ವಿಶ್ವೇಶ್ವರಯ್ಯ ತಾಂತ್ರಿಕ ವಿಶ್ವವಿದ್ಯಾಲಯ
("ವಿ ಟ ಯು ಅಧಿನಿಯಮ ೧೯೯೪"ರ ಅಡಿಯಲ್ಲಿ ಕರ್ನಾಟಕ ಸರ್ಕಾರದಿಂದ ಸ್ಥಾಪಿತವಾದ ರಾಜ್ಯ ವಿಶ್ವವಿದ್ಯಾಲಯ)
VISVESVARAYA TECHNOLOGICAL UNIVERSITY
(State University of Government of Karnataka Established as per the VTU Act, 1994)

Phone :0831-2498100 / 2405468
Fax : 0831-2405467
Email : registrar@vtu.ac.in
Web : https://vtu.ac.in

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

Phone: (0831) 2498100
Fax: (0831) 2405467

REF: VTU/BGM/BOS/PG Scheme 2022/2024-25/ 314 DATE: 17 APR 2024

CIRCULAR

Subject: Typo error in the scheme of B.Tech., in Robotics and Automation corrected regarding.

Reference: Chairperson Department of Mechanical Engineering, VTU Belagavi recommendation dated 15.04.2024

The typo error in the 2018 scheme of program B.Tech. in robotics and automation compared with the syllabus is corrected and is mentioned below:

Code	Title of the Course /Subject in the syllabus	Title of the course /subject in the scheme	To be read as
18RA823	Big Data and Analytics	Data Analytics	Big Data and Analytics
18RA824	Communication Systems	Mechatronics System Design	Communication Systems
18RA825	(18RA824) Additive Manufacturing	(18RA825) Additive Manufacturing	18RA825 (Additive Manufacturing)

The error-fixed scheme and syllabus are uploaded on the VTU web portal for stakeholder reference @ **https://vtu.ac.in/wp-content/uploads/2024/04/robo2018-1-1.pdf.**

17/04/24
REGISTRAR

To,

The Chairperson, Mechanical Engineering Department VTU Belagavi

Copy to

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

QPDS

P Manjunath.

18RA823, 824 Title corrected in comparison with Syllabus copy

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI

Scheme of Teaching and Examination (2018)

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

(Effective from the academic year 2020-21)

Programme: B.Tech. in ROBOTICS AND AUTOMATION

VIII SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	PCC	18RA81	Automotive Electronics & Hybrid Vehicles	E & E/ Mechanical	3	–	–	03	40	60	100	3
2	PEC	18RA82X	Professional Elective - 4		3	–	–	03	40	60	100	3
3	Project	18RAP83	Project Work Phase - 2		–	–	2	03	40	60	100	8
4	Seminar	18RAS84	Technical Seminar		–	–	2	03	100	–	100	1
5	Internship	18RAI85	Internship	Completed during the vacation/s of VI and VII semesters and /or VII and VIII semesters.)				03	40	60	100	3
				TOTAL	06	–	4	15	260	240	500	18

Note: PCC: Professional Core, PEC: Professional Elective.

Professional Electives - 4

Course code under 18XX82X	Course Title
18RA821	Management Information Systems (CS)
18RA822	Biomedical Signal Processing (E&C)
18RA823	Big Data and Analytics (CS)
18RA824	Communication Systems (ECE)
18RA825	Additive Manufacturing (Mechanical)

15/4/2024

15/4/24

Recieved

15/4/24

15/4/24

B.TECH. ROBOTICS AND AUTOMATION
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER -VIII

Professional Electives-4

BIG DATA & ANALYTICS

Course Code	18RA823	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course objectives:

- Understand fundamentals of Big Data analytics.
- Explore the Hadoop framework and Hadoop Distributed File system.
- Illustrate the concepts of NoSQL using MongoDB and Cassandra for Big Data.
- Employ MapReduce programming model to process the big data.
- Understand various machine learning algorithms for Big Data Analytics, Web Mining and Social Network Analysis.

Module-1

Introduction to Big Data Analytics: Big Data, Scalability and Parallel Processing, Designing Data Architecture, Data Sources, Quality, Pre-Processing and Storing, Data Storage and Analysis, Big Data Analytics Applications and Case Studies. Text book 1: Chapter 1: 1.2 -1.7

Module-2

Introduction to Hadoop (T1): Introduction, Hadoop and its Ecosystem, Hadoop Distributed File System, MapReduce Framework and Programming Model, Hadoop Yarn, Hadoop Ecosystem Tools.
Hadoop Distributed File System Basics (T2): HDFS Design Features, Components, HDFS User Commands.
Essential Hadoop Tools (T2): Using Apache Pig, Hive, Sqoop, Flume, Oozie, HBase.
Text book 1: Chapter 2 :2.1-2.6
Text Book 2: Chapter 3
Text Book 2: Chapter 7 (except walk throughs)

