

**KLEF**  
**DEPARTMENT OF BIOTECHNOLOGY**  
**MINUTES OF BOS (2015-16)**

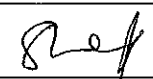
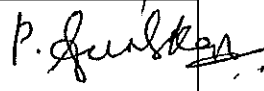
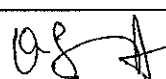

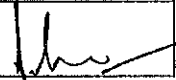
**Particulars of Meeting conducted:**

<b>Type of Meeting</b>	BOS
<b>Department conducting the Meeting</b>	Biotechnology
<b>Number of the Meeting</b>	14
<b>Date of Meeting</b>	09/06/2015
<b>Time of Meeting</b>	1:30 PM
<b>Venue of Meeting</b>	Faculty Conference Hall, Biotechnology

**Agenda items to be discussed:**

<b>Agenda Item number</b>	<b>Agenda Item Description</b>	<b>Resolution</b>
BT-BOS-15001	To design Y15 batch B-Tech and M-Tech syllabus based on industrial requirements	The BOS unanimously resolved to recommend the Y15 batch B-Tech and M-Tech syllabus according to the industrial requirements. (Annexure-1 and 2)
BT-BOS-15002	To recommend Biochemical Thermodynamics and Biomedical signals and systems instead of Thermodynamics and signal processing for Y14 Batch B-Tech	The BOS resolved to recommend the Biochemical Thermodynamics and Biomedical signals and systems instead of Thermodynamics and signal processing for Y14 Batch B-Tech(Annexure-3 and 4)

**Members Present:**

<b>S.No</b>	<b>Name of the person</b>	<b>Institution</b>	<b>Department</b>	<b>Designation</b>	<b>Position of the person in the meeting</b>	<b>Signature</b>
1	Dr K Srinivasulu	KLEF	Biotechnology	Associate Professor	Chairman	
2	Dr P Sudhakar	A N University, Guntur	Biotechnology	Associate Professor	External Member	
3	Dr BJK Singh	KLEF	Biotechnology	Associate Professor	Internal Member	
4	V Praveen Kumar	KLEF	Biotechnology	Assistant Professor	Internal Member	
5	Dr R Srinivasa Reddy	KLEF	Biotechnology	Associate Professor	Internal Member	

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**Based on the feedback received by DAC, the following recommendations were approved in the BOS.**

1. Syllabus design for Y15 batch B-Tech and M-Tech based on industrial requirements was approved in the BOS.
2. The following courses were approved instead of Thermodynamics and signal processing for Y14 Batch B-Tech
  - a) Biochemical Thermodynamics and
  - b) Biomedical signals and systems



**HOD-BT**

**Dr K Srinivasulu**

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**K L UNIVERSITY**  
**DEPARTMENT OF BIOTECHNOLOGY**  
**MINUTES OF DEPARTMENT ACADEMIC COMMITTEE MEETING(2015-16)**

The Department Academic Committee meeting was conducted in HOD, Biotechnology, seminar hall on 14 Apr 2015 at 2:00 pm.

**Agenda:**

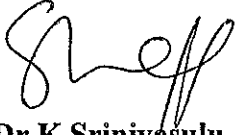
1. To discuss the feedbacks received from stake holders on curriculum
2. To propose the curriculum for B.TechY14 and Y15 batch/B-Tech and M-Tech
3. Any other points with the permission of the DAC chairman

The following members were present:

- |                        |                        |
|------------------------|------------------------|
| 1. Dr.K Srinivasulu    | Head of the Department |
| 2. Dr.BJK Singh        | Professor              |
| 3. Dr. V Praveen Kumar | Associate Professor    |
| 4. Dr.B Mahendran      | Associate Professor    |
| 5. Dr. M Sudhamani     | Associate Professor    |
| 6. Dr. V Badramurthi   | Assitant Professor     |

The following points were discussed and resolved:

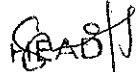
1. Upon discussing the feedback from students , the DAC discussed and resolved to recommend the BOS to consider syllabus design for Y15 batch B-Tech and M-Tech based on industrial requirements. (Annexure 1 and 2 )
  - a. Addition of courses such as Biochemical Thermodynamics and Biomedical signals and systems instead of Thermodynamics and signal processing for Y14 Batch B-Tech. (Annexure 3 and 4)
2. Upon considering above mentioned feedbacks and surveying through the policy documents in relevance to, Human Resource Development Policy, Govt. of India, National Skill Development Corporation, Govt. of India, ABET, NBA norms, AICTE statutory norms , it is resolved to propose enclosed Program development documents and curriculum for B-Tech and M-Tech-Biotechnology Program (y15 batch) for BOS approval (Annexure 1 and 2).

