



Wardha Road, Nagpur - 441108
Accredited with NAAC A+ Grade
Approved by AICTE, New Delhi, Govt. of Maharashtra



(An Autonomous Institution Affiliated to RTM Nagpur University)

Department of Biotechnology

Teaching Scheme and Syllabus

 $\underline{\text{of}}$

7th Semester B.Tech Biotechnology

(From Academic Year 2024-25)





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Department of Biotechnology

Vision of Institute

To emerge as a learning Centre of Excellence in the National Ethos in domains of Science,

Technology and Management.

Mission of Institute

- 1. To strive for rearing standard and stature of the students by practicing high standards of professional ethics, transparency and accountability.
- 2. To provide facilities and services to meet the challenges of Industry and Society.
- 3. To facilitate socially responsive research, innovation and entrepreneurship.
- **4.** To ascertain holistic development of the students and staff members by inculcating knowledge and profession as work practices.





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Department of Biotechnology

Vision of the Department

To produce competent Entrepreneurs, Researchers and industry ready Professionals in Biotechnology through quality education

Mission of the Department

- 1. To impart quality technical education and unique interdisciplinary research by merging science and technology
- 2. To make students aware about techniques of modern biotechnology and industrial advancements
- 3. To Inculcate Social and Ethical values in the students and empower them through imparting of knowledge and skills in biotechnology

Program Education Objectives (PEO)

- 1. Develop Biotechnology graduates as human resource with technical competencies and strong foundation of science and engineering.
- 2. Acquire fundamental knowledge of mathematics, Biosciences and engineering to analyze, design and implement solutions to the Biotechnological problems.
- 3. Understand emerging concepts and trends in Biotechnology and allied fields.
- 4. Apply various tools to develop innovative systems for the bioprocesses.





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Program Outcomes (PO)

- **1. Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
- 2. 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.
- **3. 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.
- **4. 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.
- **5. Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and software tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
- **6.** 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.
- **7.** 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.
- **8. Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
- **9. Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
- **10. 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.
- **11. 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 a team, to manage projects and in multidisciplinary environments.
- **12. Lifelong learning:** Recognize the need for, and have the preparation and ability to engage in independent and lifelong learning in the broadest context of technological change.

Program Specific Outcomes (PSO)

PSO-1: Ability to apply the acquired knowledge and recent techniques to come up with ideas in the domains of Bioprocess Engineering, Bioinformatics and Biopharmaceuticals.

PSO-2: Ability to utilize their proficiency and skills in solving real life problems in Diagnostics Genetic Engineering and Fermentation Technology using recent technologies.

PSO-3: Analyzing the impact of Biotechnology Engineering solutions in the societal and human context to create productive human resource for the country.



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Scheme of Instructions: Fourth Year B. Tech in Biotechnology Semester VII

Sr.	Course	Course	Course Title	L	T	P	Contact	Course		EXAM SCHEME			
No.	Category	Code					Hrs./Wk	Credits	CT1	CT2	CA	ESE	TOTAL
1	PCC	BBT4701	Fermentation Technology	3	-	-	3	3	15	15	10	60	100
2	PCC	BBT4702	Bioprocess Equipment Design	3	-	-	3	3	15	15	10	60	100
3	PEC	BBT4703-05	Professional Elective -V	3	-	-	3	3	15	15	10	60	100
4	PEC	BBT4706-08	Professional Elective -VI	3	-	-	3	3	15	15	10	60	100
5	OEC	B\$\$XX01-14	Open Elective-III	3	1	-	4	4	15	15	10	60	100
6	OEC	B\$\$XX01-14	Open Elective-IV	3	1	-	4	4	15	15	10	60	100
7	PCC	BBT4709	Bioprocess Equipment Design Lab	-	-	2	2	1	-	-	25	25	50
8	PCC	BBT4710	Data analysis and Simulations Lab	-	-	2	2	1	-	-	25	25	50
9	AU	BAU4707	Behavioral and Interpersonal Skills	2	-	-	2	Audit	-	-	-	-	-
			Total	20	2	4	26	22	90	90	110	410	700

L- Lecture T-Tutorial P-Practical CT1- Class Test 1 CT2- Class Test 2 CA- Continuous Assessment ESE- End Semester Examination (For Laboratory: End Semester Performance)

Course Category	HSMC (Hum., Soc. Sc, Mgmt.)	BSC (Basic Sc.)	ESC (Engg. Sc.)	BS (Biological Sc.)	PCC (Professional	PEC (Professional Elective Courses)	OEC (Biological Sc.)	Project (Project /Seminar/ Industrial	MCC (Mandatory Courses)
	, ,	,	56.)	,	Core courses)	,	,	Training)	,
Credits	-	-	-	-	8	6	8	-	Yes
Cumulative Sum	12	18	14	16	49	18	14	5	

Progressive Total Credits: 124+22=146

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Department Of Biotechnology
Tulsiramji Gaikwad Patil Collage Of
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Depth Academics
Fulsiramji Gaikwad-Patil
Cellege Of Engineering
and Technology, Nageur

Vice Principal
Tulsirami Gaikwad-Patil
College Of Engineering &
Technology, Nagpur.

