ವಿಶ್ವೇಶ್ವರಯ್ಯತಾಂತ್ರಿಕವಿಶ್ವವಿದ್ಯಾಲಯ
ವಿಟಿಯುಅಧಿನಿಯಮ೧೯೯೪ರಅಡಿಯಲ್ಲಿಕರ್ನಾಟಕಸರ್ಕಾರದಿಂದಸ್ಥಾಪಿತವಾದರಾಜ್ಯವಿಶ್ವವಿದ್ಯಾಲಯ
VISVESVARAYA TECHNOLOGICAL UNIVERSITY
State University of Government of Karnataka Established as per the VTU Act, 1994 "JnanaSangama" Belagavi-590018, Karnataka, India

Prof. B. E. Rangaswamy, Ph.D
REGISTRAR

Phone: (0831) 2498100
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REF: VTU/BGM/BoS/602/2024-25/ 1911 DATE: 27 JUL 2024

CIRCULAR

Dear Sir/ Madam

Subject: Regarding 7th semester's missing syllabus of Mechatronics program

Reference: Chairperson's email dated 19.06.2024

The syllabi for the 21MT735 - Additive Manufacturing and 21MT745 - Operations Research courses/subjects under the professional elective subject group were missing in the uploaded syllabus of the Mechatronics program. The syllabi for these two courses are attached to this circular for reference.

All principals and affiliated engineering colleges under the university's jurisdiction are informed to update this information for all concerned students and faculty.

Enclosure: 21MT735 and 21MT744 syllabi.

Sd/-

Registrar

To,

1. Principals of all Engineering Colleges under the ambit of the University
2. The Chairpersons/Program Coordinators of University departments @ Kalaburgi, Belagavi, Bengaluru, Mysuru and Muddenhalli

Copy to

- The Hon'ble Vice-Chancellor through the secretary to VC for information
- The Registrar (Evaluation) for information and needful
- The Director, ITI SMU VTU Belagavi for information and make arrangements to upload the circular on the VTU web portal
- The Special Officer QPDS section, VTU Examination Section VTU Belagavi for information
- Office Copy

27/07/24

REGISTRAR

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

B.E. in Mechatronics Engineering

Scheme of Teaching and Examinations 2021

Outcome Based Education(OBE) and Choice Based Credit System (CBCS)

(Effective from the academic year 2021 - 22)

Swappable VII and VIII SEMESTER

VII SEMESTER

Sl. No	Course and Course Code	Course Title	Teaching Department (TD) and Question Paper Setting Board (PSB)	Teaching Hours /Week				Examination				Credits
				Theory Lecture	Tutorial	Practical/ Drawing	Self -Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
				L	T	P	S					
1	PCC 21MT71	Thermal Engineering	TD: MT PSB: MT	3	0	0		3	50	50	100	3
2	PCC 21MT72	Communication systems	TD: MT PSB: MT	2	0	0		3	50	50	100	2
3	PEC 21MT73X	Professional elective Course-II	TD: MT PSB: MT	3	0	0		3	50	50	100	3
4	PEC 21MT74X	Professional elective Course-III	TD: MT PSB: MT	3	0	0		3	50	50	100	3
5	OEC 21MT75X	Open elective Course-II	Concerned Department	3	0	0		3	50	50	100	3
6	Project **21MTP76**	Project work		Two contact hours /week for interaction between the faculty and students.				3	100	100	200	10
								Total	**350**	**350**	**700**	**24**

VIII SEMESTER

Sl. No	Course and Course Code		Course Title	Teaching Department	Teaching Hours /Week				Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Self -Study	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P	S					
1	Seminar 21MT81		Technical Seminar		One contact hour /week for interaction between the faculty and students.				--	100	--	100	01
2	INT 21INT82		Research Internship/ Industry Internship		Two contact hours /week for interaction between the faculty and students.				03 (Batch wise)	100	100	200	15
3	NCMC	21NS83	National Service Scheme (NSS)	NSS	Completed during the intervening period of III semester toVIII semester.				--	50	50	100	0
		21PE83	Physical Education (PE) (Sports and Athletics)	PE									
		21YO83	Yoga	Yoga									
									Total	**250**	**150**	**400**	**16**

Professional Elective - II

21MT731	Digital Image Processing and Robot Vision	21MT734	Control Systems and Engineering
21MT732	Digital Controllers	21MT735	Additive Manufacturing
21MT733	Artificial Intelligence for Mechatronics		

Professional Elective – III

21MT741	VLSI (202)	21MT744	Computer Integrated Manufacturing
21MT742	Product Life Cycle Management and Concurrent Engineering	21MT745	Operations Research
21MT743	Mechatronics System Design		

ADDITIVE MANUFACTURING			
Course Code	**21MT735**	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning objectives:

CLO 1. To know the principle methods, areas of usage, possibilities and limitations of the Additive Manufacturing technologies.