  
**Dr.K Srinivasulu**  
(Head of the Department)  
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K L UNIVERSITY  
COURSE STRUCTURE 2015-16  
DEPARTMENT OF BIO-TECHNOLOGY

Annexure:1

..NO.	COURSE CODE	COURSE NAME	L-T-P	CREDITS	PRE-REQ.	OFFERED TO
		<b>HUMANITIES &amp; SOCIAL SCIENCES</b>				
	15 EN 1101	Rudiments of Communication Skills	0-0-4	2	NIL	BT
	15 EN 1202	Interpersonal Communication Skills	0-0-4	2	NIL	BT
	15 EN 2103	Professional Communication Skills	0-0-4	2	NIL	BT
	15 EN 2204	Employability Skills	0-0-4	2	NIL	BT
	15 EN 3105	Verbal and Quantitative Reasoning	0-0-4	2	NIL	BT
	15 EN 3206	Corporate Communication Skills	0-0-4	2	NIL	BT
	15 GN 1001	Ecology and Environment	2-0-0	2	NIL	BT
	15 GN 1002	Human Values	2-0-0	2	NIL	BT
		<b>BASIC SCIENCES</b>				
	15 MT 1001	Single Variable Calculus and Matrix Algebra	2-2-2	4	NIL	BT
	15 ME 1001	Mechanics	2-2-2	4	NIL	BT
	15 PH 1001	Engineering Materials	2-2-2	4	NIL	BT
	15 CY 1001	Engineering Chemistry	2-2-2	4	NIL	BT
	15 BT 1001	Biology for Engineers	2-0-0	2	NIL	BT
	15 MT 2106	Probability & Statistics	3-0-0	3	NIL	BT
	15 MT 1102	Basic Mathematics	2-2-2	4	NIL	BT
II		<b>ENGINEERING SCIENCES</b>				
	15 GN 1004	Introduction to Engineering	2-0-2	3	NIL	BT
	15 CS 1001	C Programming & Data Structures	2-4-2	5	NIL	BT
	15 ME 1002	Engineering Graphics	0-0-6	3	NIL	BT
	15 GN 1003	Measurements	0-0-4	2	NIL	BT
	15 CS 2002	Object Oriented Programming	2-2-2	4	NIL	BT
	15 ME 1003	Biochemical Thermodynamics	2-2-2	4	NIL	BT
	15 BT 2104	Fluid Mechanics and Heat Transfer	3-1-0	4	NIL	BT
	15 BT 1102	Process Engineering Principles	3-1-0	4	NIL	BT

  
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PROFESSIONAL CORE COURSES					OFFERED TO
15 BT 1203	Cell Biology	3-1-0	4	NIL	BT
15 BT 2105	Microbiology	3-0-1	4	NIL	BT
15 BT 2106	Biochemistry	3-0-1	4	NIL	BT
15 BT 2207	Bioanalytical techniques	3-0-1	4	NIL	BT
15 BT 2208	Molecular Biology	3-0-1	4	NIL	BT
15 BT 2209	Biochemical Thermodynamics	3-0-1	4	NIL	BT
15 BT 3110	Immunology	3-0-1	4	NIL	BT
15 BT 3111	Genetic Engineering	3-0-1	4	NIL	BT
15 BT 3112	Bioinformatics	3-0-1	4	NIL	BT
15 BT 3113	Fermentation Technology	3-0-1	4	NIL	BT
15 BT 3114	Mass Transfer Operations	3-0-1	4	NIL	BT
15 BT 3215	Biochemical Reaction Engg.	3-0-1	4	NIL	BT
15 BT 3216	Plant and Animal Biotechnology	3-0-1	4	NIL	BT
15 BT 3217	Down Stream Processing	3-0-1	4	NIL	BT

