneracy problem in Transportation problem and how do you resolve it?	L4	3M
5	Explain the pay of Matrix	L1	2M
6	Explain waiting Line modals?	L3	3M
7	What is the replacement problem	L2	2M
8	Define E O Q?	L1	3M
9	State the types of simulation modals	L4	2M
10	State the Hessian matrix.	L1	3M
	PART - B	**B.L**	**50M**
	ANSWER ALL THE QUESTIONS		
11.i(a)	what are the Limitations of Linear programming?	L3	3M
(b)	Solve the following LPP Using simplex method? Maximize $Z = 3X_1 + 2X_2$, STC $X_1 + X_2 \leq 4$, $X_1 - X_2 \geq 2$, $X_1, X_2 \geq 0$	L5	7M
	[OR]		
ii(a)	what are the advantages and disadvantages of linear programming Technique?	L3	3M
(b)	Solve the following LPP by using BIG M Method? maximize $= 4X_1 - 3X_2$, STC $3X_1 + 4X_2 \geq 6$, $X_1 + X_2 \leq 4$, $X_1, X_2 \geq 0$	L5	7M
12.i	Find the optimum solution to the following Transportation Problem?	L5	10M

	D1	D2	D3	D4	Supply
S1	6	4	1	5	14
S2	8	9	2	7	16
S3	4	3	6	2	5
Demand	6	10	15	4	35

	[OR]		
ii (a)	Briefly Explain the method for obtaining Initial basic feasible solution.	L4	3M
(b)	Solve the following Assignment problem?	L4	7M

	I	II	III	IV
A	10	12	9	11
B	5	10	7	8
C	12	14	13	11
D	8	15	11	9

13.i(a)	Explain main characteristics of Queuing modal.	L2	3M
(b)	A Train arrives at the yard every 15 minutes.the service time is 33minutes. If the line capacity of the yard is limited to 4 trains, Find A) the probability that the yard is empty B) The average number of Trains in the system ?	L4	7M

P.T.O

[OR]

ii (a)	Explain Dominance principle.	L3	3M
(b)	Solve the following game with pay of matrix.	L5	7M

	B1	B2
A1	12	15
A2	14	15

14.i(a)	Explain about individual and group replacements?	L3	3M
(b)	The computer contains 10,000 resistors. When any one of the resistor fails, it is replaced. The cost of replacing a single resistor is Rs.10 only. If all the resistors are replacing at the same time. The cost per resistor would be reduced to Rs.3.50. the percent surviving by the end of month " T" is following. Which is optimum plan?	L5	7M

Month(t)	0	1	2	3	6
%surviving by the end of the month	100	97	90	70	0

[OR]

ii (a)	Explain concept of probability?	L2	3M
(b)	A New paper boy buys paper for 10 paisa each and sells them for 12 paisa each. He cannot return un sold papers daily demand for news papers follows the distribution	L5	7M

Estimated demand(D)	10	11	12	13	16
probability	0.05	0.15	0.4	0.2	0.05

If each day demand is Independent of the previous day. How many papers should be

15.i	Explain in detail about the Kuhn Tucker condition?	L4	10M

[OR]

ii (a)	Define the simulation and Explain about simulation Languages?	L4	5M
(b)	Explain the Applications of simulation with suitable examples?	L4	5M

VJIT(A)

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(Aziz Nagar, C.B.Post, Hyderabad -500075) **Subject code:** A17334

IV B. Tech I SEM REGULAR EXAMINATION - NOVEMBER 2018

OPERATION RESEARCH

(MECH)

Time: 3hrs **Max.Marks:75**

Note: This question paper contains two PARTS A and B.
PART A is compulsory which carries 25 marks. Answer all questions.
PART B consists of 5 questions. Answer all the questions.

PART - A

ANSWER ALL THE QUESTIONS

1. Give various definitions of operations research?
2. What is model? List the various classifications of operations research models?
3. What is meant by optimal solution?
4. Explain the steps in transportation algorithm?
5. Define the problem of sequencing?
6. Explain the possibility and working rules of a maximization action in sequencing?
7. Which competitive situation is called a game?
8. Explain the terms (a) Pure strategy (b) Mixed strategy
9. Define Bellman's principle of optimality with examples?
10. Describe various elements of queue?

PART-B

ANSWER ALL THE QUESTIONS **5X10M=50M**

11 i) Use simplex method to

Minimize $Z = X_2 - 3X_3 + 2X_5$

Subject to constraints: $3X_2 - X_3 + 2X_5 \leq 7$,

$2X_2 + 4X_3 \leq 12$,

$-4X_2 + 3X_3 + 8X_5 \leq 10$,

$X_2 \geq 0$, $X_3 \geq 0$, $X_5 \geq 0$.

OR

ii)) old hens can be brought at Rs. 20/- each and young ones at Rs. 50/- each. The old hens lay 3 eggs per week and the young ones lay 5 eggs per week. Each egg being worth of Rs. 1.50 ps per week to feed, I have only Rs. 800/- to spend for hens. How many of each kind should I buy to give a profit of at least Rs. 60/- per week, assuming that I cannot house more than 20hens?

12.i). Find the optimal solution for the assignment problem with following cost matrix.

	I	II	III	IV	V
A	11	17	8	16	20
B	9	7	12	6	15
C	13	16	15	12	16
D	21	24	17	28	26
E	14	10	12	11	15

OR

P.T.O

ii) find the total cost using North – west corner rule method. Also find the optimal solution.

	W1	W2	W3	W4	Capacity
F1	95	105	80	15	12
F2	115	180	40	30	7
F3	195	180	95	70	5
Requirement	5	4	4	11	

13.i) Find the sequence that minimizes the total time required in performing the following jobs on three machines in the order A-B-C as shown in the below table. Also find the total elapsed time?

Machine/Job	1	2	3	4	5	6
A	8	3	7	2	5	1
B	3	4	5	2	1	6
C	8	7	6	9	10	9

OR

ii).The maintenance cost and resale value per year of a machine whose purchase price is Rs. 7000/- is given below:

Year	1	2	3	4	5	6	7	8
Maintenance Cost in Rs.	900	1200	1600	2100	2800	3700	4700	5900
Resale value in Rs.	4000	2000	1200	600	500	400	400	400

When should the machine be replaced?

14.i) .Write the assumptions made in game theory. Solve the following game graphically?

1	-3
3	5
-1	6
4	1
2	2
-5	0

OR

ii) A stockiest has to supply 400units of a product every Monday to his customers. He gets the product at Rs. 50/- per unit from the manufacturer. The cost of ordering and transportation from the manufacturer is Rs. 75/- per order. The cost of carrying inventory is 7.5 % per year of the cost of the product. Find a) the economic lot size b) the total optimal cost.

15.i) A person repairing radios finds that the time spent on the radio sets has an exponential distribution with mean 20 mins. If the radios are repaired in the order in which they come in and their arrival is approximately Poisson with an average date of 15 for 8 hr a day, what is the repairman's expected ideal time in each day? How many jobs are a head of the average set just brought in?

OR

ii) (a) state the bellman's principle of optimality?

(b) what are the applications of dynamic programming?

15. SAMPLE COPIES OF ASSIGNMENTS

Sol:- $A \to D \to B \to A$.

It is not a cycle. So take least element 1 and make assignment at (B, C) cell.

	A	B	C	D	E
A	α	⊗	2	[0]	⊗
B	⊗	α	[1]	⊗	⊗
C	2	1	α	3	[0]
D	0	[0]	3	α	4
E	[0]	⊗	⊗	4	α

5. Write its dual form of the LPP

Max $z = 10x_1 + 15x_2$

$2x_1 + 5x_2 \leq 7$

$3x_1 + 4x_2 \geq 8$

$x_1 + x_2 = 10$

x_1 and $x_2 \geq 0$

Sol:- Min $z = 7y_1 - 8y_2 + 10y_3$

$2y_1 - 3y_2 + y_3 \geq 10$

$5y_1 - 4y_2 + y_3 \geq 15$

$y_1 \geq 0$, $y_2 \geq 0$ and y_3 Unrestrict.

Assignment - 2

5/5

Name N. Adarsh
H.T NO:- 1991SA0355

1) If the saddlepoint is 7 find the value of P and q in the given game payoff matrix.

$$\begin{bmatrix} 2 & 6 & 5 \\ 10 & 7 & q \\ 5 & P & 8 \end{bmatrix}$$

Sol

Row minimum

$$\begin{bmatrix} 2 & 6 & 5 \\ 10 & 7 & q \\ 5 & P & 8 \end{bmatrix} \begin{matrix} 2 \\ 7 \\ 5 \end{matrix}$$

column matrix $\begin{matrix} 10 & 7 & 8 \end{matrix}$

As value of game = 7

so $p \leq 7$ and $q \geq 7$

2. In a Quening system with usual notations if arrival rate is 10 per hour and service rate is 12 per hour what is the idle time of server in 8 hour shift

Sol Idle time $= 8\left(1 - \frac{10}{12}\right)$

$= 1.33$ hours.

3. There are four Jobstate processed on two machines AB in that order what is the difference of processing time make span with 2 types of your choice.

A	10	8	20	7
B	12	15	4	7

Soln

Job	A In	A out	B In	B out
1	0	10	10	22
2	10	18	22	37
3	18	38	38	42
4	38	45	45	52

Job	A In	A out	B In	B out
3	0	20	20	24
4	20	27	27	34
2	27	35	35	50
1	35	45	50	62

Difference = 62 - 52

= 10 hours

4 In an inventory control Harris model find the change in EOQ if the Annual demand is doubled.

Soln

$$EOQ = \sqrt{\frac{2AS}{i}} = K_1 \text{ say}$$

$$EOQ = \sqrt{\frac{2(2A)S}{i}} = 1.414\ K_1$$

Change in EOQ = $1.414\ K_1 - K_1 = 0.414\ K_1$

% Change = 41.4.

5 Find the kuhn torker conditions

$$\text{Max } z = 10x^2 + 5y^2$$

$$2x + 3y = 10$$

Soln $L = (10x^2 + 5y^2) - \lambda (2x + 3y - 10)$

$$\frac{\partial L}{\partial x} = 20x - 2\lambda$$

$$\frac{\partial L}{\partial y} = 10y - 3\lambda$$

$$\frac{\partial L}{\partial \lambda} = 2x + 3y - 10.$$

Assignment - I

5/5

16911A0328

① Prepare the two phases of the following LPP

Max $Z = 2x + 5y$

$5x + 3y \geq 20$

$x + y = 6$

Sol:

Max $Z = 2x + 5y$

$5x + 3y - S_1 + A_1 = 20$

$x + y + A_2 = 6$

Phase 1

Max $Z^* = -A_1 - A_2$

$5x + 3y - S_1 + A_1 = 20$

$x + y + A_2 = 6$

Phase 2

Max $Z = 2x + 5y + 0S_1$

$5x + 3y - S_1 + A_1 = 20$

$x + y + A_2 = 6$

② Write the duality of the following LPP

Min $Z = 2x + 5y$

$5x + 3y \geq 20$

$x + y = 6$

(All variables are non-negative)

Sol:

Max $Z = 20p + 6r$

$5p + q \leq 2$

$3p + q \leq 5$

$-p \geq 0$; q is Unrestricted in sign

③ Make a transhipment matrix write the given TP Matrices

Depot

Factory	X	Y	Capacity
A	2	4	100
B	3	6	150
Demand	75	175	

From \ To

From \ To	A	B
A	-	10
B	12	-

From \ To

From \ To	X	Y
X	-	8
Y	7	-

Soll

	A	B	X	Y	Capacity
A	-	10	2	4	350
B	12	-	3	6	400
X	2	3	-	8	250
Y	4	6	7	-	250
Demand	250	250	325	425	

④ Write the given TPP in LPP format

Factory			Capacity
A	x_{11}	x_{12}	k_1
B	C_{21}	C_{22}	k_2
Demand	D_1	D_2	

Soll

$$\text{Min } Z = C_{11}x_{11} + C_{12}*x_{12} + C_{21}x_{21} + C_{22}x_{22}$$

$$x_{11} + x_{21} = D_1$$

$$x_{12} + x_{22} = D_2$$

$$x_{11} + x_{12} = k_1$$

$$x_{21} + x_{22} = k_2$$

(5) Players A and B tossing Rs 10 Coins each. player A wins if Coins match otherwise B wins Howevers matching of heads double premium Solve?

Soll

		B: H	B: T
A: H		20	-10
A: T		-10	10

		B: H	B: T	oddments
A: H		20	-10	20
A: T		-10	10	30
oddments		20	30	

Value of game $= \frac{20 \times 20 + 30 \times -10}{20 + 30} = \frac{100}{50} = 2$

Strategy A $= \left(\frac{20}{50}, \frac{30}{50}\right)$

Strategy B $= \left(\frac{20}{50}, \frac{30}{50}\right)$

Assignment-II

5/5

16911A03F7

(1) If the value of game is 5. find the value of p. The game has saddle point

$$A = \begin{matrix} & \text{I} & \text{II} \\ \text{I} & 10 & p \\ \text{II} & 4 & 5 \end{matrix}$$

Solution:

A	I	II	Min of row
I	10	p	p
II	4	5	4
Max of column	10	p	

Maximini = Max $(p, 4) = p$

Minimax = Min $(10, p) = p$

$\therefore p = 5$

(2) If two machines AB are used in that order to process (i) 2 Jobs (ii) 3 Jobs. Find the number of ways sequencing the Jobs

Solution:

(i) 2! ways $= 2 \times 1 = 2$

(ii) 3! ways $= 3 \times 2 \times 1 = 6$

(3) If running cost of Machine is Rs 1200 in the 2nd year find the present while assessing the replacement age of it. Take 5% rate of worth

Sol:

$$\text{pwf} = \frac{1}{1+0.05} = 0.9523$$

present worth of Running cost $= 1200 \times 0.9523 = 1142.8$

(4) In Harris model of inventory if the annual demand is doubled find change in (i) EOQ (ii) Total cost

Solution $EOQ = \sqrt{\frac{2AS}{i}}$

If demand is doubled (i) $EOQ_1 = \sqrt{\frac{2(2A)S}{i}} = 1.414\, EOQ$

% change in $EOQ = \frac{EOQ_1 - EOQ}{EOQ} = \frac{1.414\, EOQ - EOQ}{EOQ}$

$= 41.4$

(ii) $TC_1 = \sqrt{2(2A)Si} = 1.414\, TC$

$\therefore$ % change $= \frac{1.414\, TC - TC}{TC} = 41.4.$

(5) Find the necessary condition of the given NLPP

$$z = 2x^2 + 2y^2 + 3xy$$

$$x + y = 10$$

Solution: $z = 2x^2 + 2y^2 + 3xy$

$g = (x + y - 10)$

$L(z, g) = (2x^2 + 2y^2 + 3xy) + (x + y - 10)$

$\frac{\partial L}{\partial x} = 4x + 3y + 1$

$\frac{\partial L}{\partial y} = 4y + 3x + 1$

$\frac{\partial L}{\partial g} = x + y - 10$

Assignment-1.