Principalipal
Tulsiramji Gaikwad Patil College Of
Engineering and Teghnology, Nagpun

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Electives for Semester VII B.Tech Biotechnology

I	Professional Elective - III: Semester-VII	Pı	rofessional Elective - IV: Semester-VII
BBT4703	Good Manufacturing and Laboratory Practice	BBT4706	Biosensors
BBT4704	Engineering Economics	BBT4707	Protein Engineering
BBT4705	Entrepreneurship in Biotechnology	BBT4708	Bio pharmaceutical Technology

List of Open Elective									
Sr. No.	Course Code	Course Title	Sr. No.	Course Code	Course Title				
1	BCSXX01	Cyber Law and Ethics	9	BMEXX09	Nanotechnology and Surface Engineering				
2	BCSXX02	Block chain Technology	10	BMEXX10	Automobile Engineering				
3	BITXX03	Cyber Security	11	BEEXX11	Power Plant System				
4	BITXX04	Artificial Intelligence	12	BEEXX12	Electrical Materials				
5	BECXX05	Internet of Things	13	BAEXX13	Avionics				
6	BECXX06	Embedded Systems	14	BAEXX14	Unmanned Aerial Vehicles				
7	BCEXX07	Introduction to Art and Aesthetics	15	BBTXX15	Biomaterials				
8	BCEXX08	Metro Systems and Engineering	16	BBTXX16	Food and Nutrition Technology				

BOS Chairman

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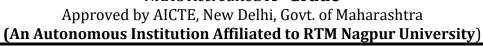
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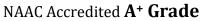




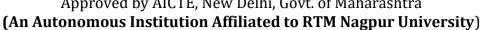
	Fourth Year B.Tech Biotechnology (Seventh Semester)							
			BBT47	701: Fermentation Technology	y			
Tea	ching Sc	heme			Examination Scheme			
Lect	tures		3 Hr / Week		ESE	60 Marks		
Tute	orial		-		CIE	40 Marks		
Pra	ctical		-		Total	100 Marks		
The	ory Cred	dits: 3			Duration of E Hours	xam: 3		
Cou	rse Obje	ectives			110415			
			is course is:					
1.	To gain its histo	a fund ory, core	amental understa e processes, mic	anding of the principles of fermerobial selection, media design,	and optimization	strategies.		
2.	product	forma	•	icrobial growth kinetics, incluthis knowledge to design, sele	•			
3.	availabi	ility, a	nd nutrient rec	cting fermentation processes, su quirements, and become fami continuous, and immobilized cel	liar with differ	ent types of		
				Course Contents				
U	nit I	fermen	tation processe	ntation technology: History of s, Microbial culture selection process optimization.				
Uı	nit II	produc	-	etics: Study of growth kinetineties in fermentation procestation media.				
Un	Unit III (temperature, pH, ox			s control: Parameters and factors affecting fermentation, xygen availability, and nutrient requirements). Types of l-batch, continuous, and immobilized cell fermenters				
Unit IV Production of Microbial products: Process technology for production of solvents such as industrial alcohol, glycerol, acetone, butanol. Production of Brief account of steroid transformation				· ·				
Unit V Microbial polysaccharides and polyesters: Production of xanthan gum, biopesticides, and biosurfactants.					biofertilizers,			



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Text Books						
T.1	Principles of Fermentation Technology (2nd Edition) by Stanbury, Whitaker, and Hall					
T.2	Biochemical Engineering Fundamentals (2nd Edition) by Bailey and Ollis					
Reference	Reference Books					
R.1	Industrial Microbiology (4th Edition) by Casida					
R.2	Shuler and Kargi: Bioprocess Engineering: Basic Concepts (3rd Edition)					

Useful Links					
1	https://nptel.ac.in/courses/102106053				
2	https://nptel.ac.in/courses/102106022				

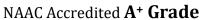
	CL	Hours	
BBT470 1.1	Apply fermentation principles to select microbial cultures and optimize media formulation.	2	7
BBT4701 .2	Analyze growth kinetics to design and optimize fermentation media and processes.	4	8
BBT4701 .3	Evaluate and control fermentation parameters in various fermenter types.	4	8
BBT4701.4	Develop and optimize processes for producing industrial alcohol, glycerol, acetone, butanol, and Vitamin B12.	3	7
BBT4701. 5	Design and implement processes for producing xanthan gum, PHA, biofertilizers, biopesticides, and biosurfactants.	2	8

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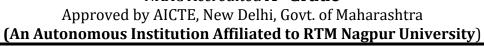
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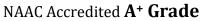