#### OF PROFESSIONAL ELECTIVES

BIOTECHNICAL ENGINEERING					
15 BT 3251	Molecular Genetics & DNA forensics	3-0-0	3	15 BT 2208	BT
15 BT 4155	Transgenic Technology	3-0-0	3	15 BT 2208	BT
15 BT 4156	Genomics & Proteomics	3-0-0	3	15 BT 2208	BT
15 BT 4157	Molecular Expression Technology	3-0-0	3	15 BT 2208	BT
15 BT 4158	Biosafety & Bioethics	3-0-0	3	15 BT 2208	BT

#### INDUSTRIAL & FOOD BIOTECHNOLOGY

15 BT 3252	Food Biotechnology	3-0-0	3	15 BT 2105	BT
15 BT 4159	Microbial Biotechnology	3-0-0	3	15 BT 2105	BT
15 BT 4160	Metabolic Engineering	3-0-0	3	15 BT 2105	BT
15 BT 4161	IPR & Patent Laws	3-0-0	3	15 BT 2105	BT
15 BT 4162	Pharmaceutical Biotechnology	3-0-0	3	15 BT 2105	BT

#### BIOTECHNICAL INFORMATICS

15 BT 3253	Molecular Modelling and Drug Design	3-0-0	3	15 BT 3111	BT
15 BT 4163	Bioperl & Perl Programming	3-0-0	3	15 BT 3111	BT
15 BT 4164	Biomedical Informatics	3-0-0	3	15 BT 3111	BT
15 BT 4165	Systems Biology	3-0-0	3	15 BT 3111	BT

#### MEDICAL BIOTECHNOLOGY

1	15 BT 3254	Cancer Biology	3-0-0	3	15 BT 1203	BT
2	15 BT 4167	Stem Cell Technology	3-0-0	3	15 BT 1203	BT
3	15 BT 4168	Nano Biotechnology	3-0-0	3	15 BT 1203	BT
4	15 BT 4169	Tissue Engineering	3-0-0	3	15 BT 1203	BT
5	15 BT 4170	Neuro Biology	3-0-0	3	15 BT 1203	BT

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### LIST OF OPEN ELECTIVES

1	15 BT 30A1	IPR & Patent Laws	3-0-0	3	NIL	BT
2	15 CE 30A2	Environmental Pollution Control Methods	3-0-0	3	NIL	CE
3	15 CE 30A3	Solid and Hazardous waste management	3-0-0	3	NIL	CE
4	15 CE 30A4	Remote Sensing & GIS	3-0-0	3	NIL	CE
5	15 CE 30A5	Disaster Management	3-0-0	3	NIL	CE
6	15 CS 30A6	Fundamentals of DBMS	3-0-0	3	NIL	CS
7	15 CS 30A7	Self Development	3-0-0	3	NIL	CS
8	15 CS 30A8	Fundamentals of Information Technology	3-0-0	3	NIL	CS
9	15 CS 30A9	Indian Culture and History	3-0-0	3	NIL	CS
10	15 EC 30B1	Image Processing	3-0-0	3	NIL	EC
11	15 EM 30B2	Linux Programming	3-0-0	3	NIL	EM
12	15 EM 30B3	E-Commerce	3-0-0	3	NIL	EM
13	15 EE 30B4	Renewable Energy Sources	3-0-0	3	NIL	EE
14	15 ME 30B5	Robotics	3-0-0	3	NIL	ME
15	15 ME 30B6	Mechatronics	3-0-0	3	NIL	ME
16	15 ME 30B7	Operations Research	3-0-0	3	NIL	ME
17	15 PH 30B8	Nano Materials & Technology	3-0-0	3	NIL	PH
18	15 PE 30B9	Subsea Engineering	3-0-0	3	NIL	PE
19	15 PE 30C1	Oil and Gas Management	3-0-0	3	NIL	PE

### LIST OF MANAGEMENT ELECTIVES

1	15 MB 3051	Emotional Intelligence	3-0-0	3	NIL
2	15 MB 3052	Paradigms in Management thought	3-0-0	3	NIL
3	15 MB 3053	Indian Economy	3-0-0	3	NIL
4	15 MB 3054	Professional Ethics & Values	3-0-0	3	NIL
5	15 MB 3055	Behavioral Sciences	3-0-0	3	NIL
6	15 MB 3056	Managing Personal Finances	3-0-0	3	NIL
7	15 MB 3057	Basics of Marketing for Engineers	3-0-0	3	NIL
8	15 MB 3058	Self Management	3-0-0	3	NIL
9	15 MB 3059	Organization Management	3-0-0	3	NIL
10	15 MB 3060	Resources Safety and Quality Management	3-0-0	3	NIL