5/5

1791/A0376

Q1 In the following IBFS of transportation problem of C_{11} is sent with one unit find the solution.

Sol

6	10	15	
4 (1)	6	16 (4)	
12 (12)	5 (8)	8 (1)	

6 (1)	10	15 (1)	
4	6	16 (5)	
12	5 (8)	8 (1.)	

the Cost = $1\times6 + 1\times15 + 16\times5 + 5\times8 + 8\times1$

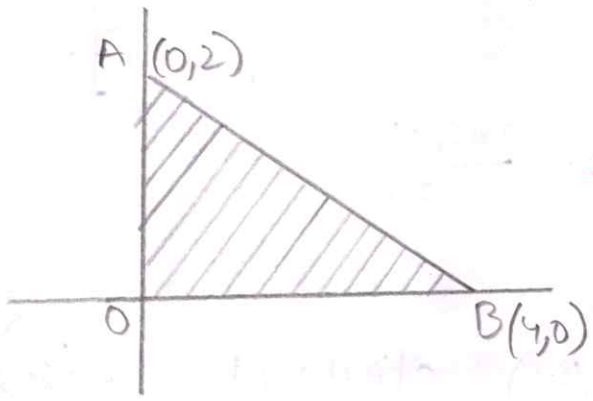
$= 149.$

Q2 Solve Graphically

$\text{Max } z = 10x + 15y$

$x + 2y \leq 4.$

Sol



z at O = 0

z at A = $10\times0 + 15\times2 = 30$

z at B = $10\times4 + 15\times0 = 40$

So maximum $z = 40$ and $x = 40, y = 0.$

Q3. write its dual form of the LPP.

Sol: $\max z = 10x_1 + 15x_2$

$2x_1 + 5x_2 \leq 7$

$3x_1 + 4x_2 \geq 8$

$x_1 + x_2 = 10$

x_1 and $x_2 \geq 0$

$\min z = 7y_1 - 8y_2 + 10y_3$

$2y_1 - 3y_2 + y_3 \geq 10$

$5y_1 - 4y_2 + y_3 \geq 15$

$y_1 \geq 0$, $y_2 \geq 0$ and y_3 unrestrich.

Q4. A and B toss one rupee coin each and if the coins match A wins otherwise B wins. The matching of heads has double premium.

Sol:

$$\begin{array}{c} \\ H \\ T \end{array} \begin{array}{c} \begin{array}{cc} H & T \end{array} \\ \begin{bmatrix} 2 & -1 \\ -1 & 1 \end{bmatrix} \end{array}$$

Oddments method

$$\begin{bmatrix} 2 & -1 & 2 \\ -1 & 1 & 3 \end{bmatrix}$$

$$\text{value of game} = \frac{2\times(2) + 3\times(-1)}{2+3}$$

$$= 1/5$$

strategy $A = (2/5, 3/5)$ strategy $B = (2/5, 3/5)$.

Q5 Reduce the distance travelled by salesman perform one iteration.

	A	B	C	D	E
A	∞	0	2	0	0
B	0	∞	1	0	0
C	2	1	∞	3	0
D	0	0	3	∞	4
E	0	0	0	4	∞

Sol $A \rightarrow D \rightarrow B \rightarrow A$. It is not a cycle. So take least element 1 and make assignment at (B,C) cell.

	A	B	C	D	E
A	∞	~~0~~	2	[0]	~~0~~
B	~~0~~	∞	[1]	~~0~~	~~0~~
C	2	1	∞	3	[0]
D	0	[0]	3	∞	4
E	[0]	~~0~~	~~0~~	4	∞

Assignment (2) 5/5

17911A03D2

(10) In a Queuing System with usual notations if arrival rate is 10/hr & service is 12/hr. What is the idle time of teller in 8 hours shift.

Sol:- Idle time $= \left(8 - \frac{10}{2}\right) = 1.33$ hours.

(20) There are four jobs to be processed on two machines A B in that order. What is the difference of processing time & Make Span. with 2 types of your choice.

A	10	8	20	7
B	12	15	4	7

Sol:-

Job	A		B	
1	0	10	10	22
2	10	18	22	37
3	18	38	38	42
4	38	45	45	52

Jobs	A		B	
3	0	20	20	24
4	20	27	27	34
2	27	35	35	50
1	35	45	50	62

(30) In an Inventory control Harris Model find the change in EOQ if the Annual demand is doubled.

Sol:- $EOQ = \sqrt{\frac{2AS}{i}} = (K_1)$ say.

$$EOQ = \sqrt{\frac{2(2A)S}{i}} = 1.414 K_1$$

change in $EOQ = 1.41K_1 - K_1 = 0.414K_1$

$$\% \text{ change} = 41.4$$

(40) Find the kuhn tucker conditions

$$\text{Max } z = 10x^2 + 5y^2$$

$$2x + 3y = 10$$

Sol:- $L = (10x^2 + 5y^2) - \lambda(2x + 3y - 10)$

$$\frac{\partial L}{\partial x} = 20x - 2\lambda$$

$$\frac{\partial L}{\partial y} = 10y - 3\lambda$$

$$\frac{\partial L}{\partial \lambda} = 2x + 3y - 10$$

(50) If the saddle point is 7 find the value of p and q in the given game pay off matrix

$$\begin{bmatrix} 2 & 6 & 5 \\ 10 & 7 & q \\ 5 & p & 8 \end{bmatrix}$$

Sol:

$$\begin{bmatrix} 2 & 6 & 5 \\ 10 & 7 & PQ \\ 5 & P & 8 \end{bmatrix} \quad \begin{matrix} \text{Row Min} \\ (2) \\ (9) \\ (5) \end{matrix}$$

$$\begin{matrix} (10) & (7) & (8) \\ \text{Column Max} \end{matrix}$$

As Value of game $= 7$ so $P \leq 7$ & $Q \geq 7$

16. ASSESSMENT SHEET – CO WISE (DIRECT ATTAINMENT)

CO ATTAINMENT		
Batch: 2017-2021	Year-Sem: IV-I	Course: OR

Mid 1													
OR_M1	Part A			Part B			Assignment					Total Marks
Roll No:	Q1	Q2	Q3	Q4	Q5	Q6	A_Q1	A_Q2	A_Q3	A_Q4	A_Q5	
17911A0301	2	2		1	1	3	1			1	1	12
17911A0302	2	2		2	2	3	1			1	1	14
17911A0303	1	2				2	1		1			7
17911A0304												AB
17911A0305												AB
17911A0306	2	1	2	3	3	4	1	1	1		1	19
17911A0308	2		2	2	2	3	1			1	1	14
17911A0309	2	2	2	3	3	4	1	1	1	1	1	21
17911A0311												AB
17911A0312	2	2		2	2	2	1			1	1	13
17911A0313	2	2		1	1	3	1			1	1	12
17911A0314	2	2		2	2	3	1			1	1	14
17911A0315	2	2		2	2	3	1			1	1	14
17911A0317		2	2	2	2	2	1			1	1	13
17911A0319		2	2	1	1	3	1			1	1	12
17911A0320	2	2	2	5	5	4	1	1	1	1	1	25
17911A0321	2	2	2	5	4	4	1	1	1	1	1	24
17911A0322	2	2	2	5	5	4	1	1	1	1	1	25
17911A0323	2	2		2	2	2	1			1	1	13
17911A0324	2	2		1	1	3	1			1	1	12
17911A0325	2	2	2	5	5	4	1	1	1	1	1	25
17911A0327	2	2		2	2	3	1			1	1	14
17911A0328	2		2	1	1	2	1			1	1	11
17911A0329	2		2	2	2	2	1			1	1	13
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17911A0331	2		2	2	2	3	1			1	1	14
17911A0332	2	2	2	5	4	4	1	1	1	1	1	24
17911A0333	2		2	2	2	3	1			1	1	14
17911A0334	2		2	2	2	3	1			1	1	14
17911A0335	2		2	2	2	3	1			1	1	14
17911A0336	2	2	2	5	4	4	1	1	1	1	1	24
17911A0337	2	2	1	2	2	3	1	1	1		1	16
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17911A0342	2	2	2	5	5	4	1	1	1	1	1	25
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17911A0345	2	2		1	1	3	1			1	1	12
17911A0346	2	2	1	2	2	2	1	1	1		1	15
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17911A0350	2	2	2	5	5	4	1	1	1	1	1	25
17911A0351		2	2	2	2	3	1			1	1	14
17911A0352		2	2	2	2	2	1			1	1	13
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17911A0356	2	1	2	2	2	4	1	1	1		1	17
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17911A0359	2	2		1	1	3	1			1	1	12
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17911A0367	2	2	1	2	2	2	1	1	1		1	15
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17911A0371	2	2		2	2	2	1			1	1	13
17911A0372	2	2	2	5	5	4	1	1	1	1	1	25
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17911A0374	2	1	2	2	2	4	1	1	1		1	17
17911A0375		2	2	2	2	2	1			1	1	13
17911A0376	2	2	2	5	5	4	1	1	1	1	1	25
17911A0377	2	2	2	3	3	3	1	1	1	1	1	20
17911A0380	2	2	2	3	3	3	1	1	1	1	1	20
17911A0381	2	1	2	2	2	2	1	1	1		1	15
17911A0382	2	2	2	5	5	4	1	1	1	1	1	25
17911A0383	2	2	2	4	4	4	1	1	1	1	1	23
17911A0384	2	2	2	5	5	4	1	1	1	1	1	25
17911A0385	2	2	2	5	5	4	1	1	1	1	1	25
17911A0386												AB
17911A0387	1	2	2	2	2	4	1	1	1		1	17
17911A0388	2	2	2	5	4	4	1	1	1	1	1	24
17911A0389	1	2	2	2	2	4	1	1	1		1	17
17911A0390	2	2		2	2	2	1			1	1	13
17911A0391	2	2	1	2	2	4	1	1	1		1	17
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17911A0397		2	2	1	1	3	1			1	1	12
17911A0398	2	2	2	5	4	4	1	1	1	1	1	24
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17911A03A0	2		2	1	1	3	1			1	1	12
17911A03A1	2	2	2	5	5	4	1	1	1	1	1	25
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17911A03A4	2	2	2	4	4	4	1	1	1	1	1	23
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17911A03A9												AB
17911A03B0	2	2	2	5	5	4	1	1	1	1	1	25
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17911A03B6	2	1	2	2	2	3	1	1	1		1	16
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17911A03F4		2	2	2	2	3	1			1	1	14
17911A03F5	2	2	2	3	3	3	1	1	1	1	1	20
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17911A03G1	2	2	2	5	5	4	1	1	1	1	1	25
17911A03G2	1	2	2	2	2	2	1	1	1		1	15
17911A03G3	2	2	2	5	5	4	1	1	1	1	1	25
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17911A03G7	2	2	2	3	3	4	1	1	1	1	1	21
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17911A03H1	2	2	1	3	3	3	1	1	1		1	18
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17911A03H3	2	2	2	5	5	4	1	1	1	1	1	25
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17911A03H5	2	2		1	1	3	1			1	1	12
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17911A03J1	2	2	2	5	5	4	1	1	1	1	1	25
17911A03J2	1	2	2	3	3	4	1	1	1		1	19
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17911A03J4	2	2	2	5	4	4	1	1	1	1	1	24
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17911A03K3	2	2	2	4	4	4	1	1	1	1	1	23
17911A03K5	1	2	2	2	2	3	1	1	1		1	16
17911A03K6	2	2	2	3	3	3	1	1	1	1	1	20
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17911A03K8	2	2	2	5	5	4	1	1	1	1	1	25
17911A03K9	2	2	2	4	4	4	1	1	1	1	1	23
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17911A03L4	1	2	2	3	3	4	1	1	1		1	19
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17911A03M1	1	2	2	2	2	3	1	1	1		1	16
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17915A0342	2	2	2	5	4	4	1	1	1	1	1	24
18915A0301	2	2	2	4	4	4	1	1	1	1	1	23
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18915A0308	1	2	2	3	3	4	1	1	1		1	19
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18915A0326	1	2				1	1		1			6
18915A0327	2	2	2	5	5	4	1	1	1	1	1	25
18915A0328	2	2	2	5	5	4	1	1	1	1	1	25
18915A0329	2		1	1	1	2	1		1			9

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18915A0332	2	2	2	5	5	4	1	1	1	1	1	25
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18915A0334	2	2	2	4	4	4	1	1	1	1	1	23
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18915A0337	1	2	2	2	2	2	1	1	1		1	15
18915A0338	2	2	2	5	5	4	1	1	1	1	1	25
18915A0339	1	2	2	2	2	3	1	1	1		1	16
18915A0340	1	2	2	2	2	4	1	1	1		1	17
18915A0341	2	2	2	4	3	4	1	1	1	1	1	22
18915A0342	2	2	2	5	5	4	1	1	1	1	1	25
18915A0343	2	2	2	5	4	4	1	1	1	1	1	24
18915A0344	2	2	2	5	5	4	1	1	1	1	1	25
18915A0345	2	2		2	2	3	1			1	1	14
18915A0346	2	2		2	2	3	1			1	1	14
18915A0347	2	2	2	4	4	4	1	1	1	1	1	23
18915A0348	2	2	2	5	4	4	1	1	1	1	1	24
18915A0349	2	2	2	5	5	4	1	1	1	1	1	25
18915A0350	2	2	2	4	3	4	1	1	1	1	1	22
18915A0351	2	2	2	5	5	4	1	1	1	1	1	25
18915A0352	2	2	2	5	4	4	1	1	1	1	1	24
18915A0353	2	2	2	5	4	4	1	1	1	1	1	24
No of students attempted	226	222	217	229	229	234	242	242	242	242	242	
No of students who scored >= 60% Marks	201	208	203	161	161	230	232	186	200	189	228	
% of students who scored >= 60% Marks	89	94	94	70	70	98	96	77	83	78	94	
Attainment	3	3	3	3	3	3	3	3	3	3	3	