	Fourth Year B.Tech Biotechnology (Seventh Semester)							
			BBT4702	2: Bioprocess Equipment Desi	gn			
Tea	ching S	cheme			Examination S	Scheme		
Lect	Lectures 3 Hr / Week				ESE	60 Marks		
Tute	orial		-		CIE	40 Marks		
Prac	ctical		-		Total	100 Marks		
The	ory Cre	edits: 3			Duration of Exam: 3			
					Hours			
Cou	rse Obj	jectives						
The	Objecti	ves of th	nis course is:					
1.				binary systems, plate efficiency,	column sizing,	and		
1.			aulic design.					
2.				ions, critical components (flange	es, piping, jacket	s, etc.), and		
		ole in fu						
3.				nd heat exchangers (including s	hell & tube), cor	nsidering		
	power	, materia	als, safety, and p	roject economics.				
				Course Contents				
U	nit I		=	ariable in distillation, design methods for binary systems, plate				
		efficiency, approximate column sizing, plate contractor and plate hydraulic design						
Uı	nit II	Bioreactors : Design principles of bioreactors, Geometric configuration, Flanges, Nozzles, Gaskets, Supports, Piping, Jackets and Coils etc.						
				·		a a4ala:1:=ana		
Un	it III	_		for bioreactors: agitators, ae	rators, air illter	s, stabilizers,		
	Power requirement Heat Exchangers: Codes and standards for heat exchangers, materials							
IIn	nit IV		_		_			
	11 t 1 v	construction, baffles and tie rod, tube joining mathods. Design of shell and tube heat exchangers.						
			<u> </u>	s, safety measures in bioreactors	Material for co	nstruction of		
III	nit V		•	on criteria. Cost estimation meth				
	iiit v	of proj		on orneria. Cost estimation men	iods and comon	iic evaluation		
		or proj						





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Text Books	Text Books					
T.1 Bioprocess Engineering Principles (2nd Edition) by Pauline M. Doran						
T.2	Distillation Design (2nd Edition) by Henry Z. Kister					
Reference	Reference Books					
R.1	Perry's Chemical Engineers' Handbook (9th Edition)					
R.2	Bioreactors for Tissue Engineering by Julian Sun and Xiaohua Liu					

Useful Links					
1	https://nptel.ac.in/courses/102106053				
2	https://nptel.ac.in/courses/102106022				

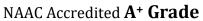
	CL	Hours	
BBT4702 .1	Apply design methods to determine the design variables in distillation for binary systems	3	8
BBT4702 .2	Evaluate the design requirements for flanges, nozzles, gaskets, supports, piping, jackets, and coils in bioreactors.	4	8
BBT4702 .3	Design agitators, aerators, air filters, and stabilizers for bioreactors.	6	8
BBT4702.4	Design the baffles and tube joining methods for shell and tube heat exchangers.	6	7
BBT4702.5	Evaluate the scale-up principles and apply them to design larger bioreactors.	5	7

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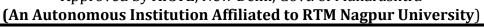
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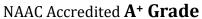


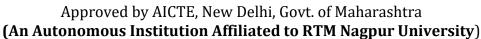


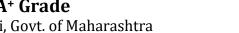
	Fourth Year B.Tech Biotechnology (Seventh Semester)						
	BBT4703: Good Manufacturing and Laboratory Practice						
Tea	ching So	cheme			Examination S	Scheme	
Lec	tures		3 Hr / Week		ESE	60 Marks	
Tut	orial		-		CIE	40 Marks	
Pra	ctical		-		Total	100 Marks	
The	ory Cre	dits: 3			Duration of Ex	xam: 3	
					Hours		
	ırse Obj						
The			nis course is:				
	_	_	=	GLP and GMP for product			
1.				ng and control, and gain an ov	erview of Quali	ty by Design	
	, , ,	princip			(DOE) : 1:	. 1 1 .	
2.	_			QBD and Design of Experimen		otech product	
		•		udies for process and analytical		-11-4	
3.			· ·	s and their use, identify nationa ir roles in product design and dr			
	autilori	ities, and	u understand the	Course Contents	ug development	•	
		Introd	uction to Good		tory Practice: I	mportance of	
U	nit I	Introduction to Good Manufacturing and Laboratory Practice: Importance of GLP and GMP for regulatory approval, Ethics in manufacturing and control,					
		Overview of principles of quality by design (QBD)					
		Quality by Design (QBD) and Design of Experiment (DOE): Introduction to QBD					
T I	nit II	and its application in biotech product development, Concept and methodology of					
U	1111	DOE, Case studies: QBD and DOE in process development, DOE in analytical					
		development					
		_	•	es and Authorities: Introduction	•		
Ur	nit III	usage, Overview of national and international regulatory authorities, Functions and					
				ies in product design and drug d	•		
				sprudence and Laws: Laws re	-	•	
Ur	nit IV			velopment and approval process		r clinical and	
				horization and marketing of dru		1 a d main - 1 - 1 -	
T T.	nit T 7			Practices and Production Mar			
	nit V	_		P, Formulation production man	_	_	
		compi	ance, Case studi	es on successful implementation	ii oi Givir iii 010	iceli ilidustry	



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Text Books	Text Books			
T.1	T.1 Good Manufacturing Practices for Pharmaceuticals (5th Edition) by Manjunath Patel			
T.2	Quality by Design for Biopharmaceutical Development by Jurandir Magalhães			
Reference	Reference Books			
R.1 Quality Assurance of Pharmaceuticals: A Compendium of Guidelines and Related Materials (10th Edition)				
R.2 Quality Assurance and Quality Management in Pharmaceutical Industry				