  
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**LIST OF FOREIGN LANGUAGES**

1	15 GN 3051	Arabic	3-0-0	3	NIL
2	15 GN 3052	Bengali	3-0-0	3	NIL
3	15 GN 3053	Chinese	3-0-0	3	NIL
4	15 GN 3054	French	3-0-0	3	NIL
5	15 GN 3055	German	3-0-0	3	NIL
6	15 GN 3056	Hindi	3-0-0	3	NIL
7	15 GN 3057	Italian	3-0-0	3	NIL
8	15 GN 3058	Japanese	3-0-0	3	NIL
9	15 GN 3059	Kannada	3-0-0	3	NIL
10	15 GN 3060	Russian	3-0-0	3	NIL
11	15 GN 3061	Simhali	3-0-0	3	NIL
12	15 GN 3062	Spanish	3-0-0	3	NIL
13	15 GN 3063	Tamil	3-0-0	3	NIL
14	15 GN 3064	Urdu	3-0-0	3	NIL

**TERM PAPER & PROJECT**

1	15 IE 3250	Term Paper	0-0-4	2	
2	15 IE 4048	Practice School	0-0-16	8	
3	15 IE 4049	Minor Project	0-0-4	2	
4	15 IE 4050	Major Project	0-0-16	8	

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**M. TECH - BIOTECHNOLOGY****First Year (First Semester):**

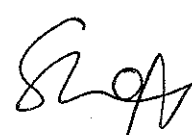
S.No	Course code	Course Title	Periods			Credits
			L	T	P	
1	15 BT 5101	Mathematics and Biostatistics	3	2	0	4
2	15 BT 5102	Biochemical Engineering	3	0	2	4
3	15 BT 5103	Molecular Biology and r-DNA Technology	3	0	2	4
4	15 BT 5104	Applied Bioinformatics	3	0	2	4
5		Elective 1	3	0	0	3
6		Elective 2	3	0	0	3
7	15 IE 5148	Seminar/Term Paper	0	0	4	2
		<b>Total Credits</b>				<b>24</b>

**First Year (Second Semester) :**

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
1	15 BT 5205	Plant and Animal Biotechnology	3	0	2	4
2	15 BT 5206	Immuno technology	3	0	2	4
3	15 BT 5207	Bioreactor modeling and Simulation	3	2	0	4
4	15 BT 5208	Downstream Processing	3	0	2	4
5		Elective 3	3	0	0	3
6		Elective 4	3	0	0	3
7	15 IE 5250	Term Paper	0	0	4	2
		<b>Total Credits</b>				<b>24</b>

**Second Year (First & Second Semester) :**

S.No	Corse Code	Course Title	Periods			Credits
			L	T	P	
1	15 IE 6050	Dissertation	0	0	72	36

  
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## ELECTIVE COURSES

S.No	Course code	Course Title	Periods			Credits
			L	T	P	
<b>Elective-1</b>						
1	15 BT 51A1	Protein Engineering	3	0	0	3
2	15 BT 51A2	Enzyme Technology	3	0	0	3
3	15 BT 51A3	Medical Biotechnology	3	0	0	3
4	15 BT 51A4	Stem cell technology	3	0	0	3
5	15 BT 51A5	Molecular Modeling and Drug Design	3	0	0	3
<b>Elective-2</b>						
6	15 BT 51B1	Food Technology	3	0	0	3
7	15 BT 51B2	Transport phenomenon in bioprocess	3	0	0	3
8	15 BT 51B3	Bio mining	3	0	0	3
9	15 BT 51B4	Bioprocess validation and cGMP	3	0	0	3
<b>Elective-3</b>						
10	15 BT 52C1	Perl programming and Bioperl	3	0	0	3
11	15 BT 52C2	Bioprocess Technology	3	0	0	3
12	15 BT 52C3	Environmental Biotechnology	3	0	0	3
13	15 BT 52C4	Nano Technology	3	0	0	3
14	15 BT 52C5	IPR and Patent Laws	3	0	0	3
<b>Elective-4</b>						
15	15 BT 52D1	Regulatory affairs & Clinical trials	3	0	0	3
16	15 BT 52D2	Bioprocess economics and plant design	3	0	0	3
17	15 BT 52D3	Genomics and Proteomics	3	0	0	3
18	15 BT 52D4	Bio catalysis and enzyme	3	0	0	3