Mid 2												
OR_M2	Part A			Part B			Assignment					Total Marks
Roll No:	Q1	Q2	Q3	Q4	Q5	Q6	A_Q1	A_Q2	A_Q3	A_Q4	A_Q5	
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17911A0302	1	2	2	2	2	2	1	1	1		1	15
17911A0303	1	2		1	1	1	1		1			8
17911A0304												AB
17911A0305												AB
17911A0306	2	1	2	3	3	4	1	1	1		1	19
17911A0308	2	2	1	2	2	2	1	1	1		1	15
17911A0309	1	2	2	3	3	4	1	1	1		1	19
17911A0311												AB
17911A0312	1	2	2	2	2	2	1	1	1		1	15
17911A0313	1	2	2	2	2	3	1	1	1		1	16
17911A0314	2	2		2	2	2	1			1	1	13
17911A0315	1	2	2	2	2	3	1	1	1		1	16
17911A0317	2	1	2	2	2	2	1	1	1		1	15
17911A0319		2	2	2	2	3	1			1	1	14
17911A0320	2	2	2	4	5	5	1	1	1	1	1	25
17911A0321	2	2	2	4	4	5	1	1	1	1	1	24
17911A0322	2	2	2	4	5	5	1	1	1	1	1	25
17911A0323	1	2	2	2	2	2	1	1	1		1	15
17911A0324	1	2	2	2	2	3	1	1	1		1	16
17911A0325	2	2	2	4	5	5	1	1	1	1	1	25
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17911A0328	2	2	1	2	2	2	1	1	1		1	15
17911A0329	2	2	1	2	2	4	1	1	1		1	17
17911A0330	2	2	1	2	2	2	1	1	1		1	15
17911A0331	2		2	2	2	3	1			1	1	14
17911A0332	2	2	2	4	4	5	1	1	1	1	1	24
17911A0333	2	2	1	2	2	3	1	1	1		1	16
17911A0334	2		2	1	1	3	1			1	1	12
17911A0335	2	2	1	2	2	2	1	1	1		1	15
17911A0336	2	2	2	3	3	3	1	1	1	1	1	20
17911A0337	2		2	2	2	3	1			1	1	14
17911A0338	2	2	2	4	4	4	1	1	1	1	1	23
17911A0339	2	2	2	4	5	5	1	1	1	1	1	25
17911A0340	2	2	2	4	5	5	1	1	1	1	1	25
17911A0341	2	2	2	4	4	4	1	1	1	1	1	23
17911A0342	2	2	2	4	5	5	1	1	1	1	1	25
17911A0343	2	2	2	4	4	4	1	1	1	1	1	23
17911A0344	2	2		2	2	2	1			1	1	13
17911A0345	2	2		2	2	2	1			1	1	13
17911A0346	2	2	1	2	2	2	1	1	1		1	15
17911A0347	2	2	2	4	5	5	1	1	1	1	1	25
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17911A0350	2	2	2	4	5	5	1	1	1	1	1	25
17911A0351	2	1	2	3	3	3	1	1	1		1	18
17911A0352		2	2	2	2	3	1			1	1	14
17911A0354	1	2	2	2	2	2	1	1	1		1	15
17911A0355	2	2	2	4	4	4	1	1	1	1	1	23
17911A0356	2	1	2	2	2	4	1	1	1		1	17
17911A0358	2	2	2	4	5	5	1	1	1	1	1	25
17911A0359	2	2		2	2	3	1			1	1	14
17911A0360	2	1	2	2	2	2	1	1	1		1	15
17911A0361	2	2	2	4	5	5	1	1	1	1	1	25

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17911A0363	2	2	2	4	4	4	1	1	1	1	1	23
17911A0365	2	2	2	4	5	5	1	1	1	1	1	25
17911A0367	2	2	1	2	2	2	1	1	1		1	15
17911A0368	2	2	2	4	5	5	1	1	1	1	1	25
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17911A0371	1	2	2	2	2	2	1	1	1		1	15
17911A0372	2	2	2	3	3	4	1	1	1	1	1	21
17911A0373	2	2		1	1	2	1			1	1	11
17911A0374	2	1	2	3	3	4	1	1	1		1	19
17911A0375	2	1	2	2	2	2	1	1	1		1	15
17911A0376	2	2	2	4	4	4	1	1	1	1	1	23
17911A0377	2	2	2	4	4	5	1	1	1	1	1	24
17911A0380		2	2	2	2	3	1			1	1	14
17911A0381	2	1	2	2	2	4	1	1	1		1	17
17911A0382	2	2	2	4	5	5	1	1	1	1	1	25
17911A0383	2	2	2	3	3	4	1	1	1	1	1	21
17911A0384	2	2	2	4	5	5	1	1	1	1	1	25
17911A0385	2	2	2	4	4	4	1	1	1	1	1	23
17911A0386												AB
17911A0387	1	2	2	2	2	2	1	1	1		1	15
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17911A0389	2	2	2	3	3	4	1	1	1	1	1	21
17911A0390	1	2	2	2	2	4	1	1	1		1	17
17911A0391	2	2	1	2	2	4	1	1	1		1	17
17911A0392	2	2	2	4	4	5	1	1	1	1	1	24
17911A0393	2		2	2	2	2	1			1	1	13
17911A0394	2	2	2	4	5	5	1	1	1	1	1	25
17911A0395	2	2	2	4	4	5	1	1	1	1	1	24
17911A0396	2	2	2	4	4	4	1	1	1	1	1	23
17911A0397	2	1	2	2	2	3	1	1	1		1	16
17911A0398	2	2	2	3	3	5	1	1	1	1	1	22
17911A0399	1	2	2	2	2	3	1	1	1		1	16
17911A03A0	2		2	2	2	2	1			1	1	13
17911A03A1	2	2	2	3	3	4	1	1	1	1	1	21
17911A03A2	1	2	2	3	3	4	1	1	1		1	19
17911A03A4	2	2	2	3	3	4	1	1	1	1	1	21
17911A03A5	2	2	2	3	3	5	1	1	1	1	1	22
17911A03A6	2	2	2	3	3	3	1	1	1	1	1	20
17911A03A7	2	2	2	4	4	4	1	1	1	1	1	23
17911A03A8	2	2	2	4	4	4	1	1	1	1	1	23
17911A03A9												AB
17911A03B0	2	2	2	4	5	5	1	1	1	1	1	25
17911A03B1	1	2	2	2	2	2	1	1	1		1	15
17911A03B2	2	2	2	4	4	5	1	1	1	1	1	24
17911A03B3	2	2	2	3	3	3	1	1	1	1	1	20
17911A03B4	2	2	2	3	3	4	1	1	1	1	1	21
17911A03B5	1	2	2	3	3	4	1	1	1		1	19
17911A03B6	2	1	2	3	3	3	1	1	1		1	18
17911A03B7	2	2	2	3	3	5	1	1	1	1	1	22
17911A03B8	2	2	2	3	3	4	1	1	1	1	1	21
17911A03B9	2	2	2	4	5	5	1	1	1	1	1	25
17911A03C1	2	2	2	4	4	4	1	1	1	1	1	23
17911A03C2	2	2	2	4	5	5	1	1	1	1	1	25
17911A03C3	2	2	2	3	3	5	1	1	1	1	1	22
17911A03C4	2	2	2	4	5	5	1	1	1	1	1	25

17911A03C5	2	2	2	4	5	5	1	1	1	1	1	25
17911A03C6	2	2	2	4	5	5	1	1	1	1	1	25
17911A03C7	2	2	2	4	5	5	1	1	1	1	1	25
17911A03C8	2	2	2	4	5	5	1	1	1	1	1	25
17911A03C9	1	2	2	3	3	3	1	1	1		1	18
17911A03D0	2	2	2	4	5	5	1	1	1	1	1	25
17911A03D1	2	2	2	4	4	4	1	1	1	1	1	23
17911A03D2	2	2	2	4	4	5	1	1	1	1	1	24
17911A03D3	2	2	2	4	5	5	1	1	1	1	1	25
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17911A03D5	1	2	2	3	3	3	1	1	1		1	18
17911A03D6	2	2	2	4	4	5	1	1	1	1	1	24
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17911A03D8	2	2	2	4	4	5	1	1	1	1	1	24
17911A03D9	2	2	2	3	3	4	1	1	1	1	1	21
17911A03E0	2		2	2	2	3	1			1	1	14
17911A03E1	2	2	2	4	5	5	1	1	1	1	1	25
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17911A03E3	2	2	2	4	5	5	1	1	1	1	1	25
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17911A03E5	2	2	1	2	2	3	1	1	1		1	16
17911A03E7	2	2	2	3	3	3	1	1	1	1	1	20
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17911A03E9	1	2	2	3	3	4	1	1	1		1	19
17911A03F0	2	2	2	3	3	5	1	1	1	1	1	22
17911A03F1	2	2	2	4	4	4	1	1	1	1	1	23
17911A03F2	2	2	2	4	4	5	1	1	1	1	1	24
17911A03F4	2	1	2	2	2	3	1	1	1		1	16
17911A03F5	2	2	2	4	4	5	1	1	1	1	1	24
17911A03F6	2	2	2	4	5	5	1	1	1	1	1	25
17911A03F7	2	2	2	3	3	3	1	1	1	1	1	20
17911A03F8	2	2	2	4	5	5	1	1	1	1	1	25
17911A03F9	2	2	2	4	4	4	1	1	1	1	1	23
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17911A03G1	2	2	2	4	5	5	1	1	1	1	1	25
17911A03G2	2	2		2	2	2	1			1	1	13
17911A03G3	2	2	2	3	3	4	1	1	1	1	1	21
17911A03G5	2	2	2	4	4	4	1	1	1	1	1	23
17911A03G6		2	2	2	2	2	1			1	1	13
17911A03G7	2	2	2	4	4	4	1	1	1	1	1	23
17911A03G8	2	2	1	3	3	3	1	1	1		1	18
17911A03H0	2	2	1	2	2	2	1	1	1		1	15
17911A03H1	2		2	2	2	3	1			1	1	14
17911A03H2	2	2	1	3	3	3	1	1	1		1	18
17911A03H3	2	2	2	4	5	5	1	1	1	1	1	25
17911A03H4	2	2	2	3	3	4	1	1	1	1	1	21
17911A03H5	1	2	2	2	2	3	1	1	1		1	16
17911A03H6	2	2	2	4	5	5	1	1	1	1	1	25
17911A03H7	2	1	2	2	2	2	1	1	1		1	15
17911A03H9	2	2	2	4	5	5	1	1	1	1	1	25
17911A03J1	2	2	2	4	4	4	1	1	1	1	1	23
17911A03J2	2	2	2	4	4	4	1	1	1	1	1	23
17911A03J3	2	2	2	4	5	5	1	1	1	1	1	25
17911A03J4	2	2	2	3	3	3	1	1	1	1	1	20
17911A03J5	2	2	2	4	4	4	1	1	1	1	1	23
17911A03J6	2	2	2	4	5	5	1	1	1	1	1	25

17911A03J7	2	2	2	4	5	5	1	1	1	1	1	25
17911A03J9	2	2	2	4	4	5	1	1	1	1	1	24
17911A03K0	2	2	2	4	4	4	1	1	1	1	1	23
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17911A03K2	2	2	2	4	4	4	1	1	1	1	1	23
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17911A03K5	1	2	2	2	2	4	1	1	1		1	17
17911A03K6	2	2	2	4	4	5	1	1	1	1	1	24
17911A03K7	1	2	2	2	2	2	1	1	1		1	15
17911A03K8	2	2	2	4	5	5	1	1	1	1	1	25
17911A03K9	1	2	2	2	2	4	1	1	1		1	17
17911A03L0	2	2	2	4	4	4	1	1	1	1	1	23
17911A03L1	1	2				1	1		1			6
17911A03L3	1		1						1			3
17911A03L4	2	2	2	4	4	4	1	1	1	1	1	23
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17911A03L6	2	2	2	3	3	4	1	1	1	1	1	21
17911A03L7	2	2	2	4	4	4	1	1	1	1	1	23
17911A03L8	2	1	2	3	3	3	1	1	1		1	18
17911A03L9	2	2	2	3	3	5	1	1	1	1	1	22
17911A03M0	2	1	2	3	3	4	1	1	1		1	19
17911A03M1	2	2		1	1	1	1			1	1	10
17911A03M2	2	2	2	4	4	5	1	1	1	1	1	24
17911A03M3		1	1						1			3
17915A0342	2	2	1	3	3	3	1	1	1		1	18
18915A0301	1	2	2	2	2	4	1	1	1		1	17
18915A0302	2	2	2	4	5	5	1	1	1	1	1	25
18915A0303	2	2	2	3	3	5	1	1	1	1	1	22
18915A0304	2	2	2	3	3	4	1	1	1	1	1	21
18915A0305		1	2	1	1	1	1		1			8
18915A0306	2	2	2	4	4	4	1	1	1	1	1	23
18915A0307	2	2	2	4	5	5	1	1	1	1	1	25
18915A0308	1	2	2	3	3	4	1	1	1		1	19
18915A0310	2	2	2	4	5	5	1	1	1	1	1	25
18915A0311	1	2	2	3	3	4	1	1	1		1	19
18915A0312	2	2	2	4	5	5	1	1	1	1	1	25
18915A0313	2	2	2	4	4	4	1	1	1	1	1	23
18915A0314		1	2			1	1		1			6
18915A0315	2	2	2	4	4	4	1	1	1	1	1	23
18915A0316		1	2			2	1		1			7
18915A0317	2	2	2	4	4	4	1	1	1	1	1	23
18915A0318	2	2	2	4	5	5	1	1	1	1	1	25
18915A0319	1	2	2	2	2	4	1	1	1		1	17
18915A0320	2	2	2	3	3	5	1	1	1	1	1	22
18915A0321	2	2	2	4	5	5	1	1	1	1	1	25
18915A0322	2	2	2	4	5	5	1	1	1	1	1	25
18915A0323	1	2	2	2	2	2	1	1	1		1	15
18915A0324	2	2	2	4	5	5	1	1	1	1	1	25
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18915A0326	1	2		1	1	1	1		1			8
18915A0327	2	2	2	4	5	5	1	1	1	1	1	25
18915A0328	2	2	2	4	4	4	1	1	1	1	1	23
18915A0329	2		1	1	1	1	1		1			8
18915A0330	2	2	2	4	4	4	1	1	1	1	1	23
18915A0331	2	2	1	3	3	4	1	1	1		1	19
18915A0332	2	2	2	4	5	5	1	1	1	1	1	25