Module-3

NoSQL Big Data Management, MongoDB and Cassandra: Introduction, NoSQL Data Store, NoSQL Data Architecture Patterns, NoSQL to Manage Big Data, Shared-Nothing Architecture for Big Data Tasks, MongoDB, Databases, Cassandra Databases. **Text book 1: Chapter 3: 3.1-3.7**

Module-4

MapReduce, Hive and Pig: Introduction, MapReduce Map Tasks, Reduce Tasks and MapReduce Execution, Composing MapReduce for Calculations and Algorithms, Hive, HiveQL, Pig.
Text book 1: Chapter 4: 4.1-4.6

Module-5

Machine Learning Algorithms for Big Data Analytics: Introduction, Estimating the relationships, Outliers, Variances, Probability Distributions, and Correlations, Regression analysis, Finding Similar Items, Similarity of Sets and Collaborative Filtering, Frequent Itemsets and Association Rule Mining. Text, Web Content, Link, and Social Network Analytics: Introduction, Text mining, Web Mining, Web Content and Web Usage Analytics, Page Rank, Structure of Web and analyzing a Web Graph, Social Network as Graphs and Social Network Analytics:
Text book 1: Chapter 6: 6.1 to 6.5
Text book 1: Chapter 9: 9.1 to 9.5

Course outcomes:

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

- Understand fundamentals of Big Data analytics.
- Investigate Hadoop framework and Hadoop Distributed File system.
- Illustrate the concepts of NoSQL using MongoDB and Cassandra for Big Data.
- Demonstrate the MapReduce programming model to process the big data along with Hadoop tools. Use Machine Learning algorithms for real world big data.
- Analyze web contents and Social Networks to provide analytics with relevant visualization tools.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	"Big Data Analytics Introduction to Hadoop, Spark, and Machine-Learning"	Raj Kamal and Preeti Saxena	McGraw Hill Education	2018 ISBN: 9789353164966, 9353164966
2	"Hadoop 2 Quick-Start Guide: Learn the Essentials of Big Data Computing in the Apache Hadoop	Douglas Eadline	Pearson Education	1st Edition, 2016
Reference Books				
1	"Hadoop: The Definitive Guide"	Tom White	O'Reilly Media	2015
2	"Professional Hadoop Solutions"	Boris Lublinsky, Kevin T Smith,	Wrox Press	1st Edition, 2014
3	Hadoop Operations: A Guide for Developers and Administrators	Eric Sammer	O'Reilly Media	1st Edition, 2012
4	"Big Data Analytics: A Hands-On Approach	Arshdeep Bahga, Vijay Madisetti	VPT Publications	1st Edition, 2018

B.TECH. ROBOTICS AND AUTOMATION
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER -VIII

Professional Electives-4

COMMUNICATION SYSTEMS

Course Code	18RA824	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course objectives:

- Determine the performance of amplitude modulation schemes in time and frequency domains and sampling process.
- Characterize the performance of modulation and generation and detection of modulated analog signals.
- Characterize analog signals in time domain as random processes and in frequency domain using Fourier transforms.
- Determine the performance of different coding techniques for different modulation types and multiplexers Understand the characteristics of communication systems, pulse amplitude modulation, pulse code modulation systems, digital multiplexers, spread spectrum modulation and its applications.

Module-1

Introduction To Communication Systems: Information, Transmitter, channel-noise, Receiver, modulation, need for modulation, band width requirements, sine wave and Fourier series review, frequency spectra of non sinusoidal waves. Basic signal processing operations in digital communication. Sampling Principles: Sampling Theorem.

Revised Bloom's Taxonomy Level	L1, L2

Module-2

Amplitude Modulation: Introduction AM Time-Domain description, Frequency – Domain description. Generation of AM wave: square law modulator, switching modulator. Detection of AM waves: square law detector, envelop detector. Double side band suppressed carrier modulation (DSBSC): Time-Domain description, Frequency-Domain representation, Generation of DSBSC waves: balanced modulator, ring modulator. Coherent detection of DSBSC modulated waves. Costas loop...

Revised Bloom's Taxonomy Level	L1, L2

Module-3

Angle Modulation & Demodulation: Basic definitions, FM, narrow band FM, wide band FM, transmission bandwidth of FM waves, generation of FM waves: indirect FM and direct FM, Demodulation of FM waves, FM stereo multiplexing, Phase-locked loop, Nonlinear model of the phase – locked loop, Linear model of the phase – locked loop, Nonlinear effects in FM systems

Revised Bloom's Taxonomy Level	L1, L2

Module-4

Waveform Coding Techniques: PAM, TDM. Waveform Coding Techniques, PCM, Quantization noise and SNR, robust quantization. DPCM, DM, applications. Line Codes : Unipolar RZ& NRZ, Polar RZ& NRZ, Bi-Polar RZ & NRZ ,Manchester.