CLO 2. To be familiar with the characteristics of the different materials those are used in Additive Manufacturing.

CLO 3. To know the principles of polymerization and powder metallurgy process, extrusion-based system printing processes, sheet lamination processes, beam deposition processes, direct write technologies Direct Digital Manufacturing.

CLO 4. To get exposed to process selection, software issues and post processing.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Adopt flipped classroom teaching method.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1

Introduction and basic principles: Need for Additive Manufacturing, Generic AM process, stereo lithography or 3dprinting, rapid proto typing, the benefits of AM, distinction between AM and CNC machining, other related technologies- reverse engineering technology.

Development of Additive Manufacturing Technology: Introduction, computers, computer-aided design technology ,other associated technologies, the use of layers, classification of AM processes, metals systems, hybrid systems, milestones in AM development.

Additive Manufacturing Process chain: Introduction, the eight steps in additive manufacture, variations from one AM machine to another

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving/White board

Module-2

Photo polymerization processes: Stereo lithography (SL), Materials, SL resin curing process, Micro- Stereo lithography, Process Benefits and Drawbacks, Applications of Photo polymerization Processes.

Powder bed fusion processes: Introduction, Selective laser Sintering (SLS), Materials, Powder fusion mechanism, SLS Metal and ceramic part creation, Electron Beam melting (EBM), Process Benefits and Drawbacks, Applications of Powder Bed Fusion Processes.

Extrusion-based systems: Fused Deposition Modelling (FDM), Principles, Materials, Plotting and path control, Bio-Extrusion, Process Benefits and Drawbacks, Applications of Extrusion-Based Processes.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving/White board

Module-3

Printing Processes: evolution of printing as an additive manufacturing process, research achievements in printing deposition, technical challenges of printing, printing process modeling, material modification methods, three-dimensional printing, advantages of binder printing Sheet Lamination Processes: Materials, Laminated Object Manufacturing (LOM), Ultrasonic Consolidation (UC), Gluing, Thermal bonding, LOM and UC applications. Beam Deposition Processes: introduction, general beam deposition process, description material delivery, BD systems, process parameters, typical materials and microstructure, processing–structure–properties relationships, BD benefits and drawbacks. Direct Write Technologies: Background, ink –based DW, laser transfer, DW thermals pray, DW beam deposition, DW liquid-phase direct deposition.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving/White board
Module-4	
Guidelines for Process Selection: Introduction, selection methods for apart, challenges of selection, example system for preliminary selection, production planning and control. Software issues for Additive Manufacturing: Introduction, preparation of cad models – the STL file, problems with STL files, STL file manipulation. Post- Processing: Support material removal, surface texture improvements, preparation for use as a pattern, property enhancements using non-thermal techniques and thermal techniques.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving/White board
Module-5	
The use of multiple materials in additive manufacturing: Introduction, multiple material approaches, discrete multiple material processes, porous multiple material processes, blended multiple material processes, commercial applications using multiple materials, future directions. AM Applications: Functional models, Pattern for investment and vacuum casting, Medical models, art models, Engineering analysis models, Rapid tooling, new materials development, Bi-metallic parts, Remanufacturing. Application: Examples for Aerospace, defense, automobile, Bio-medical and general engineering industries. Direct digital manufacturing: Align Technology, Siemens and phonak, DDM drivers, manufacturing vs. prototyping, life- cycle costing, future of direct digital manufacturing.	
Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving/White board

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

- **CO1.** Demonstrate the knowledge of the broad range of AM processes, devices, capabilities and materials that are available.
- **CO2.** Demonstrate the knowledge of the broad range of AM processes, devices, capabilities and materials that are available.
- **CO3.** Understand the various software tools, processes and techniques that enable advanced/additive manufacturing.
- **CO4.** Apply the concepts of additive manufacturing to design and create components that satisfy product development/prototyping requirements, using advanced/additive manufacturing devices and processes.
- **CO5.** Understand characterization techniques in additive manufacturing.
- **CO6.** Understand the latest trends and business opportunities in additive manufacturing.