18915A0333	2	2	2	4	5	5	1	1	1	1	1	25
18915A0334	2	1	2	2	2	4	1	1	1		1	17
18915A0335	2	2	2	3	3	4	1	1	1	1	1	21
18915A0336	2	2	2	4	5	5	1	1	1	1	1	25
18915A0337	2	2		2	2	2	1			1	1	13
18915A0338	2	2	2	3	3	4	1	1	1	1	1	21
18915A0339	2	2		1	1	1	1			1	1	10
18915A0340	2	2		2	2	2	1			1	1	13
18915A0341	2	2	2	4	4	5	1	1	1	1	1	24
18915A0342	2	2	2	4	5	5	1	1	1	1	1	25
18915A0343	2	2	2	3	3	5	1	1	1	1	1	22
18915A0344	2	2	2	4	5	5	1	1	1	1	1	25
18915A0345	1	2	2	2	2	3	1	1	1		1	16
18915A0346	2	2		2	2	3	1			1	1	14
18915A0347	2	2	2	4	5	5	1	1	1	1	1	25
18915A0348	2	2	2	4	4	5	1	1	1	1	1	24
18915A0349	2	2	2	3	3	4	1	1	1	1	1	21
18915A0350	2	2	2	3	3	5	1	1	1	1	1	22
18915A0351	2	2	2	4	4	4	1	1	1	1	1	23
18915A0352	2	2	2	4	4	5	1	1	1	1	1	24
18915A0353	2	2	2	4	4	5	1	1	1	1	1	24
No of students attempted	230	228	227	232	232	235	242	242	242	242	242	
No of students who scored >= 60% Marks	193	208	207	161	161	226	235	204	218	166	228	
% of students who scored >= 60% Marks	84	91	91	69	69	96	97	84	90	69	94	
Attainment	3	3	3	2	2	3	3	3	3	2	3	

External	
Roll No:	External Marks
17911A0301	38
17911A0302	43
17911A0303	AB
17911A0304	AB
17911A0305	AB
17911A0306	71
17911A0308	28
17911A0309	68
17911A0311	4
17911A0312	39
17911A0313	23
17911A0314	25
17911A0315	41
17911A0317	42
17911A0319	24
17911A0320	72
17911A0321	66
17911A0322	69
17911A0323	25
17911A0324	24
17911A0325	43
17911A0327	42
17911A0328	24
17911A0329	43
17911A0330	64
17911A0331	42
17911A0332	71
17911A0333	44
17911A0334	22
17911A0335	22
17911A0336	73
17911A0337	40
17911A0338	43
17911A0339	65
17911A0340	42
17911A0341	66
17911A0342	64
17911A0343	71
17911A0344	24
17911A0345	22
17911A0346	21
17911A0347	72
17911A0349	68
17911A0350	69
17911A0351	32
17911A0352	41
17911A0354	42
17911A0355	43
17911A0356	65
17911A0358	69
17911A0359	25
17911A0360	24
17911A0361	64
17911A0362	41

17911A0363	75
17911A0365	73
17911A0367	44
17911A0368	72
17911A0369	67
17911A0371	40
17911A0372	73
17911A0373	40
17911A0374	39
17911A0375	39
17911A0376	72
17911A0377	73
17911A0380	73
17911A0381	43
17911A0382	73
17911A0383	71
17911A0384	74
17911A0385	72
17911A0386	AB
17911A0387	39
17911A0388	67
17911A0389	31
17911A0390	40
17911A0391	43
17911A0392	64
17911A0393	72
17911A0394	70
17911A0395	65
17911A0396	73
17911A0397	39
17911A0398	70
17911A0399	41
17911A03A0	42
17911A03A1	68
17911A03A2	44
17911A03A4	72
17911A03A5	70
17911A03A6	74
17911A03A7	75
17911A03A8	75
17911A03A9	AB
17911A03B0	75
17911A03B1	73
17911A03B2	75
17911A03B3	71
17911A03B4	70
17911A03B5	65
17911A03B6	39
17911A03B7	73
17911A03B8	73
17911A03B9	75
17911A03C1	75
17911A03C2	70
17911A03C3	67
17911A03C4	71
17911A03C5	75

17911A03C6	71
17911A03C7	74
17911A03C8	73
17911A03C9	43
17911A03D0	75
17911A03D1	72
17911A03D2	73
17911A03D3	65
17911A03D4	73
17911A03D5	42
17911A03D6	75
17911A03D7	72
17911A03D8	67
17911A03D9	68
17911A03E0	42
17911A03E1	70
17911A03E2	75
17911A03E3	71
17911A03E4	72
17911A03E5	44
17911A03E7	68
17911A03E8	67
17911A03E9	43
17911A03F0	70
17911A03F1	74
17911A03F2	70
17911A03F4	40
17911A03F5	69
17911A03F6	75
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17911A03G1	75
17911A03G2	40
17911A03G3	73
17911A03G5	74
17911A03G6	39
17911A03G7	73
17911A03G8	69
17911A03H0	40
17911A03H1	38
17911A03H2	75
17911A03H3	74
17911A03H4	64
17911A03H5	25
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17911A03H7	25
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17911A03J1	75
17911A03J2	74
17911A03J3	75
17911A03J4	75
17911A03J5	73
17911A03J6	75
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17911A03J9	75
17911A03K0	73
17911A03K1	65
17911A03K2	71
17911A03K3	68
17911A03K5	25
17911A03K6	69
17911A03K7	43
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17911A03L6	70
17911A03L7	75
17911A03L8	75
17911A03L9	73
17911A03M0	68
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17911A03M3	2
17915A0342	75
18915A0301	65
18915A0302	71
18915A0303	75
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18915A0306	67
18915A0307	71
18915A0308	75
18915A0310	72
18915A0311	74
18915A0312	71
18915A0313	64
18915A0314	5
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18915A0317	75
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18915A0319	65
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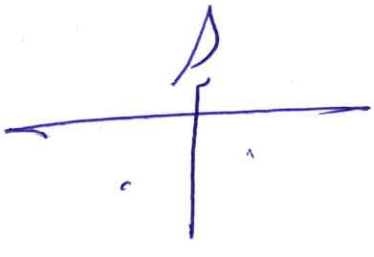
18915A0326	5
18915A0327	75
18915A0328	72
18915A0329	25
18915A0330	75
18915A0331	66
18915A0332	75
18915A0333	75

18915A0334	75
18915A0335	75
18915A0336	75
18915A0337	42
18915A0338	75
18915A0339	72
18915A0340	24
18915A0341	71
18915A0342	72
18915A0343	73
18915A0344	75
18915A0345	26
18915A0346	23
18915A0347	75
18915A0348	69
18915A0349	74
18915A0350	71
18915A0351	75
18915A0352	75
18915A0353	75
No of students attempted	237
No: of students who scored more than 60%	158
% of students who scored more than 60%	67
Attainment	2

CO	Method	Value	Average	Attainment Level (Internal)	Attainment Level (External)	CO Direct Attainment (25%Int+75%Ext)
CO1	M1_D_Q1	3	3.00	2.87	2.00	2.22
	M1_D_Q4	3				
	M1_A_Q1	3				
	M1_A_Q2	3				
CO2	M1_D_Q2	3	3.00			
	M1_D_Q5	3				
	M1_A_Q3	3				
	M1_A_Q4	3				
CO3	M1_D_Q3	3	2.83			
	M1_D_Q6	3				
	M1_A_Q5	3				
	M2_D_Q1	3				
	M2_D_Q4	2				
	M2_A_Q1	3				
CO4	M2_D_Q2	3	2.75			
	M2_D_Q5	2				
	M2_A_Q2	3				
	M2_A_Q3	3				
CO5	M2_D_Q3	3	2.75			
	M2_D_Q6	3				
	M2_A_Q4	2				
	M2_A_Q5	3				

Direct CO Attainment	2.22
Indirect CO Attainment	2.52
Overall CO Attainment (0.8 * Direct Attainment+ 0.2 * Indirect Attainment)	2.28



CO ATTAINMENT		
Batch: 2016-2020	Year-Sem: IV-I	Course: OR

Mid 1													
OR_M1	Part A			Part B			Assignment					Total Marks
Roll No:	Q1	Q2	Q3	Q4	Q5	Q6	A_Q1	A_Q2	A_Q3	A_Q4	A_Q5	
16911A0301	2	2	2	4	3	4	1	1	1	1	1	22
16911A0303	2	2	2	5	5	4	1	1	1	1	1	25
16911A0304	2	2	2	4	3	4	1	1	1	1	1	22
16911A0305	1	2	2	2	2	3	1	1	1		1	16
16911A0306	2	1	2	2	2	2	1	1	1		1	15
16911A0307	2	2	2	5	5	4	1	1	1	1	1	25
16911A0308	2	1	2	2	2	4	1	1	1		1	17
16911A0310	2	1	2	3	3	3	1	1	1		1	18
16911A0312	2	2	2	4	3	4	1	1	1	1	1	22
16911A0313	2	2	2	3	3	3	1	1	1	1	1	20
16911A0314	2		2	2	2	2	1			1	1	13
16911A0315	2	2	2	3	3	4	1	1	1	1	1	21
16911A0317	1	2	2	3	3	3	1	1	1		1	18
16911A0318		2	2	1	1	2	1			1	1	11
16911A0319	2	2	2	5	5	4	1	1	1	1	1	25
16911A0321	2	2	2	5	5	4	1	1	1	1	1	25
16911A0322	2	2	2	5	5	4	1	1	1	1	1	25
16911A0323		2	2	1	1	3	1			1	1	12
16911A0324	2	2	2	5	5	4	1	1	1	1	1	25
16911A0325	2	2	2	5	4	4	1	1	1	1	1	24
16911A0326	1	2	2	2	2	3	1	1	1		1	16
16911A0328	1	2	2	2	2	4	1	1	1		1	17
16911A0329	1	2	2	2	2	4	1	1	1		1	17
16911A0330	1	2	2	2	2	4	1	1	1		1	17
16911A0331	2	2	2	5	5	4	1	1	1	1	1	25
16911A0332	2	2	1	2	2	3	1	1	1		1	16
16911A0333	2	2	2	3	3	4	1	1	1	1	1	21
16911A0334	2		2	1	1	3	1			1	1	12
16911A0335	2	2	1	3	3	4	1	1	1		1	19
16911A0336	2		2	2	2	3	1			1	1	14
16911A0337	2	2	2	5	5	4	1	1	1	1	1	25
16911A0338	2	2	2	5	5	4	1	1	1	1	1	25
16911A0339	2		2	1	1	1	1			1	1	10
16911A0340	2	2	2	4	4	4	1	1	1	1	1	23
16911A0341	2		2	2	2	2	1			1	1	13
16911A0342	2	2	2	5	4	4	1	1	1	1	1	24
16911A0343	2	2	2	4	4	4	1	1	1	1	1	23
16911A0345	2	2		1	1	3	1			1	1	12
16911A0346	2	2		2	2	2	1			1	1	13
16911A0347	1	2	2	2	2	3	1	1	1		1	16
16911A0348	2	2	2	5	4	4	1	1	1	1	1	24
16911A0349	2	2		1	1	2	1			1	1	11
16911A0351	2	2	2	3	3	4	1	1	1	1	1	21
16911A0352	1	2	2	3	3	3	1	1	1		1	18
16911A0354	2	2	2	5	5	4	1	1	1	1	1	25
16911A0355	2	2	2	5	5	4	1	1	1	1	1	25
16911A0356	2	2	2	4	4	4	1	1	1	1	1	23
16911A0357	2	2	2	5	5	4	1	1	1	1	1	25
16911A0358	2	1	2	3	3	3	1	1	1		1	18
16911A0359	2	2	2	3	3	4	1	1	1	1	1	21

16911A0360	1	2	2	3	3	3	1	1	1		1	18
16911A0361	2	2	2	5	4	4	1	1	1	1	1	24
16911A0362	2	2	2	3	3	4	1	1	1	1	1	21
16911A0364	2	2	2	3	3	4	1	1	1	1	1	21
16911A0365	2		2	2	2	3	1			1	1	14
16911A0366	2	2	1	2	2	2	1	1	1		1	15
16911A0367	2	2	1	2	2	4	1	1	1		1	17
16911A0368	2	2	1	3	3	3	1	1	1		1	18
16911A0370	2	2	2	3	3	3	1	1	1	1	1	20
16911A0371	2	2		2	2	3	1			1	1	14
16911A0372	2	2	2	4	4	4	1	1	1	1	1	23
16911A0374	2	2	2	5	5	4	1	1	1	1	1	25
16911A0375	2	2	2	4	3	4	1	1	1	1	1	22
16911A0376	2	2	2	5	5	4	1	1	1	1	1	25
16911A0377		2	2	1	1	2	1			1	1	11
16911A0378	2	1	2	2	2	3	1	1	1		1	16
16911A0379	2		2	2	2	2	1			1	1	13
16911A0380	2	2	2	5	5	4	1	1	1	1	1	25
16911A0381	2	2	2	4	3	4	1	1	1	1	1	22
16911A0382	1	2	2	2	2	4	1	1	1		1	17
16911A0383	2	2	2	3	3	4	1	1	1	1	1	21
16911A0384	2	2	2	5	5	4	1	1	1	1	1	25
16911A0385	1	2	2	3	3	4	1	1	1		1	19
16911A0386	2	2		1	1	1	1			1	1	10
16911A0387	2	2	2	4	4	4	1	1	1	1	1	23
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16911A0389		2	2	1	1	2	1			1	1	11
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16911A0395	2	2	2	5	5	4	1	1	1	1	1	25
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16911A0399		2	2	2	2	3	1			1	1	14
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16911A03A3	2	2	2	3	3	4	1	1	1	1	1	21
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16911A03B8	2	2		2	2	3	1			1	1	14
16911A03B9	1	2	2	2	2	3	1	1	1		1	16
16911A03C0	2	2	2	3	3	4	1	1	1	1	1	21