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BIOCHEMICAL THERMODYNAMICS

L-T-P : 3-2-0

Credits : 4

**Syllabus :**

**Basic concepts** -Systems and Processes, Homogeneous and Heterogeneous systems, Closed and Open systems, intensive and extensive properties state & path functions, equilibrium state and phase rule, zeroth law of thermodynamics, heat reservoirs & heat engines reversible & irreversible process, internal energy enthalpy first law of thermodynamics and its limitations, P.V.T. Behavior of pure fluids, equation of state, Joule Thomson coefficient. Processes involving ideal gasses: constant Volume process, adiabatic process, polytropic process. Equation of state for real gases: Van der equation, redlich-kwong equation, redlick kwong-soave equation, virial equation.**Second law of thermodynamics** -General statement of II Law of thermodynamics, entropy & Heat, entropy & Temperature, the carnot principle, calculation of entropy changes, process involving ideal gases, adiabatic mixing process, Applications of the law of thermodynamics: Flow processes continuity equation, energy equation, Bernoulli's equation, steam ejector, joule-Thomson expansion, refrigeration, coefficient of performance, carnot cycle and limitations, liquefaction process, Linde process for gas liquefaction. **Thermodynamic properties of fluids** -Classification, work function, Gibbs free energy, fundamental property relations, maxevells equations classics-clapeyson equation, entropy-heat capacity relationships, Fugacity, standard state of Fugacity, fugacity coefficient, effect of temperature & pressure on fugacity, Activity, effect of temp and pressure on activity. Properties of solutions: Partial molar properties and properties of solution, chemical potential, effect of temp & pressure on chemical potential fugacity in solutions, Lewis randall rule, Henry's law and dilute solutions, activity in solutions, activity coefficient, effect of pressure and temperature on activity coefficient. **Phase equilibria**-Criteria of phase equilibrium, phase equilibria in single and multi component systems, phase rule for non reacting systems, VLE, phase diagram for binary solutions, equilibrium diagrams, constant temperature equilibrium, Non-ideal solutions: Azeotrope, minimum & maximum B.P.azeotropes;Liquid-liquid equilibrium diagrams-binary liquid-liquid equilibria, Chemical reactions equilibria: Reaction stoichiometry, reaction coordination, criteria of chemical reaction equilibrium, equilibrium constant, equilibrium constant and standard free energy change, effect of temperature on equilibrium constant, **Biochemical thermodynamics**-Stoichiometry and energetic analysis of Cell Growth and Product Formation. Elemental balances, degrees of reduction of substrate and biomass, available electron balances, yield Coefficients of biomass and Product formation, Maximum possible yield. Thermodynamics of microbial growth.

  
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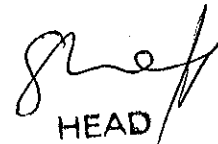
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**Text books:**

1. K.V.Narayanan," A text book of chemical engineering thermodynamics",edition, Phi learning (2009)
- 2.J.M.Smith, H.C.Vanness&Abbott, " Introduction to chemical engineering thermodynamics",edition, Mcgraw Hill Higher Education (2001-05-01)

**Reference books:**

1. Vern Schramm,"Methods In Enzymology, Volume 308 - Enzyme Kinetics And Mechanisms, Part E, Energetics Of Enzyme Catalysis, (Hardcover) ", Publisher: Elsevier (1999) .



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## THERMODYNAMICS

Code: 13ES201

L - T - P: 3-0-0

Prerequisite: Nil

Credits: 3

**Fundamental Concepts and Definitions:** Thermodynamic system and control volume, Macroscopic and Microscopic points of view. Thermodynamic properties, processes, state, path, cycle. Thermodynamic equilibrium and Quasi-static process. Reversible and Irreversible processes, Zeroth law, concept of temperature.

**Work and Heat:** Definition of work, units, work done at the moving boundary of system, work done in various non-flow processes, definition of heat, units, comparison of heat and work. **First Law for Non-Flow Systems:** First law of thermodynamics for a closed system undergoing a cycle and for a change of state, energy-a property of system, internal energy and enthalpy. Specific heat at constant volume and constant pressure. PMM1 and Converse of PMM1. **First Law for Flow Systems:** Control mass and control volume, First law of thermodynamics for a control volume, Steady flow energy equation and applications to engineering equipment.