Useful Links					
1	https://www.ich.org/				
2	https://www.fda.gov/drugs				

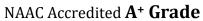
	Course Outcomes	CL	Hours
BBT4703.1	Apply the principles of Good Manufacturing Practice (GMP) and Good Laboratory Practice (GLP) to ensure regulatory compliance in biotechnology and pharmaceutical manufacturing.	3	7
BBT4703.2	Implement Quality by Design (QBD) methodologies and Design of Experiment (DOE) techniques in the development and optimization of biotech products.	3	7
BBT4703 .3	Interpret and apply ICH guidelines and regulatory requirements from national and international authorities to the design and development of pharmaceutical products.	3	7
BBT4703.4	Analyze and apply laws and regulations governing drug development, approval processes, and marketing authorizations to ensure compliance in pharmaceutical jurisprudence.	4	8
BBT4703.5	Evaluate and manage production processes by implementing Good Manufacturing Practices (GMP) to ensure quality and compliance in biotech and pharmaceutical production.	5	8

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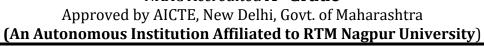
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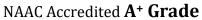


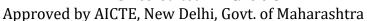
	Fourth Year B.Tech Biotechnology (Seventh Semester)					
	BBT4704: Engineering Economics					
Tea	ching So	heme			Examinat	ion Scheme
Lec	tures		3 Hr / Week		ESE	60 Marks
Tut	orial		-		CIE	40 Marks
Pra	ctical		-		Total	100 Marks
The	Theory Credits: 3			Duration	of Exam: 3 Hours	
Cou	rse Obj	ectives				
The	Objectiv	es of th	is course is:			
1.	To mas	ster fund	lamental concep	ots and the importance of e	ngineering econ	omics.
2.	To app	ly vario	us cost estimati	on techniques and conduct	analyses includ	ing break-even and
۷.	cost-benefit analysis.					
3.	To eva	aluate investment alternatives using NPV, IRR, and other economic evaluation				
٥.	method	ls.				
				Course Contents		
U	nit I		•	ering Economics: Basic of		•
		Importance in engineering, Time value of money, Interest formulas and their applications.				
U	nit II	Cost Analysis and Estimation: Types of costs, Cost estimation techniques, Break-even				
			<u> </u>	analysis, Cost-benefit analys		1 (MIDM)
T T	nit III	Investment Decisions: Evaluation of investment alternatives, Net present value (NPV),				
UI	111 111	Internal rate of return (IRR), Payback period, Comparison of alternatives using various methods.				
				ecision Making: Depreciatio	n methods Inflati	ion and its impact on
Uı	nit IV		•	isk and uncertainty in eco		•
			ity analysis.		,	
		Enginee	ering Economic	Applications: Case studies	in engineering	economic decision-
U	nit V	making,	, Application of	economic principles in engi	neering projects,	Project management
		and eco	nomic feasibility	studies, Environmental econ	omics in engineer	ring.





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Text Books				
T.1 Engineering Economic Analysis (14th Edition) by Donald G. Newnan, Ted G. Eschen and Jerome P. Lavelle				
T.2	Fundamentals of Engineering Economic Analysis (2nd Edition) by John A. White, Kenneth E. Case, and David B. Pratt			
Reference	Reference Books			
R.1	R.1 Engineering Economy (15th Edition) by Leland Blank and Anthony Tarquin			
R.2 Economic Analysis for Engineers (5th Edition) by David Whitman and William Lang				

Useful Links				
1	https://nptel.ac.in/courses/106105470			
2	https://nptel.ac.in/courses/130106117			

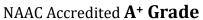
	Course Outcomes	CL	Hours
BBT4704.1	Interpret the fundamental concepts of engineering economics and the significance of time value of money in engineering decision-making processes.	2	7
BBT4704 .2	Assess various cost estimation techniques and conduct break-even and life-cycle cost analyses to support cost-benefit assessments.	3	7
BBT4704 .3	Evaluate investment alternatives using methods such as NPV, IRR, and payback period to compare different financial options.	5	7
BBT4704.4	Assess the impact of depreciation, inflation, and risk on economic decisions through the use of decision trees and sensitivity analysis.	4	7
BBT4704. 5	Develop case studies and project management plans that incorporate economic principles and feasibility studies, including considerations of environmental economics in engineering projects.	6	7

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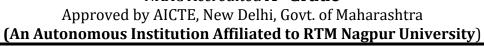
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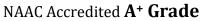