16911A03C1	2	1	2	2	2	2	1	1	1		1	15
16911A03C2	2	1	2	3	3	3	1	1	1		1	18
16911A03C3	2	1	2	3	3	4	1	1	1		1	19
16911A03C4		2	2	2	2	2	1			1	1	13
16911A03C5	2	1	2	2	2	3	1	1	1		1	16
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16911A03C7	2	2	1	2	2	2	1	1	1		1	15
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16911A03C9	2	2	2	4	3	4	1	1	1	1	1	22
16911A03D0	2	1	2	3	3	4	1	1	1		1	19
16911A03D1	2	2	2	4	4	4	1	1	1	1	1	23
16911A03D2		2	2	2	2	2	1			1	1	13
16911A03D3	2	2	2	3	3	4	1	1	1	1	1	21
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16911A03D6	1	2	2	2	2	2	1	1	1		1	15
16911A03D7	2	2	2	5	5	4	1	1	1	1	1	25
16911A03D8	2	2		2	2	3	1			1	1	14
16911A03E0	1	2	2	2	2	3	1	1	1		1	16
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16911A03G9	2	1	2	3	3	4	1	1	1		1	19
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16911A03H7	2	2	2	5	5	4	1	1	1	1	1	25
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16911A03J0	2	2	2	3	3	4	1	1	1	1	1	21
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16911A03J2	2	2		1	1	1	1			1	1	10
16911A03J3	1	2	2	2	2	3	1	1	1		1	16
16911A03J4	2	2	2	3	3	3	1	1	1	1	1	20
16911A03J5	2	2	2	3	3	4	1	1	1	1	1	21
16911A03J6	2	2	2	5	5	4	1	1	1	1	1	25
16911A03J7		1	2	1	1	2	1		1			9
16911A03J8	1	2	2	2	2	4	1	1	1		1	17
16911A03J9		2	2	2	2	2	1			1	1	13
16911A03K0	2	1	2	3	3	3	1	1	1		1	18
16911A03K1	2	2	1	2	2	3	1	1	1		1	16
16911A03K2	1	2	2	2	2	2	1	1	1		1	15
16911A03K3	2	2	2	3	3	4	1	1	1	1	1	21
16911A03K4	2	2		1	1	1	1			1	1	10
16911A03K5	2	2		1	1	1	1			1	1	10
16911A03K8	1	2				2	1		1			7
16911A03K9	2		2	1	1	3	1			1	1	12
16911A03L0	2		2	1	1	3	1			1	1	12
16911A03L1	2	2	1	2	2	4	1	1	1		1	17
16911A03L2	2	2	1	2	2	4	1	1	1		1	17
16911A03L3	2	2	1	2	2	2	1	1	1		1	15
16911A03L4	2		2	1	1	2	1			1	1	11
16911A03L5	2		2	1	1	3	1			1	1	12
16911A03L6	2	2	1	2	2	4	1	1	1		1	17
16911A03L7	2		2	1	1	1	1			1	1	10
16911A03L8	2	2	1	2	2	2	1	1	1		1	15
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16911A03M3	2	2	2	3	3	3	1	1	1	1	1	20
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16911A03M5	1	2	2	2	2	2	1	1	1		1	15
16911A03M6	1	2	2	3	3	3	1	1	1		1	18
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16911A03M9	1	2	2	2	2	2	1	1	1		1	15
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16911A03N1	1	2				1	1		1			6
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16911A03N3	2	1	2	3	3	3	1	1	1		1	18
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17915A0301	2	2		1	1	2	1			1	1	11
17915A0302	2	2	2	5	5	4	1	1	1	1	1	25
17915A0303	2	2		1	1	1	1			1	1	10
17915A0304	2	2	2	4	4	4	1	1	1	1	1	23
17915A0305	1	2	2	3	3	4	1	1	1		1	19
17915A0306	2	2	2	5	5	4	1	1	1	1	1	25
17915A0307	2	2	2	5	5	4	1	1	1	1	1	25
17915A0308	2	2	2	4	4	4	1	1	1	1	1	23
17915A0309	2	2	2	5	5	4	1	1	1	1	1	25
17915A0310	2	2	2	4	3	4	1	1	1	1	1	22
17915A0311	2	2	2	5	5	4	1	1	1	1	1	25
17915A0312	2	2	2	3	3	4	1	1	1	1	1	21
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17915A0316	2	2	2	4	3	4	1	1	1	1	1	22
17915A0317	2	2	2	5	5	4	1	1	1	1	1	25
17915A0318	2	2	2	5	5	4	1	1	1	1	1	25

17915A0320	1	2	2	2	2	3	1	1	1		1	16
17915A0321	2	2	2	5	5	4	1	1	1	1	1	25
17915A0322	2	2	2	4	4	4	1	1	1	1	1	23
17915A0323	2	2	2	4	3	4	1	1	1	1	1	22
17915A0324	2	1	2	3	3	3	1	1	1		1	18
17915A0325	2	2	2	5	5	4	1	1	1	1	1	25
17915A0327	2	2	2	4	4	4	1	1	1	1	1	23
17915A0328	2	2	2	4	4	4	1	1	1	1	1	23
17915A0329	2	2	2	3	3	4	1	1	1	1	1	21
17915A0330	2	2		2	2	3	1			1	1	14
17915A0331	2		2	2	2	3	1			1	1	14
17915A0333	2	2	2	4	4	4	1	1	1	1	1	23
17915A0334	2	2	2	3	3	4	1	1	1	1	1	21
17915A0335	2	2	1	3	3	3	1	1	1		1	18
17915A0336	2	2	1	2	2	2	1	1	1		1	15
17915A0337	2	2	2	3	3	3	1	1	1	1	1	20
17915A0338	2	2	2	3	3	4	1	1	1	1	1	21
17915A0339	2	2	2	3	3	4	1	1	1	1	1	21
17915A0340	2	2	1	3	3	3	1	1	1		1	18
17915A0341	2	2	2	3	3	4	1	1	1	1	1	21
17915A0343	2	1	2	3	3	3	1	1	1		1	18
17915A0344	2	2	2	3	3	4	1	1	1	1	1	21
17915A0345	1	2	2	2	2	3	1	1	1		1	16
17915A0346	2	2		1	1	1	1			1	1	10
17915A0347	2	2	2	5	5	4	1	1	1	1	1	25
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17915A0351	2	2	2	5	4	4	1	1	1	1	1	24
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17915A0353	1	2	2	3	3	4	1	1	1		1	19
No of students attempted	240	228	226	246	246	249	249	249	249	249	249	
No of students who scored >= 60% Marks	203	207	203	148	148	235	249	196	203	168	242	
% of students who scored >= 60% Marks	85	91	90	60	60	94	100	79	82	67	97	
Attainment	3	3	3	2	2	3	3	3	3	2	3	

Mid 2												
OR_M2	Part A			Part B			Assignment					Total Marks
Roll No:	Q1	Q2	Q3	Q4	Q5	Q6	A_Q1	A_Q2	A_Q3	A_Q4	A_Q5	
16911A0301	1	2	2	3	3	3	1	1	1		1	18
16911A0303	2	2	2	4	5	5	1	1	1	1	1	25
16911A0304	1	2	2	3	3	3	1	1	1		1	18
16911A0305	2	2		2	2	3	1			1	1	14
16911A0306	2	1	2	3	3	4	1	1	1		1	19
16911A0307	2	2	2	3	3	4	1	1	1	1	1	21
16911A0308	2	1	2	2	2	2	1	1	1		1	15
16911A0310	2	2	2	3	3	3	1	1	1	1	1	20
16911A0312	2	2	2	4	4	5	1	1	1	1	1	24
16911A0313	2	2	2	4	4	5	1	1	1	1	1	24
16911A0314	2		2	1	1	2	1			1	1	11
16911A0315	2	2	2	4	5	5	1	1	1	1	1	25
16911A0317	1	2	2	3	3	3	1	1	1		1	18
16911A0318		2	2	1	1	2	1			1	1	11
16911A0319	2	2	2	3	3	4	1	1	1	1	1	21
16911A0321	2	2	2	4	5	5	1	1	1	1	1	25
16911A0322	2	2	2	4	5	5	1	1	1	1	1	25
16911A0323		2	2	1	1	1	1			1	1	10
16911A0324	2	2	2	4	5	5	1	1	1	1	1	25
16911A0325	2	2	2	4	4	5	1	1	1	1	1	24
16911A0326	1	2	2	2	2	3	1	1	1		1	16
16911A0328	2	2	2	3	3	4	1	1	1	1	1	21
16911A0329	1	2	2	2	2	2	1	1	1		1	15
16911A0330	1	2	2	2	2	2	1	1	1		1	15
16911A0331	2	2	2	4	5	5	1	1	1	1	1	25
16911A0332	2		2	2	2	3	1			1	1	14
16911A0333	2	2	2	3	3	4	1	1	1	1	1	21
16911A0334	2	2	1	2	2	3	1	1	1		1	16
16911A0335	2	2	1	2	2	4	1	1	1		1	17
16911A0336	2		2	1	1	3	1			1	1	12
16911A0337	2	2	2	4	4	4	1	1	1	1	1	23
16911A0338	2	2	2	4	5	5	1	1	1	1	1	25
16911A0339	2		2	2	2	3	1			1	1	14
16911A0340	2	2	2	4	5	5	1	1	1	1	1	25
16911A0341	2		2	1	1	2	1			1	1	11
16911A0342	2	2	2	3	3	3	1	1	1	1	1	20
16911A0343	2	2	2	4	5	5	1	1	1	1	1	25
16911A0345	2	2		1	1	3	1			1	1	12
16911A0346	1	2	2	2	2	4	1	1	1		1	17
16911A0347	1	2	2	2	2	3	1	1	1		1	16
16911A0348	2	2	2	3	3	3	1	1	1	1	1	20
16911A0349	1	2	2	2	2	2	1	1	1		1	15
16911A0351	1	2	2	3	3	4	1	1	1		1	19
16911A0352	2	2	2	3	3	3	1	1	1	1	1	20
16911A0354	2	2	2	3	3	4	1	1	1	1	1	21
16911A0355	2	2	2	4	4	4	1	1	1	1	1	23
16911A0356	2	2	2	3	3	4	1	1	1	1	1	21
16911A0357	2	2	2	4	5	5	1	1	1	1	1	25
16911A0358	2	1	2	3	3	3	1	1	1		1	18
16911A0359	1	2	2	3	3	4	1	1	1		1	19
16911A0360	1	2	2	3	3	3	1	1	1		1	18
16911A0361	2	2	2	4	4	5	1	1	1	1	1	24
16911A0362	1	2	2	2	2	4	1	1	1		1	17

16911A0364	2	2	2	4	5	5	1	1	1	1	1	25
16911A0365	2		2	1	1	3	1			1	1	12
16911A0366	2		2	2	2	2	1			1	1	13
16911A0367	2	2	1	3	3	4	1	1	1		1	19
16911A0368	2	2	1	2	2	3	1	1	1		1	16
16911A0370	2	2	2	3	3	3	1	1	1	1	1	20
16911A0371	1	2	2	2	2	2	1	1	1		1	15
16911A0372	1	2	2	3	3	4	1	1	1		1	19
16911A0374	2	2	2	4	5	5	1	1	1	1	1	25
16911A0375	2	2	2	4	4	5	1	1	1	1	1	24
16911A0376	2	2	2	4	5	5	1	1	1	1	1	25
16911A0377		2	2	1	1	3	1			1	1	12
16911A0378	2	2	2	3	3	3	1	1	1	1	1	20
16911A0379	2		1	1	1	2	1		1			9
16911A0380	2	2	2	4	5	5	1	1	1	1	1	25
16911A0381	2	2	2	3	3	5	1	1	1	1	1	22
16911A0382	1	2	2	3	3	4	1	1	1		1	19
16911A0383	1	2	2	3	3	4	1	1	1		1	19
16911A0384	2	2	2	4	4	4	1	1	1	1	1	23
16911A0385	1	2	2	2	2	4	1	1	1		1	17
16911A0386	2	2		1	1	3	1			1	1	12
16911A0387	2	2	2	3	3	4	1	1	1	1	1	21
16911A0388	2	2	2	4	4	5	1	1	1	1	1	24
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16911A0390	2	2	2	3	3	3	1	1	1	1	1	20
16911A0391	2	2	2	3	3	4	1	1	1	1	1	21
16911A0392	2	2	2	3	3	3	1	1	1	1	1	20
16911A0393	2	2	2	3	3	5	1	1	1	1	1	22
16911A0394	2		2	1	1	1	1			1	1	10
16911A0395	2	2	2	4	5	5	1	1	1	1	1	25
16911A0396	2	2	2	3	3	3	1	1	1	1	1	20
16911A0397	2	1	2	3	3	4	1	1	1		1	19
16911A0399	2	1	2	2	2	3	1	1	1		1	16
16911A03A0	2	2	2	4	4	4	1	1	1	1	1	23
16911A03A1	2	2	2	4	5	5	1	1	1	1	1	25
16911A03A2	2	2	2	4	5	5	1	1	1	1	1	25
16911A03A3	1	2	2	2	2	4	1	1	1		1	17
16911A03A5	2	2	2	4	4	5	1	1	1	1	1	24
16911A03A6	2	2	2	3	3	4	1	1	1	1	1	21
16911A03A7	2	2	2	4	5	5	1	1	1	1	1	25
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16911A03B0	2	2	2	4	5	5	1	1	1	1	1	25
16911A03B1	2	2	2	4	4	4	1	1	1	1	1	23
16911A03B2	2	2	2	4	4	4	1	1	1	1	1	23
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16911A03B4	2	1	2	2	2	4	1	1	1		1	17
16911A03B5	2	1	2	2	2	2	1	1	1		1	15
16911A03B6	2	2	2	4	4	4	1	1	1	1	1	23
16911A03B7	1	2	2	2	2	4	1	1	1		1	17
16911A03B8	2	2		1	1	1	1			1	1	10
16911A03B9	1	2	2	3	3	3	1	1	1		1	18
16911A03C0	2	2	2	3	3	4	1	1	1	1	1	21
16911A03C1	2	1	2	3	3	4	1	1	1		1	19
16911A03C2	2	2	2	3	3	3	1	1	1	1	1	20
16911A03C3	2	2	2	4	4	4	1	1	1	1	1	23

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16911A03C5		2	2	1	1	3	1			1	1	12
16911A03C6	2	2	2	4	4	5	1	1	1	1	1	24
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16911A03D0	2	2	2	4	4	4	1	1	1	1	1	23
16911A03D1	2	2	2	4	5	5	1	1	1	1	1	25
16911A03D2		1	2	1	1	2	1		1			9
16911A03D3	2	1	2	3	3	4	1	1	1		1	19
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16911A03D6	1	2	2	3	3	4	1	1	1		1	19
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16911A03E0	1	2	2	2	2	3	1	1	1		1	16
16911A03E1	1	2	2	3	3	3	1	1	1		1	18
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16911A03E4	2		2	2	2	3	1			1	1	14
16911A03E5	2	2	2	3	3	4	1	1	1	1	1	21
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16911A03E8	2		2	1	1	1	1			1	1	10
16911A03E9	2	2	2	4	5	5	1	1	1	1	1	25
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16911A03F6	2	2		2	2	2	1			1	1	13
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16911A03G6	1	2	2	2	2	2	1	1	1		1	15
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16911A03H3	2	2	2	4	5	5	1	1	1	1	1	25
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16911A03H6		2	2	2	2	2	1			1	1	13
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16911A03H9	2	2	1	3	3	4	1	1	1		1	19
16911A03J0	2	2	2	3	3	4	1	1	1	1	1	21
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16911A03J3	2	2	2	3	3	3	1	1	1	1	1	20
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16911A03J5	2	2	2	3	3	4	1	1	1	1	1	21
16911A03J6	2	2	2	4	5	5	1	1	1	1	1	25
16911A03J7		1	2			2	1		1			7
16911A03J8	1	2	2	2	2	4	1	1	1		1	17
16911A03J9	2	1	2	2	2	2	1	1	1		1	15
16911A03K0	2	2	2	3	3	5	1	1	1	1	1	22
16911A03K1	2	2	2	3	3	3	1	1	1	1	1	20
16911A03K2	2	2		2	2	2	1			1	1	13
16911A03K3	2	2	2	4	4	4	1	1	1	1	1	23
16911A03K4	2	2		1	1	3	1			1	1	12
16911A03K5	1	2				1	1		1			6
16911A03K8	1	2				2	1		1			7
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16911A03L0	2		2	2	2	3	1			1	1	14
16911A03L1	2	2	1	2	2	4	1	1	1		1	17
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16911A03M3	2	2	2	3	3	3	1	1	1	1	1	20
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16911A03M5	1	2	2	2	2	2	1	1	1		1	15
16911A03M6	2	2		2	2	3	1			1	1	14
16911A03M7	1	2	2	2	2	3	1	1	1		1	16
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16911A03N0	1	2	2	2	2	3	1	1	1		1	16
16911A03N1	2	2		1	1	1	1			1	1	10
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17915A0304	2	2	2	3	3	4	1	1	1	1	1	21
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17915A0308	2	2	2	4	5	5	1	1	1	1	1	25
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17915A0318	2	2	2	4	5	5	1	1	1	1	1	25
17915A0320	2	2		2	2	3	1			1	1	14
17915A0321	2	2	2	4	4	4	1	1	1	1	1	23
17915A0322	2	2	2	4	5	5	1	1	1	1	1	25