Assessment Details (both CIE and SEE)

The weightage of Continuous Internal Evaluation (CIE) is 50% and for Semester End Exam (SEE) is 50%. The minimum passing mark for the CIE is 40% of the maximum marks (20 marks out of 50). A student shall be deemed to have satisfied the academic requirements and earned the credits allotted to each subject/ course if the student secures not less than 35% (18 Marks out of 50)in the semester-end examination(SEE), and a minimum of 40% (40 marks out of 100) in the sum total of the CIE (Continuous Internal Evaluation) and SEE (Semester End Examination) taken together

Continuous Internal Evaluation:

Three Unit Tests each of **20 Marks (duration 01 hour)**

- First test at the end of 5th week of the semester
- Second test at the end of the 10th week of the semester
- Third test at the end of the 15th week of the semester

Two assignments each of **10 Marks**

- First assignment at the end of 4th week of the semester
- Second assignment at the end of 9th week of the semester

Group discussion/Seminar/quiz any one of three suitably planned to attain the COs and POs for **20 Marks (duration 01 hours)**

- At the end of the 13th week of the semester

The sum of three tests, two assignments, and quiz/seminar/group discussion will be out of 100 marks and will be **scaled down to 50 marks**

(to have less stressed CIE, the portion of the syllabus should not be common /repeated for any of the methods of the CIE. Each method of CIE should have a different syllabus portion of the course).

CIE methods /question paper is designed to attain the different levels of Bloom's taxonomy as per the outcome defined for the course.

Semester End Examination:

Theory SEE will be conducted by University as per the scheduled timetable, with common question papers for the subject (**duration 03 hours)**

- The question paper will have ten questions. Each question is set for 20 marks.
- There will be 2 questions from each module. Each of the two questions under a module (with a maximum of 3 sub-questions), **should have a mix of topics** under that module.

The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Additive Manufacturing Technologies Rapid Prototyping to Direct Digital Manufacturing I. Gibson l D. W. Rosen l B. Stucker Springer New York Heidelberg Dordrecht, London ISBN: 978-1- 4419-1119-3 e-ISBN: 978- 1-4419- 1120-9 DOI 10.1007/978 -1-4419- 1120-9
2. "Rapid Prototyping: Principles & Applications Chua Chee Kai, Leong Kah Fai World Scientific 2003
3. Rapid Prototyping: Theory & Practice Ali K. Kamrani, Springer 2006 Emand Abouel Nasr,
4. Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling" D.T. Pham, S.S. Dimov Springer 2001
5. Rapid Prototyping: Principles and Applications in Manufacturing Rafiq Nooran John Wiley & Sons 2006
6. Additive Manufacturing Technology Hari Prasad, A.V. Suresh Cengage 2019
7. Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing Andreas Gebhardt Hanser Publishers 2011

Activity Based Learning (Suggested Activities in Class)/ Practical Based learning

- Case studies
- Quiz
- Topic Seminar presentation
- Assignments

OPERATIONS RESEARCH			
Course Code	21MT 745	CIE Marks	50
Teaching Hours/Week (L:T:P: S)	3:0:0:0	SEE Marks	50
Total Hours of Pedagogy	40	Total Marks	100
Credits	03	Exam Hours	03

Course Learning Objectives:

CLO 1. To enable the students to understand the scientific methods of providing various departments of an organization with a quantitative basis of decision making.

CLO 2. To enable the students to understand the importance of various tools and techniques in finding optimal solutions to problems involving limited resources in the form of Men, Materials and machinery.

Teaching-Learning Process (General Instructions)

These are sample Strategies, which teacher can use to accelerate the attainment of the various course outcomes.

1. Adopt different types of teaching methods to develop the outcomes through PowerPoint presentations and Video demonstrations or Simulations.
2. Chalk and Talk method for Problem Solving.
3. Adopt flipped classroom teaching method.
4. Adopt collaborative (Group Learning) learning in the class.
5. Adopt Problem Based Learning (PBL), which fosters students' analytical skills and develops thinking skills such as evaluating, generalizing, and analysing information.