	Fourth Year B.Tech Biotechnology (Seventh Semester)					
	BBT4705: Entrepreneurship in Biotechnology					
Tea	Teaching Scheme Examination Scheme					cheme
	ectures 3 Hr / Week ESE 60 Marks			60 Marks		
Tut	orial		-		CIE	40 Marks
Pra	ctical		-		Total	100 Marks
The	eory Cre	edits: 3			Duration of Exa	am: 3 Hours
Cou	ırse Ob	jectives				
The			nis course is:			
1.	_		view of entrepren economic growth.	eurship in the biotechnology sect	or and its role in dri	iving
2.		n technic h and an	-	g business opportunities in biotec	chnology, including	market
3.				ness plan and strategy for biotechation, and financial planning.	nnology ventures, en	ncompassing
				Course Contents		
τ	J nit I	entrepo driving success	reneurship in the grinnovation and sful biotechnology.	Entrepreneurship in Bio e biotechnology sector, Impo nd economic growth in biot ogy entrepreneurs, Case stu and their impact	ortance of entrepo echnology, Chara	acteristics of
U	nit II	needs a for ide regulat	and gaps in the bintifying businessory landscape,	ities in Biotechnology Entrep iotechnology market, Market re s opportunities, Assessing mar , Recognizing emerging t	esearch and analys	sis techniques apetition, and
Uı	Unit III business plan for bio defining the target m strategies, Formulating		ess Planning and ss plan for biough the target miles, Formulatin	technology ventures, Develop arket, Crafting a business m g a go-to-market strategy and fundraising strategies	ping a value pro nodel and revenu	position and e generation
Unit IV Legal and Regulatory Considerations in Biotechnology Entrepolation Intellectual property (IP) protection strategies for biotechnology Understanding regulatory requirements and compliance in the biotechnology agreements, partnerships, and collaborations, Ethics responsibility in biotechnology entrepreneurship, Managing risks and		innovations, ech industry, and social				
U	biotech ventures Scaling Up and Managing Growth in Biotechnology Ventures: Strategies for scaling up biotech startups, Building and managing teams for growth and innovation. Establishing operational processes and quality management systems, Expanding market reach and internationalization strategies, Exit strategies for biotechnology entrepreneurs: IPOs, acquisitions, mergers, or strategic partnerships				d innovation, s, Expanding	



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Text Book	Text Books				
T.1	Biotechnology Entrepreneurship: Starting and Running a Biotechnology Business (3rd Edition) by Robert A. Burgener				
T.2	The Business of Biotechnology: From Science to Enterprise (3rd Edition) by Julie A. Graves and Thomas N. Reynolds				
Reference	Books				
R.1	Serial Innovators: How Great Entrepreneurs Create Ideas from Thin Air (1st Edition) by Kim Clark				
R.2	The Startup Owner's Manual: The Step-by-Step Guide for Building a Great Company (Updated Edition) by Steve Blank and Bob Dorf				

Useful Links				
1	https://nptel.ac.in/courses/109105176			
2	https://nptel.ac.in/courses/110106141			

	Course Outcomes	CL	Hours
BBT4705 .1	Understand the role of entrepreneurship in driving innovation and economic growth within the biotechnology sector, analyzing characteristics of successful biotechnology entrepreneurs through case studies.	2	7
BBT4705.2	Identify opportunities in biotechnology entrepreneurship by conducting market research, analyzing market potential, competition, and regulatory landscapes, and recognizing emerging trends and technologies.	4	8
BBT4705 .3	Apply business planning and strategic thinking to biotechnology ventures, including developing value propositions, crafting business models, formulating go-to-market strategies, and financial planning for fundraising.	4	8
BBT4705.4	Analyze legal and regulatory considerations in biotechnology entrepreneurship, including intellectual property protection, regulatory compliance, licensing agreements, and ethical responsibilities.	3	9
BBT4705. 5	Develop strategies for scaling up and managing growth in biotechnology ventures, including building and managing teams, establishing operational processes, expanding market reach, and exploring exit strategies such as IPOs, acquisitions, mergers, or strategic partnerships.	2	8

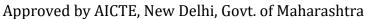
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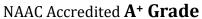


	Fourth Year B.Tech Biotechnology (Seventh Semester)						
	BBT4706: Biosensors						
Tea	ching S	cheme			Examination So	cheme	
Lec	tures		3 Hr / Week		ESE	60 Marks	
Tut	orial		ı		CIE	40 Marks	
Pra	ctical		ı		Total	100 Marks	
The	ory Cre	edits: 3			Duration of Ex	am: 3 Hours	
Cou	ırse Ob	ectives					
The	Objecti	ves of th	is course is:				
1.				significance of biosensors, explor	ring their historical	development	
_		y compor		eptors, their mechanisms of intera	ction and methods	for	
2.	immob	ilization.					
3.			mine transducers in biosensors, including types, principles of transduction, and selection				
	criteria	based or	n application requ	Course Contents			
		Introd	uction to Riose		tance of biosenso	re Historical	
	· • • •	Introduction to Biosensors : Definition and importance of biosensors, Historical development, Components of biosensors (bioreceptors, transducers, and signal					
U	nit I	processors), Types of biosensors, Applications in various fields (medical,					
		environmental, industrial)					
	·4 TT	Bioreceptors : Types of bioreceptors (enzymes, antibodies, nucleic acids, cells),					
U	nit II	Mechanisms of bioreceptor interaction, Specificity and sensitivity of bioreceptors, Methods for immobilization of bioreceptors					
				sensors: Types of transduc	ers (electrochem	ical ontical	
Ur	nit III						
		piezoelectric, thermal), Principles of transduction mechanisms, Signal processing and amplification, Selection criteria for transducers based on application					
				sign of Biosensors: Materia			
Uı	nit IV	Microfabrication techniques, Integration of bioreceptors with transducers,					
		Miniaturization and microfluidics in biosensor design, Case studies of biosensor design for specific applications					
				Applications of Biosensor	s: Evaluation o	of biosensor	
				ity, specificity, response tim			
U	nit V	validat	ion of biose	ensors, Real-world applica	tions (clinical	diagnostics,	
				ring, food safety, bioprocess	control), Emergin	g trends and	
		future	directions in bio	sensor technology			





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Text Books	Text Books					
T.1	Biosensors: Principles and Applications (2nd Edition) by Edward A. Katz and Ioannis Willner					
T.2	Fundamentals of Biosensors and Bioelectronics (2nd Edition) by Miniatuurized Analytical Chemistry for Medicine and Environmental Studies					
Reference	Books					
R.1 Handbook of Biosensors and Bioelectronic Devices (1st Edition) by Richard F. Turner, Ajit P. Kumar, and Irvine S. Krull						
R.2	Biosensors for Environmental Monitoring: Principles and Applications (Edited by Emilia Emilia et al.)					