17915A0323	2	2	2	4	4	5	1	1	1	1	1	24
17915A0324		2	2	2	2	3	1			1	1	14
17915A0325	2	2	2	4	5	5	1	1	1	1	1	25
17915A0327	1	2	2	3	3	4	1	1	1		1	19
17915A0328	1	2	2	3	3	4	1	1	1		1	19
17915A0329	2	2	2	4	5	5	1	1	1	1	1	25
17915A0330	1	2	2	3	3	3	1	1	1		1	18
17915A0331	2	2	1	3	3	3	1	1	1		1	18
17915A0333	2	2	2	3	3	4	1	1	1	1	1	21
17915A0334	2	2	2	4	4	4	1	1	1	1	1	23
17915A0335	2		2	2	2	3	1			1	1	14
17915A0336	2	2	1	3	3	4	1	1	1		1	19
17915A0337	2	2	2	3	3	3	1	1	1	1	1	20
17915A0338	2	2	2	4	4	4	1	1	1	1	1	23
17915A0339	2	2	2	4	5	5	1	1	1	1	1	25
17915A0340	2		2	2	2	3	1			1	1	14
17915A0341	2	2	2	3	3	4	1	1	1	1	1	21
17915A0343	2	2	2	3	3	5	1	1	1	1	1	22
17915A0344	2	1	2	2	2	4	1	1	1		1	17
17915A0345	2	2		2	2	3	1			1	1	14
17915A0346	2	2		2	2	3	1			1	1	14
17915A0347	2	2	2	4	5	5	1	1	1	1	1	25
17915A0348	2	2	2	4	5	5	1	1	1	1	1	25
17915A0349	2	2	2	3	3	5	1	1	1	1	1	22
17915A0350	1	2	2	2	2	4	1	1	1		1	17
17915A0351	2	2	2	4	4	5	1	1	1	1	1	24
17915A0352	2	2	2	3	3	3	1	1	1	1	1	20
17915A0353	2	2	2	4	4	4	1	1	1	1	1	23
No of students attempted	240	223	225	246	246	249	249	249	249	249	249	
No of students who scored >= 60% Marks	200	205	206	152	152	233	249	190	200	172	239	
% of students who scored >= 60% Marks	83	92	92	62	62	94	100	76	80	69	96	
Attainment	3	3	3	2	2	3	3	3	3	2	3	

External	
Roll No:	External Marks
16911A0301	64
16911A0303	67
16911A0304	63
16911A0305	67
16911A0306	33
16911A0307	69
16911A0308	65
16911A0310	27
16911A0312	60
16911A0313	69
16911A0314	60
16911A0315	63
16911A0317	63
16911A0318	35
16911A0319	60
16911A0321	65
16911A0322	70
16911A0323	35
16911A0324	60
16911A0325	67
16911A0326	34
16911A0328	65
16911A0329	39
16911A0330	68
16911A0331	62
16911A0332	21
16911A0333	62
16911A0334	38
16911A0335	66
16911A0336	34
16911A0337	62
16911A0338	60
16911A0339	27
16911A0340	66
16911A0341	35
16911A0342	60
16911A0343	67
16911A0345	35
16911A0346	34
16911A0347	30
16911A0348	62
16911A0349	65
16911A0351	69
16911A0352	60
16911A0354	62
16911A0355	62
16911A0356	24
16911A0357	67
16911A0358	20
16911A0359	67
16911A0360	19
16911A0361	38
16911A0362	18
16911A0364	64

16911A0365	39
16911A0366	18
16911A0367	70
16911A0368	21
16911A0370	40
16911A0371	29
16911A0372	61
16911A0374	60
16911A0375	62
16911A0376	34
16911A0377	19
16911A0378	20
16911A0379	20
16911A0380	66
16911A0381	32
16911A0382	35
16911A0383	68
16911A0384	69
16911A0385	70
16911A0386	27
16911A0387	36
16911A0388	65
16911A0389	38
16911A0390	69
16911A0391	18
16911A0392	69
16911A0393	62
16911A0394	21
16911A0395	60
16911A0396	19
16911A0397	68
16911A0399	26
16911A03A0	65
16911A03A1	62
16911A03A2	62
16911A03A3	67
16911A03A5	38
16911A03A6	62
16911A03A7	64
16911A03A8	65
16911A03A9	65
16911A03B0	64
16911A03B1	69
16911A03B2	64
16911A03B3	65
16911A03B4	40
16911A03B5	17
16911A03B6	63
16911A03B7	62
16911A03B8	28
16911A03B9	60
16911A03C0	66
16911A03C1	26
16911A03C2	67
16911A03C3	66
16911A03C4	69

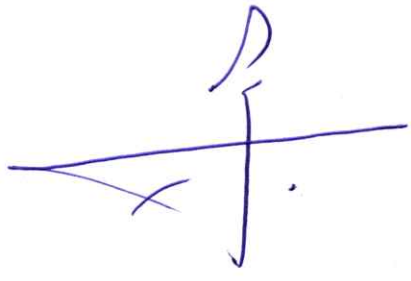
16911A03C5	62
16911A03C6	70
16911A03C7	67
16911A03C8	69
16911A03C9	63
16911A03D0	67
16911A03D1	60
16911A03D2	40
16911A03D3	65
16911A03D4	69
16911A03D6	65
16911A03D7	63
16911A03D8	31
16911A03E0	69
16911A03E1	63
16911A03E2	30
16911A03E3	60
16911A03E4	28
16911A03E5	24
16911A03E6	63
16911A03E7	66
16911A03E8	40
16911A03E9	69
16911A03F0	40
16911A03F1	66
16911A03F2	64
16911A03F3	60
16911A03F5	18
16911A03F6	64
16911A03F7	64
16911A03F9	69
16911A03G0	66
16911A03G1	38
16911A03G2	66
16911A03G3	63
16911A03G4	61
16911A03G5	33
16911A03G6	66
16911A03G7	64
16911A03G8	29
16911A03G9	67
16911A03H0	60
16911A03H1	61
16911A03H2	40
16911A03H3	62
16911A03H4	60
16911A03H6	23
16911A03H7	63
16911A03H8	60
16911A03H9	36
16911A03J0	70
16911A03J1	64
16911A03J2	20
16911A03J3	64
16911A03J4	64
16911A03J5	62

16911A03J6	63
16911A03J7	31
16911A03J8	63
16911A03J9	40
16911A03K0	65
16911A03K1	61
16911A03K2	61
16911A03K3	64
16911A03K4	65
16911A03K5	28
16911A03K8	31
16911A03K9	24
16911A03L0	66
16911A03L1	61
16911A03L2	24
16911A03L3	62
16911A03L4	70
16911A03L5	62
16911A03L6	21
16911A03L7	19
16911A03L8	67
16911A03L9	32
16911A03M1	21
16911A03M3	69
16911A03M4	68
16911A03M5	70
16911A03M6	67
16911A03M7	30
16911A03M8	69
16911A03M9	63
16911A03N0	40
16911A03N1	69
16911A03N2	64
16911A03N3	68
16911A03N4	27
17915A0301	22
17915A0302	69
17915A0303	21
17915A0304	22
17915A0305	40
17915A0306	63
17915A0307	60
17915A0308	60
17915A0309	64
17915A0310	65
17915A0311	60
17915A0312	69
17915A0313	33
17915A0314	62
17915A0316	70
17915A0317	69
17915A0318	66
17915A0320	65
17915A0321	62
17915A0322	69
17915A0323	63

17915A0324	50
17915A0325	63
17915A0327	61
17915A0328	69
17915A0329	62
17915A0330	30
17915A0331	23
17915A0333	66
17915A0334	70
17915A0335	23
17915A0336	65
17915A0337	69
17915A0338	63
17915A0339	62
17915A0340	30
17915A0341	61
17915A0343	62
17915A0344	65
17915A0345	68
17915A0346	61
17915A0347	45
17915A0348	52
17915A0349	54
17915A0350	37
17915A0351	63
17915A0352	54
17915A0353	46
No of students attempted	249
No: of students who scored more than 60%	169
% of students who scored more than 60%	68
Attainment	2

CO	Method	Value	Average	Attainment Level (Internal)	Attainment Level (External)	CO Direct Attainment (25%Int+75%Ext)
CO1	M1_D_Q1	3	2.75	2.72	2.00	**2.18**
	M1_D_Q4	2				
	M1_A_Q1	3				
	M1_A_Q2	3				
CO2	M1_D_Q2	3	2.50			
	M1_D_Q5	2				
	M1_A_Q3	3				
	M1_A_Q4	2				
CO3	M1_D_Q3	3	2.83			
	M1_D_Q6	3				
	M1_A_Q5	3				
	M2_D_Q1	3				
	M2_D_Q4	2				
	M2_A_Q1	3				
CO4	M2_D_Q2	3	2.75			
	M2_D_Q5	2				
	M2_A_Q2	3				
	M2_A_Q3	3				
CO5	M2_D_Q3	3	2.75			
	M2_D_Q6	3				
	M2_A_Q4	2				
	M2_A_Q5	3				

Direct CO Attainment	2.18
Indirect CO Attainment	2.23
Overall CO Attainment (0.8 * **Direct Attainment+ 0.2 * Indirect Attainment)**	2.19



17. COURSE END SURVEY FORM

COURSE (OUTCOME) END SURVEY FORM (THEORY/ LABORATORY)

Faculty Name:		Designation / Department	
Course Code:	A27334	Course Name:	OR
Student Name (Optional):		Roll No./Reg. No. (Optional):	
Programme:	B.Tech (Mechnaical Engineering)	Semester:	IV/I
Academic Year:	2021-22	Batch:	2018-22

[Please tick (√) appropriately]

CO's	To what extent do you have learnt and will be able to do the following (which of the CO's of the course)	Poor	Average	Good
		1	3	5
CO 1	Model the real life situations with mathematical models. Understand the concept of linear programming.			√
CO 2	Solve transportation and assignment and sequencing problems.			√
CO 3	Understand the various waiting lines and replacement concepts.		√	
CO 4	Identify and apply game theory and inventory models.			√
CO 5	Apply dynamic programming and network scheduling models.		√	

Any other feed back / suggestions:

CALCULATION OF INDIRECT ATTAINMENT

Average of indirect CO attainment from course end survey of all the students for OR =

VIDYA JYOTHI INSTITUTE OF TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

COURSE INDIRECT ATTAINMENT REPORT

Batch: 2017-21
Year-Sem: IV-I
Course: OR (C401)

Back

Course Indirect Attainment: 2.52

Students Participated: 154 **Total Students:** 242 **Survey Date:** 14-11-2020

Roll Number	CO1	CO2	CO3	CO4	CO5
Anonymous	2	3	3	2	3
Anonymous	2	3	3	2	3
Anonymous	2	3	3	2	3
Anonymous	2	3	2	2	3
Anonymous	2	3	2	2	3
Anonymous	2	3	2	2	3
Anonymous	2	3	2	2	3
Anonymous	2	3	2	2	3

COURSE (OUTCOME) END SURVEY FORM (THEORY/ LABORATORY)

Faculty Name:	K.Rajesh Kumar	Designation / Department	Mechanical Engg.
Course Code:	A17334	Course Name:	OR
Student Name (Optional):		Roll No./Reg. No. (Optional):	
Programme:	B.Tech (Mechnaical Engineering)	Semester:	IV/I
Academic Year:	2020-21	Batch:	2017-21

[Please tick (√) appropriately]

CO's	To what extent do you have learnt and will be able to do the following (which of the CO's of the course)	Poor	Average	Good
		1	3	5
CO 1	Model the real life situations with mathematical models. Understand the concept of linear programming.			√
CO 2	Solve transportation and assignment and sequencing problems.			√
CO 3	Understand the various waiting lines and replacement concepts.		√	
CO 4	Identify and apply game theory and inventory models.			√
CO 5	Apply dynamic programming and network scheduling models.		√	

Any other feed back / suggestions:

CALCULATION OF INDIRECT ATTAINMENT

Average of indirect CO attainment from course end survey of all the students for OR = **2.52**

VIDYA JYOTHI INSTITUTE OF TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

COURSE INDIRECT ATTAINMENT REPORT

Batch: 2016-20
Year-Sem: IV-I
Course: OR (C401)

Back

Course Indirect Attainment: 2.22

Students Participated: 174 **Total Students:** 249 **Survey Date:** 19-10-2019

Roll Number	CO1	CO2	CO3	CO4	CO5
Anonymous	3	2	3	3	3
Anonymous	2	2	2	2	3
Anonymous	2	2	2	2	3
Anonymous	2	2	2	2	3
Anonymous	2	2	2	2	3
Anonymous	2	2	2	2	3
Anonymous	2	2	2	2	3
Anonymous	2	2	2	2	2

COURSE (OUTCOME) END SURVEY FORM (THEORY/ LABORATORY)

Faculty Name:		Designation / Department	
Course Code:	A17334	Course Name:	OR
Student Name (Optional):		Roll No./Reg. No. (Optional):	
Programme:	B.Tech (Mechnaical Engineering)	Semester:	IV/I
Academic Year:	2019-20	Batch:	2016-20

[Please tick (√) appropriately]

CO's	To what extent do you have learnt and will be able to do the following (which of the CO's of the course)	Poor	Average	Good
		1	3	5
CO 1	Model the real life situations with mathematical models. Understand the concept of linear programming.			√
CO 2	Solve transportation and assignment and sequencing problems.			√
CO 3	Understand the various waiting lines and replacement concepts.		√	
CO 4	Identify and apply game theory and inventory models.			√
CO 5	Apply dynamic programming and network scheduling models.		√	