**Second Law of Thermodynamics:** Thermal reservoirs, Kelvin-Plank and Clausius statements of second law of thermodynamics, Equivalence of Kelvin-Plank and Clausius statements, Carnot cycle, Reversed heat engine, Carnot's theorem, Corollary of Carnot's theorem, Absolute thermodynamic temperature scale, problems.

**Entropy:** Definition of entropy, Clausius theorem, entropy change in reversible process Temperature-entropy plot, Inequality of Clausius, entropy change in an irreversible process, principle of increase of entropy, Applications of entropy principle, entropy change of an ideal gas, Availability and Irreversibility.

**Thermodynamic Relations:** Maxwell's equations, TdS equations, Difference in heat capacities, Ratio of heat capacities, energy equation, Clausius - Clapeyron equation

**Air standard cycles:** Otto, Diesel, Dual and Brayton cycles- Performance evaluation and mean effective pressure, Reversed Carnot cycle and Bell Coleman cycle.

## TEXT BOOKS

1. Thermodynamics, An Engineering Approach - Younus A Cengel & Michael Boles, (6E) Tata McGraw Hill, New Delhi.
2. Engineering Thermodynamics - P.K.Nag, (4E) Tata McGraw Hill, New Delhi.

## REFERENCE BOOKS

1. Fundamentals of Thermodynamics - G.J. Van Wylen., Sonntag (6E), Wiley India publications.
2. Engineering Thermodynamics Coheand Rogers (5 E)-Pearson education India limited.
3. Heat and Thermodynamics - Zemansky, Mc Graw Hill (5E).



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Annexure:4

## SIGNAL PROCESSING

Code:13ES205

L - T - P: 3-0-2

Prerequisite: Nil

Credits: 4

**Introduction to Discrete Time (DT) Sequences and Systems:** Introduction to Signal processing: Elements of Continuous Time and Digital Signal Processing systems. Advantages of DSP systems over Analog processing systems. **Sampling and Reconstruction:** Graphical and analytical proof of sampling theorem. Reconstruction of signal from its samples. Flat Top Sampling, Effect of under sampling-Aliasing. Sampling of Band-pass Signals. **DT Sequences:** Representation of DT sequences, some elementary DT sequences, Classification of discrete time sequences and Elementary manipulation of DT sequences. **DT Systems:** Input-output Description of Systems, Classification of DT systems: Linearity, Static, Time-Invariant, Causality and Stability of systems. Interconnection of DT system. **Analysis of LTI Systems: Analysis of Discrete-Time Linear Time-Invariant (LTI) Systems:** Response of LTI systems to arbitrary inputs: The Convolution Sum. Properties of Convolution, Causality and Stability of LTI systems in terms of impulse response. **Frequency domain representation of discrete time signals and systems:** Discrete Time Fourier Transform (DTFT) and its Properties. **Review of Z-transforms,** System Function, Impulse Response, Causality and Stability of LTI systems in terms of System Function. **Applications of Z-Transforms:** Solutions of Linear Constant Coefficient Difference Equations. **Power and Energy Density Spectrum Relations of LTI systems (both in continuous and discrete) Fourier Transformation of Discrete Time Sequences: Discrete Fourier Series (DFS):** Introduction to DFS, DFS representation of periodic sequences. Properties of discrete Fourier Series. **Discrete Fourier Transforms (DFT):** Introduction to DFT, Properties of DFT, Circular convolution Linear convolution using DFT, Computation of DFT. Relation between Z-Transform and DFS. **Fast Fourier Transforms (FFT):** Introduction to FFT - Radix-2 Decimation in Time (DIT) and Decimation in Frequency (DIF) FFT Algorithms, Inverse FFT using direct FFT. **Design and Realization of Digital IIR Filters: Digital Filter-IIR Design:** Introduction, properties of IIR filters, Normalized Butterworth and Chebyshev Functions. Design of Digital filters using Bilinear Transformation, Impulse invariance and Step Invariance Transformation Methods, Frequency Transformation in Analog and Digital

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Domains. **Realization of IIR system structures:** Basic Elements of Digital Systems, Realization of Direct form structures, Cascade form Structures and Parallel form structures. **Design and Realization of Digital FIR Filters: Digital Filter-FIR Design:** Introduction, Characteristics of Linear Phase FIR filters, frequency Response, Designing FIR filters using Windowing Methods. Frequency Sampling Method, Comparison of IIR & FIR Filters. **Realization of FIR system structures:** Realization of Direct Form, Transposed Direct Form, Direct form for Linear-Phase FIR systems and Cascade Form structures.