	Useful Links			
ſ	1 https://nptel.ac.in/courses/108108113			
	2 https://nptel.ac.in/courses/108106193			

Course Outcomes			Hours
BBT4706 .1	Understand the definition, historical development, and components of biosensors, and their applications in various fields	2	9
BBT4706 .2	Analyze the types of bioreceptors, their mechanisms of interaction, specificity, sensitivity, and methods of immobilization	3	8
BBT4706 .3	Explain the types of transducers used in biosensors, their principles of operation, signal processing, and selection criteria	3	8
BBT4706 .4	Apply knowledge of materials, microfabrication techniques, and integration methods in the fabrication and design of biosensors	4	9
BBT4706.5	Evaluate biosensor performance, calibrate and validate biosensors, and explore real-world applications and emerging trends	4	8

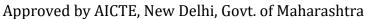
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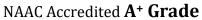


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	Fourth Year B.Tech Biotechnology (Seventh Semester)						
	BBT4707: Protein Engineering						
	Teaching Scheme				Examination Scheme		
Lec	tures		3 Hr / Week		ESE	60 Marks	
Tut	orial		-		CIE	40 Marks	
Pra	ctical		-		Total	100 Marks	
The	ory Cre	edits: 3			Duration of Exa	am: 3 Hours	
Cou	rse Ob	jectives					
The	Objecti	ves of th	is course is:				
1.	To exp	lore the	importance and a	applications of protein engineering	ng, focusing on pro	otein structure,	
1.			g, and stability.				
2.		_	•	hods for protein design and model	ing, including struc	ture prediction	
			lynamics simulation i	ons. techniques, such as mutagenesis, l	ibrary construction	and screening	
3.			gh case studies.	teeninques, such as matagenesis, i	iorary construction,	and sereening	
				Course Contents			
T	nit I	Introd	uction to Prot	ein Engineering: Importance	e and application	s of protein	
		engineering, Protein structure and function, Protein folding and stability					
	•4 11	Protein Design and Modelling: Computational methods for protein design, Protein					
U	nit II	structure prediction, Molecular dynamics simulations, Protein-protein and protein-					
		ligand interactions Directed Evolution and Sepagnings Mutaconesis techniques Library construction					
Ur	nit III	Directed Evolution and Screening: Mutagenesis techniques, Library construction and screening methods, High-throughput screening platforms, Directed evolution					
		case studies					
				Techniques: Site-directed mu	tagenesis, Rationa	al design and	
Ur	nit IV	semi-rational design, Protein grafting and loop engineering, Disulfide engineering					
and glycoengineering							
		Enzyn	ne Technology				
		Enzyma Principles and Riotechnological Applications: Classification atmesture					
IJ	nit V	- Enzyme Principles and Biotechnological Applications: Classification, structure, kinetics, and inhibition of enzymes, Industrial applications of enzymes					
				d Kinetics: Effect of pH and te		•	
			•	etics and enzyme inhibition	•	•	
		regulat	ion of enzyme a	ctivity			





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Text Books	Text Books				
T.1	Protein Engineering: Principles and Practice (3rd Edition) by Liang Li and Scott E. Decatur				
T.2	Introduction to Protein Science (3rd Edition) by Arthur Lesk				
Reference	Reference Books				
R.1	Protein Engineering Handbook (2nd Edition) by Robert A. Meyers				
R.2 Directed Evolution Library Creation: Methods and Applications (Methods in Molec Biology) by Frances H. Arnold					

Useful Links				
1 https://nptel.ac.in/courses/102105089				
2	https://nptel.ac.in/courses/102101049			

	Course Outcomes	CL	Hours
BBT4707 .1	Understand the importance and applications of protein engineering, and the fundamentals of protein structure, function, folding, and stability	2	9
BBT4707 .2	Analyze computational methods for protein design, structure prediction, molecular dynamics simulations, and protein interactions	3	8
BBT4707 .3	Evaluate mutagenesis techniques, library construction, screening methods, and high-throughput screening platforms in directed evolution	4	8
BBT4707 .4	Apply protein engineering techniques such as site-directed mutagenesis, rational design, grafting, loop engineering, disulfide engineering, and glycoengineering	4	9
BBT4707. 5	Explain the classification, structure, kinetics, inhibition, and industrial applications of enzymes, as well as the effects of pH, temperature, Michaelis-Menten kinetics, and enzyme regulation	3	8

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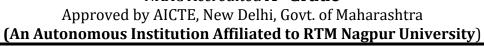
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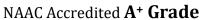