Module-1

Introduction: Evolution of OR, Definitions of OR, Scope of OR, Applications of OR, Phases in OR study. Characteristics and limitations of OR, models used in OR, Linear Programming Problem (LPP), Generalized LPP- Formulation of problems as L.P.P. Solutions to LPP by graphical method (Two Variables).

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving/White board

Module-2

LPP: Simplex method, Canonical and Standard form of LP problem, slack, surplus and artificial variables, Solutions to LPP by Simplex method, Big-M Method and two-phase Simplex Method, Degeneracy in LPP. Concept of Duality, writing Dual of given LPP. Solutions to L.P.P by Dual Simplex Method.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving/White board

Module-3

Transportation Problem: Formulation of transportation problem, types, initial basic feasible solution using North-West Corner rule, Vogel's Approximation method. Optimality in Transportation problem by Modified Distribution (MODI) method. Unbalanced T.P. Maximization T.P. Degeneracy in transportation problems, application of transportation problem. Assignment Problem-Formulation, Solutions to assignment problems by Hungarian method, Special cases in assignment problems, unbalanced, Maximization assignment problems. Travelling Salesman Problem (TSP). Difference between assignment and T.S.P, Finding best route by Little's method. Numerical Problems.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving/White board

Module-4

Network analysis: Introduction, Construction of networks, Fulkerson's rule for numbering the nodes, AON and AOA diagrams; Critical path method to find the expected completion time of a project, determination of floats in networks,

PERT networks, determining the probability of completing a project, predicting the completion time of project; Cost analysis in networks. Crashing of networks- Problems.
Queuing Theory: Queuing systems and their characteristics, Pure-birth and Pure-death models (only equations), Kendall & Lee's notation of Queuing, empirical queuing models – Numerical on M/M/1 and M/M/C Queuing models.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving/White board

Module-5

Game Theory: Definition, Pure Strategy problems, Saddle point, Max-Min and Min-Max criteria, Principle of Dominance, Solution of games with Saddle point. Mixed Strategy problems. Solution of 2X2 games by Arithmetic method, Solution of 2Xn m and mX2 games by graphical method. Formulation of games.
Sequencing: Basic assumptions, Johnson's algorithm, sequencing 'n' jobs on single machine using priority rules, sequencing using Johnson's rule-'n' jobs on 2 machines, 'n' jobs on 3 machines, 'n' jobs on 'm' machines. Sequencing of 2 jobs on 'm' machines using graphical method.

Teaching-Learning Process	1. Power-point Presentation, 2. Video demonstration or Simulations, 3. Chalk and Talk are used for Problem Solving/White board

Course outcome (Course Skill Set)

At the end of the course the student will be able to:

- **CO 1.** Understand the meaning, definitions, scope, need, phases and techniques of operations research.
- **CO 2.** Formulate as L.P.P and derive optimal solutions to linear programming problems by graphical method, Simplex method, Big-M method and Dual Simplex method.
- **CO 3.** Formulate as Transportation and Assignment problems and derive optimum solutions for transportation, Assignment and travelling salesman problems.
- **CO 4.** Solve problems on game theory for pure and mixed strategy under competitive environment.
- **CO 5.** Solve waiting line problems for M/M/1 and M/M/K queuing models.
- **CO 6.** Construct network diagrams and determine critical path, floats for deterministic and PERT networks including crashing of Networks

Determine minimum processing times for sequencing of n jobs-2 machines, n jobs-3 machines, n jobs-m machines and 2 jobs-n machines using Johnson's algorithm.

Assessment Details (both CIE and SEE)

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The students have to answer 5 full questions, selecting one full question from each module

Suggested Learning Resources:

Books

1. Operations Research P K Gupta and D S Hira S. Chand and Company LTD. Publications, New Delhi 2007
2. Operations Research, An Introduction Hamdy A. Taha PHI Private Limited Seventh Edition, 2006

Reference Books

1. Operations Research, Theory and Applications J K Sharma Trinity Press, Laxmi Publications Pvt.Ltd. Sixth Edition, 2016
2. Operations Research Paneerselvan PHI
3. Operations Research A M Natarajan, P Balasubramani Pearson Education, 2005
4. Introduction to Operations Research Hillier and Lieberman McGraw Hill 8thEd

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- Quiz
- Topic Seminar presentation
- Assignments