Any other feed back / suggestions:

CALCULATION OF INDIRECT ATTAINMENT

Average of indirect CO attainment from course end survey of all the students for OR = **2.23**

CCXXX

VIDYA JYOTHI INSTITUTE OF TECHNOLOGY

DEPARTMENT OF MECHANICAL ENGINEERING

COURSE INDIRECT ATTAINMENT REPORT

Batch: 2015-19
Year-Sem: IV-I
Course: OR (C401)

Back

Course Indirect Attainment: 2.6

Students Participated: 167 **Total Students:** 237 **Survey Date:** 03-11-2018

Roll Number	CO1	CO2	CO3	CO4	CO5
Anonymous	3	3	3	3	3
Anonymous	3	3	3	3	3
Anonymous	3	3	3	3	3
Anonymous	3	3	3	3	3
Anonymous	3	3	3	3	3
Anonymous	3	3	2	2	3
Anonymous	3	3	2	2	2
Anonymous	3	3	2	2	2

COURSE (OUTCOME) END SURVEY FORM (THEORY/ LABORATORY)

Faculty Name:		Designation / Department	
Course Code:	A17334	Course Name:	OR
Student Name (Optional):		Roll No./Reg. No. (Optional):	
Programme:	B.Tech (Mechnaical Engineering)	Semester:	IV/I
Academic Year:	2018-19	Batch:	2015-19

[Please tick (√) appropriately]

CO's	To what extent do you have learnt and will be able to do the following (which of the CO's of the course)	Poor	Average	Good
		1	3	5
CO 1	Model the real life situations with mathematical models. Understand the concept of linear programming.			√
CO 2	Solve transportation and assignment and sequencing problems.			√
CO 3	Understand the various waiting lines and replacement concepts.		√	
CO 4	Identify and apply game theory and inventory models.			√
CO 5	Apply dynamic programming and network scheduling models.		√	

Any other feed back / suggestions:

CALCULATION OF INDIRECT ATTAINMENT

Average of indirect CO attainment from course end survey of all the students for OR = **2.6**

18. TOPICS COVERED UNDER CONTENT BEYOND SYLLABUS (GAP ANALYSIS)

1. Operational Research-

Operational Research (OR)

The University of Nottingham

Synonyms:

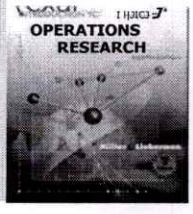
- Operations Research; Systems Analysis

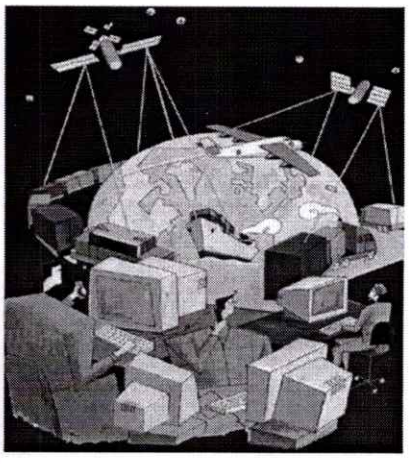
Definition:

- The discipline of applying advanced analytical methods to help make better decisions.

Analytical methods used

- Linear Programming
- Network Analysis
- Meta Heuristics
- Queuing Theory
- Game Theory
- Simulation





2. Manufacturing Systems Simulation: An Introduction

What is Simulation (1/2)?

The University of Nottingham

1. Operational Research-

Operational Research (OR)

The Univeisity of Nottingham

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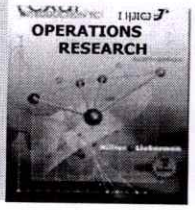
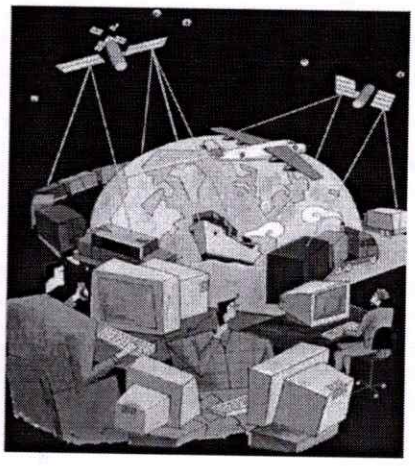
- Linear Programming
- Network Analysis
- Meta Heuristics
- Queuing Theory
- Game Theory
- Simulation

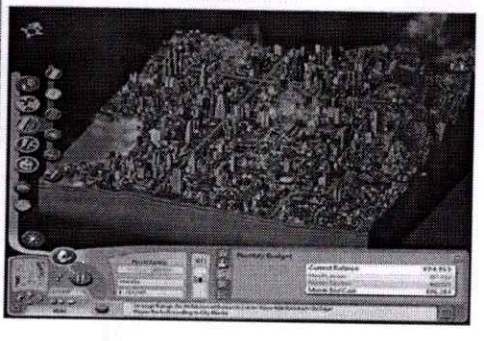




2. Manufacturing Systems Simulation: An Introduction

What is Simulation (1/2)?

The University of Nottingham



What is Simulation (2/2)?

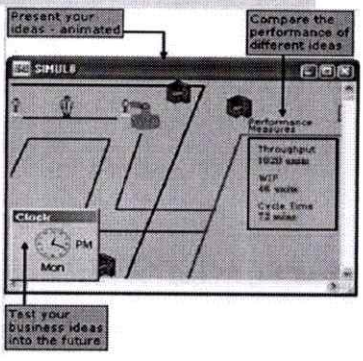
The University of Nottingham

Definition:

- Simulation is the process of designing a model of a real system and conducting experiments with this model for the purpose of understanding the behaviour of the system and/or evaluating various strategies for the operation of the system.

Purpose of simulation:

- Gaining insight into the operation of a system
- Developing operating or resource policies to improve system performance.
- Testing new concepts and/or systems before implementation.
- Gaining information without disturbing the actual system.



Simulation Modelling Classifications

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Static vs. Dynamic:

- Static: No attempts to model a time sequence of changes.
- Dynamic: Updating each entity at each occurring event.

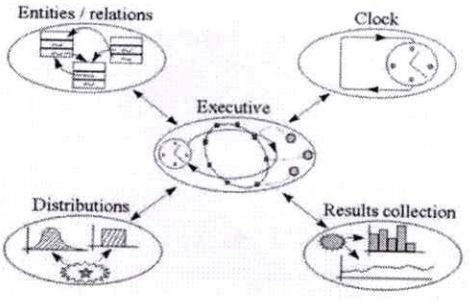
Deterministic vs. Stochastic:

- Deterministic: Rule based.
- Stochastic: Based on conditional probabilities.

Discrete vs. Continuous:

- Discrete: Changes in the state of the system occur instantaneously at random points in time as a result of the occurrence of discrete events.
- Continuous: Changes of the state of the system occur continuously over time.

Elements of a Discrete Event Simulation Model



- Entities: Tangible elements (temporary/permanent) found in the real world.
- Logical Relationships: Link the different entities together.
- Executive: Controlling the time advance (dynamic behaviour of the model).
- Random number generator: Used to provides stochastic behaviour.

Common Types of OR Simulation Applications

Application Types:

- Design and Operation of Queuing Systems
- Managing Inventory Systems
- Estimating the Probability of Completing a Project by the Deadline
- Design and Operation of Manufacturing & Distribution Systems
- Financial Risk Analysis
- Health Care Applications
- Applications to Other Service Industries
  - Government service, banking, hotels, restaurants, educational institutions, disaster planning, the military, amusement parks, ...

Simulation Packages:

- Arena, AutoMOD, Extend, ProModel, Quest, Simul8, Witness, etc.

2. Manufacturing Systems Simulation: An Introduction

The Steps in a Simulation Study

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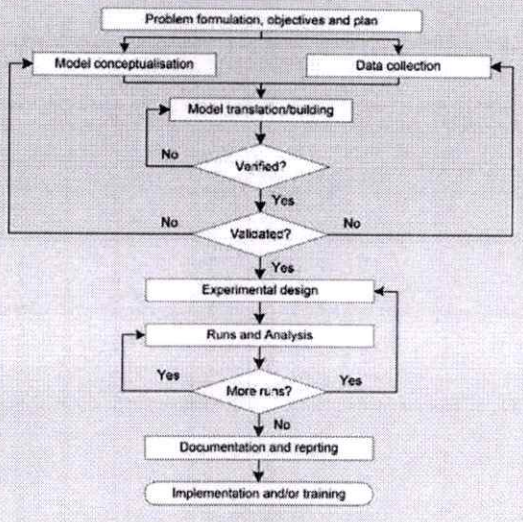

2. Manufacturing Systems Simulation: An Introduction

Advantages of Simulation (1/2)

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Advantages:

- Interaction of random events: e.g. random occurrence of machine breakdowns
- Non-standard distributions: Only simulation gives you the flexibility to describe events and timings as they occur in real life
- Communication tool (visualisation, animation). Lets you clearly describe your proposal to others
- It is able to show the behaviour of a system (how the system develops over time) rather than just the end result.
- Makes you think: Simulation provides a vehicle for a discussion about all aspects of a process
- Most simulation packages have some optimisation add-ons; once a valid simulation model exists it can also be used for optimisation

Advantages of Simulation (2/2)

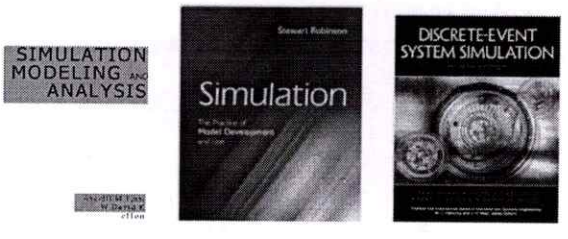
Advantages (continued):

- Basic concept of simulation is easy to comprehend and hence easier to justify to customer.
- Requires fewer simplifying assumptions and hence captures more of the true characteristic of the system under study.
- Allows us to gain insight into how a modelled system actually works and understanding of which variables are most important to performance.

Disadvantages of Simulation

Disadvantages:

- Utility of the study depends upon the quality of the model and the skills of the modeller.
- Gathering highly reliable input data can be time consuming and therefore expensive.
- Simulation models do not yield an optimal solution, rather they serve as a tool for analysis of the behaviour of a system under conditions specified by the experimenter.



PhD Research - Aim and Method

The University of Nottingham

Research Aim:

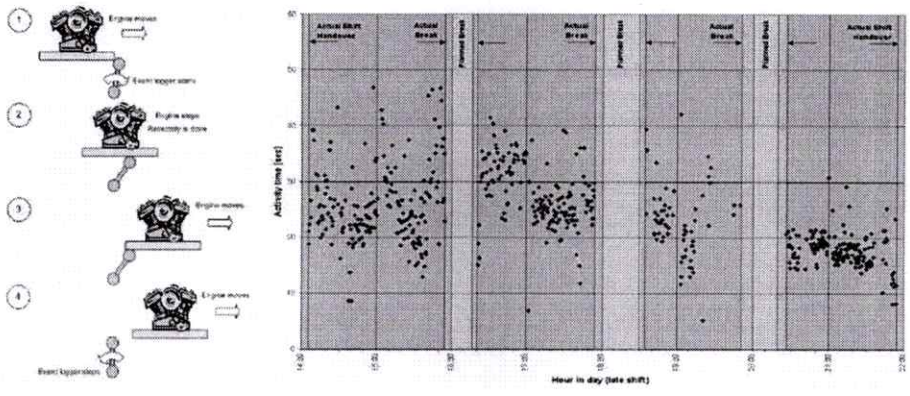
- To demonstrate the importance of incorporating Human Performance Variation (HPV) models into manufacturing system simulation models.

Research Method:

- Examination of the level of randomness inherent in HPV for different tasks.
- Design of representative HPV models.
- Sensitivity analysis to identify the impact that HPV has on the accuracy of manufacturing systems DES models.
- Literature review for more advanced methods of representing the human element within simulation models.

Step 1: Examination of Level of Randomness

The University of Nottingham



19. INNOVATIONS IN TEACHING

Introduction to Non-linear Programming

INTRODUCTION

Non-Linear Programming is a mathematical technique for determining the optimal solution to many business problems. Knowledge of differential calculus is essential to do computational work in solving the problems. In linear programming problems, we use to deal with linear objective functions and constraints to find the optimal solution. The constraints we have used in linear programming technique is of $\leq$ or $\geq$ type or a combination of these two. It is also assumed in linear programming that the cost of production, or unit profit contribution or problem constraints do not vary for the planning period and also at different levels of production. But it is only an assumption to simplify the matter. But in real world problem the profit, requirement of resources by competing candidate all will vary at different levels of production. Also due to many economic behaviors of demand, cost etc. the objective function tends to be non-linear many a time.

GENERAL NON-LINEAR PROGRAMMING PROBLEM

Let z be a real valued function of n variables defined by:

(*a*) $z = f(x1, x2, \ldots\ldots xn)$ **Objective function.**

Let $(b1, b2, \ldots\ldots bm)$ be a set of constraints, such that:

(*b*) $g1\ (x1, x2, \ldots\ldots xn)\ [\leq \text{or} \geq \text{or} =]\ b1$

$g2\ (x1, x2, \ldots\ldots xn)\ [\leq \text{or} \geq \text{or} =]\ b2$

$g3\ (x1, x2, \ldots\ldots xn)\ [\leq \text{or} \geq \text{or} =]\ b3$

$gm\ (x1, x2, \ldots\ldots xn)\ [\leq \text{or} \geq \text{or} =]\ bm$

Where g1 s are real valued functions of n variables, $x1, x2, \ldots\ldots xn$. Finally, let

(*c*) $x\,j \geq 0$ where $j = 1, 2, \ldots. n$. **Non-negativity constraint.**

If either $f(x1, x2, \ldots\ldots, xn)$ or some g1 $(x1, x2, \ldots\ldots xn)$ or both are non-linear, then the problem of determining the n-type $(x1, x2, \ldots. xn)$ which makes z a minimum or maximum and satisfies both (*b*) and (*c*), above is called a **general non-linear programming problem (GNLPP).**

General Non-Linear Programming Problem can be solved by a method very similar to Simplex algorithm. Also there are many methods have been developed to get the solution since the appearance of the fundamental theoretical paper by **Kuhn** and **Tucker** (1915). In the coming discussion some methods of solution to general non-linear programming problem are discussed. In Linear Programming, the objective function and also the constraints were linear in decision variable. Though this linearity is justified in many real life situations, there do arise such problems in business and industry that the relationship between the decision variables and the objective function itself may contain non-linear expression of the decision variables. One way seems to be to approximate the non-linear relationship is by replacing approximated linear relationships and view the given problem as a perturbed version of the ideal problem. But the conclusion in such a situation may not be valid for the given problem or present solutions which may not give the required optimality. Unfortunately, there is no known algorithm to effectively and efficiently solve a given general non-linear programming problem. A method that is found to be useful in one problem may not be useful in another. This is one of the reasons why all the non-linear programming problems cannot be grouped under the same title.