#### **TEXT BOOKS**

1. John G Proakis, Dimtris G Manolakis, "Digital Signal Processing: Principles, Algorithms and Applications", Pearson Education.
2. Ludeman " Fundamentals of Digital Signal Processing", Wiley India Pvt. Ltd.

#### **REFERENCE TEXT BOOKS**

1. Alan V Oppenherim, Ronald W Schafer, John R Back, Discrete Time Signal Processing, Pearson Education, 2<sup>nd</sup> Edition.
2. Emmanuel C Ifechor, Digital Signal Processing, Pearson Education, 2<sup>nd</sup> Edition.
3. Andreas Antonious, " Digital Signal Processing , Signals, Systems and Filters " Mc-Graw Hill,
4. Dimitris G. Manolakis, Vinay K. Ingle, "Applied Digital Signal Processing : Theory and practice", Cambridge University Press
5. Kumar, A. Anand, "Digital Signal Processing", PHI.

  
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**SYLLABUS (As approved by BoS):**

**Signals and systems:** Continuous time (CT) signals, Discrete time (DT) signals, periodic, periodic, random, energy and power signals, step, ramp, impulse and exponential function, Transformation in independent variable of signals: time scaling, time shifting and time inverting, classification and properties of systems, LTI systems - convolution and stability, physiological signals and their properties, Time invariant and time varying physiological systems. **Signal analysis:** Basic concepts and development of the Fourier Series, Determination of the Fourier series representation of Continuous and Discrete time periodic signal, Properties of continuous and discrete time Fourier series, Continuous Time Fourier Transform (CTFT) and Discrete Time Fourier Transform (DTFT), ECG signal analysis. **Sampling Theorem and Z-Transforms:** Representation of continuous time signals by its sample, Sampling theorem, Reconstruction of a Signal from its samples, aliasing, Basic principles of z-transform, z-transform definition, Properties of z-transform, Poles and Zeros, inverse z-transform. **Noise and Feed Back System::** Sources and types of noise, noise factor and temperature, equivalent noise resistance and noise factor in cascade amplifier, Basic Feedback concept, Positive and Negative Feedback, Sensitivity analysis, Effect of Feedback on disturbance or Noise, Distortion analysis by Feed Back, Control system, Open loop Control System, Control system With Feed Back, Application of feed back in physiological systems and its importance. **Physiological System:** Block diagram representation of cardio vascular system, Electrical circuit model of Blood Pressure, Electrical analog of blood vessels and its transfer function, model of coronary circulation ant its analysis, Germ, Plasma cell, Antibody, system equation and transfer function. Application of feedback and block diagram reduction techniques.

**BoS Approved Text books:**

1. Northrop, "Signals and Systems Analysis in Biomedical Engineering", John Wiley & Sons
2. Robert B. Northrop, "Signals and Systems Analysis In Biomedical Engineering" The biomedical engineering series
3. Joseph V. Tranquillo "Biomedical Signals and Systems (Synthesis Lectures on Biomedical Engineering)" Morgan and Claypool publishers.

**BoS Approved Reference Books:**

1. Rangaraj M. Rangayyan, "Biomedical Signal Analysis, A Case Study Approach", IEEE Press Series on Biomedical Engineering, John Wiley & Sons, INC.
2. Willis J. Tompkins, "Biomedical Digital signal processing", PHI publication.
3. K J Blinowska, J Zygierewicz, "Practical Biomedical signal analysis Using MATLAB", CRC press, 2012 by Taylor & Francis Group, LLC

**Other Books, References: (As recommended for reference by the course team, if any)**

1. Suresh R. Devasahayam "Signals and Systems in Biomedical Engineering" Springer Science & Business Media, 01-Jan-2000.
2. A. Anand Kumar, "Signals and systems", Second Edition, PHI Publishers.

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