	Fourth Year B.Tech Biotechnology (Seventh Semester)						
	BBT4708: Bio pharmaceutical Technology						
Tea	ching S	cheme			Examination Scheme		
Lec	tures		3 Hr / Week		ESE	60 Marks	
Tut	orial		-		CIE	40 Marks	
Pra	ctical		-		Total	100 Marks	
The	eory Cre	edits: 3		Duration of Exam: 3 Hour			
Cou	ırse Obj	ectives					
			nis course is:				
1.				gnificance of biopharmaceutica	l technology, und	erstanding its	
1.	distinct	ions fror	n traditional phar	maceuticals, key products, and his	storical developmen	nt.	
2.				production and manufacturing production and regulatory requirement		upstream and	
				control, and regulatory requirement mulation and delivery principles,		on techniques.	
3.				f excipients, through case studie			
	deliver	y method	ls.				
				Course Contents			
				pharmaceutical Technology			
U	nit I	Differences from traditional pharmaceuticals, Key products (monoclonal antibodies,					
		recombinant proteins, vaccines), History and development, Current trends and future prospects					
				Production and Manufactur	ing: Overview o	of production	
		processes, Upstream processing: cell line development, media optimization,					
U	nit II	Fermentation and cell culture techniques, Downstream processing: purification,					
		concentration, formulation, Quality control and assurance, Regulatory requirements					
		and GN		Formulation and Delivery	Deinginles of	formavlation	
		_		Formulation and Delivery: s, Delivery systems (injections		· ·	
Uı	nit III			of excipients, Case studies or			
			y methods	r encipionis, cuse studies of	1 5400055141 10111		
			•	ies in Biopharmaceutical	Development :	Methods for	
Uı	nit IV			maceuticals (HPLC, mass spe	•		
		purity, potency, and stability, Importance of bioassays, Regulatory guidelines,					
			ces in analytical			Thomas and:	
		Applicannlica		Market Trends in Bioply, infectious diseases, autoimm			
U	nit V			rcialization challenges and opp			
	•	_		directions, Case studies on si			
		impact		,	F		



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Text Books	Text Books				
T.1	T.1 Biopharmaceutical Production: Principles and Processes (2nd Edition) by Gary Walsh				
T.2 Biopharmaceutical Drug Design and Development (2nd Edition) by Sneha Kumari Ashish Tripathi					
Reference	Reference Books				
R.1 Recombinant DNA and Biotechnology: A Guide for Students (3rd Edition) by J. Reich A. Rich, and R. Wetzel					
R.2	Biopharmaceutical Processing: Validation and Qualification (2nd Edition) by James Robinson				

Useful Links				
1	https://nptel.ac.in/courses/102108077			
2	https://nptel.ac.in/courses/104102113			

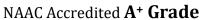
	Course Outcomes	CL	Hours
BBT4708 .1	Summarize about biopharmaceutical technology, its importance, and key products, differentiating from traditional pharmaceuticals	2	9
BBT4708 .2	Describe biopharmaceutical production processes, including quality control, assurance, and regulatory requirements	2	8
BBT4708 .3	Analyze biopharmaceutical formulation principles, stabilization techniques, and delivery systems	3	8
BBT4708 .4	Evaluate analytical techniques for characterizing biopharmaceuticals and assessing regulatory compliance	4	9
BBT4708. 5	Apply knowledge of market trends, commercialization challenges, and therapeutic applications in biopharmaceuticals	4	8

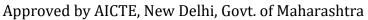
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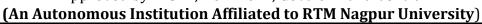
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Fourth Year B.Tech Biotechnology (Seventh Semester)							
	BBT4709: Bioprocess Equipment Design Lab						
Teacl	hing Scheme			Examination Sci	neme		
Lectures 2 Hr / Week		2 Hr / Week		ESE 25 Ma			
Tuto	rial	-		CIE	25 Marks		
Pract	Practical -			Total	50 Marks		
Practical Credit: 1 Duration of Exam: 2 H					m: 2 Hours		
Cour	se Objectives	<u>.</u>					
The C	Objectives of this	course is:					
1.	1. To create a clear and labeled diagram depicting the setup of a stirred-tank bioreactor.						
2.	2. To illustrate the assembly process of a chromatography column with detailed labeling for each component.						
3.	3. To design a schematic diagram of a heat exchanger that demonstrates effective temperature control mechanisms.						

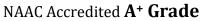
Sr. No.	Experiments
1	Draw a labeled diagram of a stirred-tank bioreactor.
2	Sketch the layout of a membrane filtration unit.
3	Illustrate the assembly of a chromatography column.
4	Design a schematic of a heat exchanger for temperature control.
5	Outline the setup of a centrifuge for cell harvesting.
6	Create a piping diagram for a bioprocess control system.
7	Draw a simple fermentation unit layout.
8	Diagram the internal components of a bioreactor vessel.
9	Sketch a basic cross-section of a filling machine.
10	Create a flowchart for a cell culture process.