To approximate the difficulty in the approach let us distinguish between the factors that make Linear Programming Problem (LPP) more attractive and a Non-Linear Programming Problem (NLPP) as more complex.

* The algorithm for solving LPP is based on the property that optimal solutions are to be found

at the extreme points of the convex polyhedron. This implieds that we limit our search to corner points and this could be completed in a finite number of iterations. But in NLPP the optimal solution can be anywhere along the boundaries of the feasible region or anywhere within the feasible region.

* Linear relationship between the decision variables is very easily amendable to linear algebraic transformation but non-linear relationship should be dealt with extreme care resulting in complex situations.

* The non-linear nature of relationship results in distinction between local solutions and global solutions. This means that any solution that is locally optimal has to be tested for its optimality over the entire feasible region and not only at the extreme points as has been possible in an LPP. This also means that Simplex type algorithms do not suffice to solve NLPPs.

Let us take a small numerical example and try to understand the difference between LPP and NLPP.

Example

Minimize $Z = [(x1 - 8)2 + (x\,2 - 4)2]1 / 2$

Subject to $x\,1 + x\,2 \leq 8$

$-\,3x1 + 2x2 \leq 6$ and

Both $x1$ and $x2 \geq 0$

Solving graphically, we have to find a feasible point that lies at the shortest distance away from the points (8,4).

The optimal solution $x1 = 6$ and $x2 = 2$ where the indifference circle $Z = 2.828$ is tangent to the boundary of the feasible region. The optimum solution does not lie at an extreme point and thus a simplex type algorithm could not solve the problem. The feasible existence of local optima might not give an optimal solution for the same region. It may also be possible in some NLPPs that the feasible region may consist of two or more entirely disconnected sets of points.

MATHEMATICAL FORMULATION OF THE PROBLEM

Let us take a numerical example to understand the formulation of the problem.

Problem .1.

A company manufactures two products *A* and *B* on two machines. Whatever is manufactured is sold in the market, as the market for the product is good. The capacities of the machines are limited to produce daily 80 units of product *A* and 60 units of product *B*. The raw material supply required for the product is limited to produce 600 units per day. The labour required is 160 man-days and the organization has 160 men on the roll. The production of *A* requires one man day hour of labour and that of product *B* is 2 man day hour. The company's objective is to maximize the total profit if the sales–price relationships are as given below.

Product	Unit Price	Quality Demand	Cost Function
A	P_1	1500-5 P_1	$200a+0.1a^2$
B	P_2	3800-10 P_2	$300b+0.1b^2$

In the above table *a* and *b* are the number of units of *A* and *B* produced, respectively. This can also be written as:

$$a = 1500 - 5\,P_1 \text{ and } b = 3800 - 10\,P_2$$

Solution

Let *R* be the revenue on sales and *C* the cost of production, so that Profit = Revenue – Cost.

$R = P_1\,a + P_2\,b = (300 - 0.2\,a)\,a + (380 - 0.1b)\,b = 300a - 0.2a^2 + 380b - 0.1b^2$ and

$C = (200a + 0.1a^2) + (300b + 0.1b^2)$

Therefore, Maximize $Z = R - C = 100a + 0.3a^2 + 80b - 0.2b^2$
To check P_1 and P_2, computed in the problem let us construct
$A \leq 80$, $b < 60$, $5a + 6b \leq 600$, $a + 2b \leq 160$ and both a and b are ≥ 0.

GLOBAL MINIMA AND LOCAL MINIMA OF A FUNCTION

One of the major difficulties one has to face in solving an NLPP is the determination of the solution point, which gives not only optimal solution for the objective function at the point but also optimizes the function over the complete solution space.

Definition of Global Minimum: A function $f(x)$ has a **global minimum** at a point x° of a set of points K if an only if $f(x^\circ) \leq f(x)$ for all x in K.

Definition of Local Minimum: A function $f(x)$ has the **local minimum** point x° of a set of points K if and only if there exists a positive number such that $f(x^\circ) \leq f(x)$ for all x in K at which $\| x_0 - x \| <$C -

Remarks: In case of functions of a single variable, a necessary condition for a particular solution $x = x^*$ to be either a minimum or maximum is that $d/dx\ f(x) = 0$ at $x = x^*$. That is x^* must be local minimum (local maximum) if $f(x)$ is strictly convex (strictly concave) within a neighbourhood of x^*. That is, second derivative of x^* is positive (negative). If second derivatives are zero then we move to higher derivatives, to find the global minimum (global maximum) and identify that one of them yields the smallest (largest) value of $f(x)$.

For functions involving several variables we carry out the analysis using partial derivatives. Though non-linear optimization problems require determination of a global minimum, the computational procedures will, in general, lead to a solution which is only a local minimum. There is no general procedure to determine whether the local minimum is really a global minimum. In contrast the simplex procedure of an LPP gives a local minimum, which is also a global minimum. This is the reason why we have to develop some new mathematical concepts to deal with NLPP.

LAGRANGE MULTIPLIERS

Here the optimization problem of continuous functions is discussed. As the non-linear programming problem is composed of some differentiable objective function and equality side constraints, the optimization may be achieved by the use of **Lagrange multipliers** (a way of generating the necessary condition for a stationary point).

A Lagrange multiplier measures the sensitivity of the optimal value of the objective function to change in the given constraints bi in the problem. Consider the problem of determining the global optimum of
$Z = f(x1, x2, \ldots. xn)$ subject to the 'm' constraints $gi\ (x1, x2, \ldots xn) = bi$, $i = 1, 2, \ldots m$.

Let us first formulate the Lagrange function L defined by:
$L\ (x1, x2, \ldots\ldots xn, \lambda1, \lambda2\ , \ldots.\ \lambda n\ ) - \Sigma\ \lambda i\ [gi\ (x1, x2, \ldots xn) = bi$ where $i = 1, 2, \ldots m$ and $\lambda1, \lambda2\ , \ldots \lambda n$ are called as **Lagrange Multipliers**. The optimal solution to the Lagrange function is determined by taking partial derivatives of the function L with respect to each variable (including Lagrange multipliers and setting each partial derivative to zero and finding the values that make the partial derivatives zero. Then the solution will turn out to be the solution to the original problem.

KUHN – TUCKER CONDITIONS

If the constraints of a Non-linear Programming Problem are of inequality form, we can solve them by

using Lagrange multipliers, which are slightly modified. Let us consider a problem.

Maximize $Z = f(x1, x2, x3, \ldots.. xn)$, subject to the constraints

$G(x1, x2, x3, \ldots..xn) \leq c$ and $x1, x2, \ldots..xn \geq 0$ and c is a constant.

The constraints can be modified to the form $h(x1, x2, \ldots..xn) \leq 0$ by introducing a function $h(x1, x2, \ldots..xn = g(x1, x2, \ldots..xn) - c$

Maximize $Z = f(x)$

Subject to $h(x) \leq 0$ and $x \geq 0$ where, $x\ Rn$.

This problem can be slightly modified by introducing a new variable S. Define $Sr = -h(x)$ or $h(x) + S2 = 0$, S can be interpreted as slack variable.

It appears as its square in the constraint equation so as to ensure its being non-negative.

The problem can be restated as Optimize $Z = f(x).\ x\ Rn$

Subject to constraints $h(x) + S2 = 0$ and $x \geq 0$

which is the problem of constrained optimization in $(n + 1)$ variables with a single equation constraint and can be solved by Lagrange multiplier method.

To determine the stationary points, consider the Lagrange function as $L(x, S, \lambda) = f(x) - \lambda [h(x) + S2]$, where λ is Lagrange multiplier. Necessary conditions for stationary points are:

$x\,j$

L

∂

∂

$= = 0$

∂

$-\lambda\,\partial$

∂

∂

$j\,x\,j$

h

x

f for $j = 1$ to $n \ldots 1$

$\partial\lambda$

∂L

$= -[h(x) + S\,2\,] = 0 \ldots 2$

S

L

∂

∂

$= -2S\,\lambda = 0 \ldots 3$

Equation 3 gives = 0

∂

∂

S

L

which receives either $\lambda = 0$ or $S = 0$. If $S = 0$ equation 2 implies $h(x) = 0$, thus 2 and 3 together imply

$\lambda\, h(x) = 0$ of $S = 0 \ldots 4$

The slack variable was introduced to convert the unequal constraints to an equal one, so it may be
discarded and as $S2 \geq 0$, equation 2 gives:
$h(x) \leq 0 \ldots 5$
whenever $h(x)$, 0 from equation 4, we get $\lambda = 0$, whenever $\lambda > 0$ $h(x) = 0$. λ is unrestricted in sign
whenever $h(x) \leq 0$ and the problem reduces to the problem of equation constraint.
The necessary conditions for the point x to be a point of maximum are stated as:
$fj - \lambda hj = 0$ ($j = 1, 2, 3, \ldots n$)
$\lambda h = 0$ maximum f
$h \leq 0$ subject to the constraint $\lambda \geq 0$ and $h \leq 0$.
(a) General case of the constrained optimization of nonlinear function in n variables under m ($< n$) inequality constraint:
Consider NLPP Maximize $Z = f(x)$ x $\square Rn$
Subject to constraint $gi(x) \leq ci$ $i = 1, 2, \ldots m$ and $x \geq 0$
Introducing the function $hi(x) = gi(x) - ci$ for all $i = 1, 2, \ldots m$ the inequality constraint can be written as
Introduction to Non-linear Programming 633
$hi(x) \leq 0$ for $i = 1, 2, \ldots m$.
By introducing the slack variables $Stt = 1, 2, \ldots m$ defined by $hi(x) + 2$
$Si = 0$, $i = 1, 2, \ldots m$.
The inequality constraints are converted to equality ones. The stationary value of x can thus be obtained by Lagrangian multiplier method. The Lagrangian function is
$L(x, S, \lambda) = f(x) - \Sigma \lambda i [hi(x) + c$
$Si]$ where $\lambda = (\lambda 1, \lambda 2 \ldots \lambda m)$ Lagrangian multipliers.
Necessary conditions for $f(x)$ to be the maximum are:
1. $\Sigma =$
$=$
∂
$- \lambda \partial$
∂
$= \partial$
∂
∂m
jj
i
j
jj
jn
x
h
x
f
x
L
1
for 1, 2, ...

2. *h S i m L*
i
i
i
2 for all 1, 2,...
= + 0 =
∂λ
∂
=
3. *S i m*
s
L
i i
i
= –2 λ = 0 for =1, 2,...
∂
∂
L = *L* (*x*, *S*, λ) *f* = *f* (*x*) *hi* = *hi* (*x*) from equation 3 either λ *i* = 0 or *Si* = 0.
Using the same argument as in the single in equality case, conditions (3) and (2) together are replaced by the conditions (5), (6) and (7) below:
(5) λ *i hi* = 0 for *i* = 1, 2, …*m*
(6) *h i* ≤ 0 for *i* = 1, 2, …*m*
(7) λ *i* ≥ 0 for *i* = 1, 2, …..*m*
Kuhn – Tucker conditions for maximum are restated as:
fi =Σ=
λ =
m
i
i
jhj j m
1
(1, 2,....)
λ *i* ≤ 0
ih (*i* = 1, 2, ... *m*)
λ*i* ≥ 0 (*i* = 1, 2, ...*m*)
where
j
i
j
i
x
h h
∂
= ∂
Maximize *f* subject to *hi* ≤ 0 , *i* = 1, 2, …., *m*

SUFFICIENCY OF KUHN – TUCKER CONDITION

20. COURSE CLOSURE REPORT

Regulation: R18

Academic Year: 2021 - 2022

Program: B.Tech (Mechanical Engineering)

Year/Sem: IV/I

Course Name: OPERATION RESEARCH

Course Code: A27334

Contact Hours: 4 Lectures/1Tutorial/4Credits

No. of Students: 222

No. of lecture classes taken	**64**
No. of tutorial classes taken	**10**
Course delivery modes	Lectures, Demonstration
Technology utilization	Power Point / OHP Slides
Assessment Tools	Internal Mid Examinations, Assignments, Autonomous End Exam

OVERALL ATTAINMENT (80% DIRECT + 20% INDIRECT)	
DIRECT	
INDIRECT	
OVERALL ATTAINMENT	

Regulation: R15

Academic Year: 2020 - 2021

Program: B.Tech (Mechanical Engineering)

Year/Sem: IV/I

Course Name: OPERATION RESEARCH

Course Code: A17334

Contact Hours: 4 Lectures/1Tutorial/4Credits

No. of Students: 242

No. of lecture classes taken	**64**
No. of tutorial classes taken	**10**
Course delivery modes	Lectures, Demonstration
Technology utilization	Power Point / OHP Slides
Assessment Tools	Internal Mid Examinations, Assignments, Autonomous End Exam

OVERALL ATTAINMENT (80% DIRECT + 20% INDIRECT)	
DIRECT	2.22
INDIRECT	2.52
OVERALL ATTAINMENT	2.28

Regulation: R15

Academic Year: 2019 - 2020

Program: B.Tech (Mechanical Engineering)

Year/Sem: IV/I

Course Name: OPERATION RESEARCH

Course Code: A17334

Contact Hours: 4 Lectures/1Tutorial/4Credits

No. of Students: 223

No. of lecture classes taken	**64**
No. of tutorial classes taken	**10**
Course delivery modes	Lectures, Demonstration
Technology utilization	Power Point / OHP Slides
Assessment Tools	Internal Mid Examinations, Assignments, Autonomous End Exam

OVERALL ATTAINMENT (80% DIRECT + 20% INDIRECT)	
DIRECT	2.18
INDIRECT	2.23
OVERALL ATTAINMENT	2.19

Regulation: R15

Academic Year: 2018 - 2019

Program: B.Tech (Mechanical Engineering)

Year/Sem: IV/I

Course Name: OPERATION RESEARCH

Course Code: A17334

Contact Hours: 4 Lectures/1Tutorial/4Credits

No. of Students: 233

No. of lecture classes taken	**64**
No. of tutorial classes taken	**10**
Course delivery modes	Lectures, Demonstration
Technology utilization	Power Point / OHP Slides
Assessment Tools	Internal Mid Examinations, Assignments, Autonomous End Exam

OVERALL ATTAINMENT (80% DIRECT + 20% INDIRECT)	
DIRECT	2.11
INDIRECT	2.51
OVERALL ATTAINMENT	2.19