Revised Bloom's Taxonomy Level	L1, L2

Module-5

Spread Spectrum Modulation: Pseudo noise sequences, notion of spread spectrum, direct sequence spread spectrum, coherent binary PSK, frequency hop spread spectrum, applications. Digital Multiplexers: FDM ,TDM ,Classification of Multiplexers ,T1 Carrier System

Revised Bloom's Taxonomy Level	L1, L2

Course outcomes:

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

- Able to determine the performance of amplitude modulation schemes in time and frequency domains and sampling process.
- Able to characterize the performance of modulation and generation and detection of modulated analog signals.
- Able to Characterize analog signals in time domain as random processes and in frequency domain using Fourier transforms.
- Able to Determine the performance of different coding techniques for different modulation types and multiplexers

  Able to Understand the characteristics of communication systems, pulse amplitude modulation, pulse code modulation systems, digital multiplexers, spread spectrum modulation and its applications.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Communication Systems	Simon Haykins	John Willey	3rd Edition,1996
2	An Introduction to Analog and Digital Communication	Simon Haykins	John Willey	2003
3	Digital communications	Simon Haykins	John Willey	2003
Reference Books				
1	Modern digital and analog Communication systems	B. P. Lathi	Oxford University press	3rd Edition 2005
2	Communication Systems	P.E, Stern Samy and A Mahmond	Pearson	Edition 2004

code corrected as per scheme.

B.TECH. ROBOTICS AND AUTOMATION
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VIII

ADDITIVE MANUFACTURING

Course Code	18RA825	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course objectives:

- To know the principle methods, areas of usage, possibilities and limitations of the Additive Manufacturing technologies.
- To be familiar with the characteristics of the different materials those are used in Additive Manufacturing.
- To know the principles of polymerization and powder metallurgy process, extrusion-based system printing processes, sheet lamination processes, beam deposition processes, direct write technologies and Direct Digital Manufacturing.
- To get exposed to process selection, software issues and post processing.

Module-1

Introduction and basic principles: Need for Additive Manufacturing, Generic AM process, stereoli tho graphy 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-aidedde sign technology ,other associated technologies, the use of layers, classification of AM processes, metals ystems, hybrid systems, milestones in AM development.
Additive Manufacturing Process chain: Introduction, the eight steps in additive manufacture, variations from one AM machine to another ,metal systems, maintenance of equipment, materials handling issues, design for AM, and application areas.

Module-2

Photo polymerization processes: Stereolitho graphy (SL), Materials, SL resin curing process, Micro-stereoli thography, Process Benefits and Drawbacks, Applications of Photo polymerization Processes.
Powder bedfusion 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.

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 -basedDW,laser transfer, DW thermals pray,DW beam deposition, DW liquid-phase directde position.

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.

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.

Course outcomes:

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.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Additive Manufacturing Technologies Rapid Prototyping to Direct Digital Manufacturing	I. Gibson I D. W. Rosen I B. Stucker	Springer New York Heidelberg Dordrecht, London	2010
Reference Books				
1	"Rapid Prototyping: Principles & Applications	Chua Chee Kai, Leong Kah Fai	World Scientific	2003
2	Rapid Prototyping: Theory & Practice	Ali K. Kamrani, EmandAbouel	Springer	2006
3	Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling"	D.T. Pham, S.S. Dimov	Springer	2001

4	Rapid Prototyping: Principles and Applications in Manufacturing	RafiqNooran	John Wiley & Sons	2006
5	Additive Manufacturing Technology	Hari Prasad, A.V.Suresh	Cengage	2019
6	Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing	Andreas Gebhardt	Hanser Publishers	2011

ವಿಶ್ವೇಶ್ವರಯ್ಯ ತಾಂತ್ರಿಕ ವಿಶ್ವವಿದ್ಯಾಲಯ
(ವಿ ಟಿ ಯು ಅಧಿನಿಯಮ ೧೯೯೪" ರ ಅಡಿಯಲ್ಲಿ ಕರ್ನಾಟಕ ಸರ್ಕಾರದಿಂದ ಸ್ಥಾಪಿತವಾದ ರಾಜ್ಯ ವಿಶ್ವವಿದ್ಯಾಲಯ)
Visvesvaraya Technological University
(State University of Government of Karnataka Established as per the VTU Act, 1994)
"Jnana Sangama" Belagavi-590018, Karnataka, India