Text Books	Text Books		
T.1	Bioprocess Engineering Principles (2nd Edition) by Pauline M. Doran		
T.2	Distillation Design (2nd Edition) by Henry Z. Kister		
Reference	Reference Books		
R.1	R.1 Perry's Chemical Engineers' Handbook (9th Edition)		
R.2	Bioreactors for Tissue Engineering by Julian Sun and Xiaohua Liu		





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Useful Links				
1	https://nptel.ac.in/courses/102106053			
2	https://nptel.ac.in/courses/102106022			

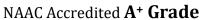
Course Outcomes			Hours
BBT4709.1	Apply design methods to determine the design variables in distillation for binary systems	3	4
BBT4709.2	Evaluate the design requirements for flanges, nozzles, gaskets, supports, piping, jackets, and coils in bioreactors.	4	4
BBT4709.3	Design agitators, aerators, air filters, and stabilizers for bioreactors.	6	4
BBT4709.4	Design the baffles and tube joining methods for shell and tube heat exchangers.	6	4
BBT4709.5	Evaluate the scale-up principles and apply them to design larger bioreactors.	5	4

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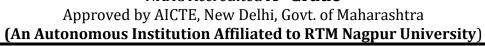
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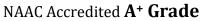
	Fourth Year B.Tech Biotechnology (Seventh Semester)						
		BBT4710: D	ata analysis and Simulation	s Lab			
Teacl	hing Scheme			Examination Sci	heme		
Lectu	ires	2 Hr / Week		ESE	25 Marks		
Tuto	rial	-		CIE	25 Marks		
Pract	Practical -			Total	50 Marks		
Pract	Practical Credit: 1 Duration of Exam: 2 Hours						
Cour	se Objectives						
The C	Objectives of this	course is:					
1.	1. To utilize MS-Excel for plotting graphs and calculating regression coefficients.						
2.	To apply various numerical methods (Jacobi Iterative, Newton-Raphson, Bisection, Regula Falsi, Secant) using MS-Excel/MATLAB for solving simultaneous equations.						
3.	To perform linear regression analysis, solve ordinary differential equations, and create pivot tables for data summarization using MS-Excel/MATLAB.						

Sr. No.	Experiments
1	Plot graph using MS-Excel.
2	Calculate regression coefficient of data using MS-Excel.
3	Perform Linear Regression Analysis
4	Find unknown of simultaneous equations using Jacobi Iterative method using MS-Excel/MATLAB.
5	Find unknown of simultaneous equations using Newton Raphson method using MS-Excel/MATLAB.
6	Find unknown of simultaneous equations using Bisection method using MS-Excel/MATLAB.
7	Find unknown of simultaneous equations using Regula Falsi method using MS-Excel/MATLAB.
8	Find unknown of simultaneous equations using Secant method using MS-Excel/MATLAB.
9	Find Initial Value ordinary differential equation using MS-Excel/MATLAB.
10	Draw Pivot Tables for Data Summarization

Text Books	Text Books		
T.1	T.1 Bioprocess Engineering Principles (2nd Edition) by Pauline M. Doran		
T.2	Distillation Design (2nd Edition) by Henry Z. Kister		
Reference	Reference Books		
R.1	R.1 Perry's Chemical Engineers' Handbook (9th Edition)		
R.2	Bioreactors for Tissue Engineering by Julian Sun and Xiaohua Liu		



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	Useful Links				
1	https://nptel.ac.in/courses/102105099				
2	https://nptel.ac.in/courses/110104125				

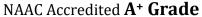
Course Outcomes			Hours
BBT4709.1	Plot graphs using MS-Excel for data visualization	3	4
BBT4709.2	Calculate regression coefficients of data using MS-Excel	4	4
BBT4709.3	Perform linear regression analysis using MS-Excel	4	4
BBT4709.4	Utilize Jacobi Iterative method in MS-Excel/MATLAB to find unknowns of simultaneous equations	4	4
BBT4709.5	Employ Newton Raphson method in MS-Excel/MATLAB to find unknowns of simultaneous equations	4	4

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Fourth Year B.Tech Biotechnology (Seventh Semester)						
BAU4707: Behavioral and Interpersonal Skills						
Teaching Scheme Examination Scheme						
Lectu	ires	2 Hr / Week		ESE/CIE -		-
Total	Credit: Audit	l		Duration of Exam: -		
Cour	se Objectives					
The C	Objectives of this	course is:				
1.	_	lents to understand an increased self-co	d their real self by recognizing onfidence.	g different aspects of th	eir self-	-concept
2.			ating effectively in both forma	l as well as in informal se	ettings.	
3.	To help the stude	ents to understand t	he importance of non-verbal a	spects of effective comm	nunicatio	on.
4.	_	ents to understand ive dealing with en	Emotion and emotional intellementary at work.	ligence, Managing ones'	own en	notional
5.		students in understated of a successful lead	anding the formation and func der.	tion of group and team a	ınd to he	elp them
6.	To help the stude	nts in understandin olved in goal settir	g and practicing the goal setting. The activities involved are			
	<u> </u>		Course Contents			Hours
Each individual has behavior patterns that are shaped by the context of his or her past. Most often, adapting the behavior to the changing context of the reality a person lives in becomes difficult which may lead to the reduction in personal effectiveness and natural self-expression. The main focus of this course is to equip the students with useful approaches to help in the deeper understanding of self and help individuals empower themselves to be the source of their own growth and development. Thecourse will help students to learn effective communication skills, Group and team building skills and will help them learn the goal setting process and thus become more effective in achieving their goals. The broader objective of this course is to make the students aware about the different facets of self				(08)		

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