Dr. R. R. Malagi
Professor and Chairman

☎: 0831-2498180, 944801 4682,
E-mail : chairman_mech@vtu.ac.in

Ref No: VTU/BGM/ME/B.Tech/Intern/2023-24/ 572 Date: 15 APR 202

To,
Special Officer,
Academic Section (Syllabus)

Faculty Mapping

Program: B. Tech. Robotics & Automation (RA)					**Semester: VIII**
Sl. No.	**Subject Code**	**Subject Name**		**Faculty Name**	**Contact No.**
1	**18RA81**	Automotive Electronics & Hybrid Vehicles (AEHV)	1	M/s. Pooja Angolkar Asst. Professor Dept. of RA, AITM -Belagavi	8919925014
			2	Mr. Ananth Ghadi Asso. Professor, Department of ME, MMEC, Belagavi	9008604343
			3	Mr. Vishwanath M Khadakbhavi Asst. Professor Dept. of Mechanical Engineering, SGBIT Belagavi	7892375367
			4	Mr. Satish B Herekar Asst. Professor Department of Mechanical Engineering, VTU Belagavi.	7676879678
2	**18RA825** (Note: Corrected Syllabus Copy and Scheme attached.)	Additive Manufacturing (AM)	1.	Dr. R. R. Malagi, Professor & Chairman Department of Mechanical Engineering, VTU Belagavi.	9448907847
			2.	Dr. Ashok M. Hulagabali Dept. of Mechanical Engineering, SGBIT Belagavi	9480563550
			3.	Mr. Kiran Lakkam Asst. Professor Department of RI, MMEC, Belagavi.	9591421637
			4.	Mr. Nikhil Changoli Asst. Professor Department of Mechanical Engineering, VTU Belagavi.	7892068807

25/4/2024

Chairman
25/4/24

18RA823, 824 Title corrected in comparison with Syllabus copy

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination (2018)
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
(Effective from the academic year 2020-21)

Programme: B.Tech. in ROBOTICS AND AUTOMATION

VIII SEMESTER

Sl. No	Course and Course code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	PCC	18RA81	Automotive Electronics & Hybrid Vehicles	E & E/ Mechanical	3	–	–	03	40	60	100	3
2	PEC	18RA82X	Professional Elective - 4		3	–	–	03	40	60	100	3
3	Project	18RAP83	Project Work Phase - 2		–	–	2	03	40	60	100	8
4	Seminar	18RAS84	Technical Seminar		–	–	2	03	100	–	100	1
5	Internship	18RAI85	Internship	Completed during the vacation/s of VI and VII semesters and /or VII and VIII semesters.)				03	40	60	100	3
				TOTAL	06	–	4	15	260	240	500	18

Note: PCC: Professional Core, PEC: Professional Elective.

Professional Electives - 4

Course code under 18XX82X	Course Title
18RA821	Management Information Systems (CS)
18RA822	Biomedical Signal Processing (E&C)
18RA823	Big Data and Analytics (CS)
18RA824	Communication Systems (ECE
18RA825	Additive Manufacturing (Mechanical)

15/04/2024

code corrected as per scheme.

B.TECH. ROBOTICS AND AUTOMATION
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER -VIII

ADDITIVE MANUFACTURING

Course Code	18RA825	CIE Marks	40
TeachingHours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course objectives:

- To know the principle methods, areas of usage, possibilities and limitations of the Additive Manufacturing technologies.
- To be familiar with the characteristics of the different materials those are used in Additive Manufacturing.
- To know the principles of polymerization and powder metallurgy process, extrusion-based system printing processes, sheet lamination processes, beam deposition processes, direct write technologies and Direct Digital Manufacturing.
- To get exposed to process selection, software issues and post processing.

Module-1

Introduction and basic principles: Need for Additive Manufacturing, Generic AM process, stereoli tho graphy or 3dprinting, rapid proto typing ,the benefits of AM, distinction between AM and CNC machining, other related technologies- reverse engineering technology.
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Additive Manufacturing Process chain: Introduction, the eight steps in additive manufacture, variations from one AM machine to another ,metal systems, maintenance of equipment, materials handling issues, design for AM, and application areas.

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Direct digital manufacturing: Align Technology, siemens and phonak, DDM drivers, manufacturing vs. prototyping, life- cycle costing, future of direct digital manufacturing.

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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.

Question paper pattern:

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- Each full question will be for 20 marks.
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Reference Books				
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3	Rapid Manufacturing: The Technologies and Applications of Rapid Prototyping and Rapid Tooling"	D.T. Pham, S.S. Dimov	Springer	2001

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6	Understanding additive manufacturing: rapid prototyping, rapid tooling, rapid manufacturing	Andreas Gebhardt	Hanser Publishers	2011