Pimpri Chinchwad Education Trust's

PIMPRI CHINCHWAD COLLEGE OF ENGINEERING

SECTOR NO. 26, PRADHIKARAN, NIGDI, PUNE 411044

STRUCTURE FOR THIRD YEAR B. TECH SEM-III (E&TC ENGINEERING)

Course Code	Course Type	B.TECH Semester-V												
		Course Name	Teaching Scheme					Evaluation Scheme						
			L	P	T	Hours	Credits	CE	MTE	ETE	TW	PR	OR	Total
BET5414	PCC	Control System	2		1	3	3	20	30	50				100
BET5415	PCC	Digital communication	3			3	3	20	30	50				100
BET5416	PCC	Digital communication Lab		2		2	1				25	25		50
BET5417	PCC	Project Based Learning-V		2		2	1				50			50
BET55xx	PEC	Program Elective-I	2			2	2	20	30	50				100
BET55xx	PEC	Program Elective-I Lab		2		2	1				25	25		50
BET55xx	PEC	Program Elective-II	2			2	2	20	30	50				100
BET55xx	PEC	Program Elective-II Lab		2		2	1				25		25	50
BET56xx	OEC	Open Elective-II	3			3	3	20	30	50				100
	HSMC	HSMC-5	1			1	2	30		20				50
	MC-ES/PDT	MC-ES/PDT		2		2								0
BET59XX	PFC	PFC		2		2								0
	AC	AC		1		1								0
Total			**14**	**13**	**1**	**28**	**19**							**750**

List of Program Elective-I (Code:BET55xx)

Course Code	Course Name	
BET5501	Power Electronics	Choose any one
BET5502	Power Electronics Lab	
BET5503	Advanced Microcontroller	
BET5504	Advanced Microcontroller Lab	
BET5505	**Multidimensional Signal Simulation**	
BET5506	**Multidimensional Signal Simulation** Lab.	
BET5507	Information Theory and Coding	
BET5508	Information Theory and Coding Lab.	
BET5509	Object oriented programming	
BET5510	Object oriented programming Lab.	

List of Program Elective-II (Code:BET55xx)

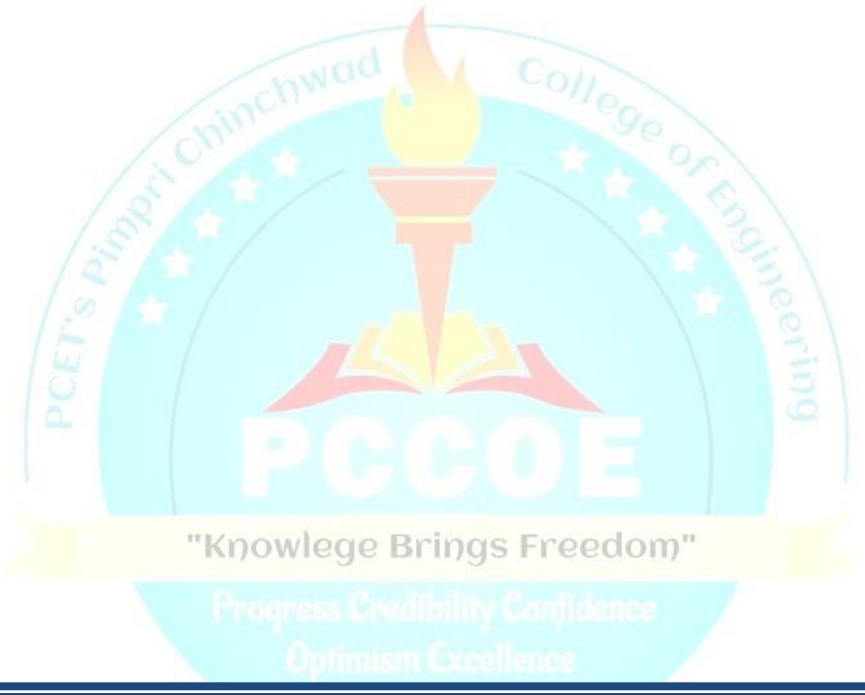
Course Code	Course Name	
BET5511	Robotronics and Automation	Choose any one
BET5512	Robotronics and Automation Lab.	
BET5513	Digital Design with Verilog HDL	
BET5514	Digital Design with Verilog HDL Lab.	
BET5515	Digital Image processing	
BET5516	Digital Image processing Lab.	
BET5517	Antenna & wave Propagation	
BET5518	Antenna & wave Propagation Lab.	
BET5519	Computational Tools for Data Analytics	
BET5520	Computational Tools for Data Analytics Lab.	

List of Open Elective-II (Code:BET56xx)

Course Code	Course Name	
BET5601	Smart City: An Electronic Perspectives	Choose any one
BET5602	Modeling and Simulation with MATLAB	

List of Proficiency Courses (BET59xx)

Course Code	Course Name	
BET5911	Basics of Lab View	Choose any one
BET5912	MATLAB Scripting	
BET5913	Embedded Product Design	
BET5914	Model based Development using MATLAB	
BET5915	PCB Design Skill	



Course Syllabus

T.Y. B.Tech. Semester-V

Program:	B. Tech. (E&TC)					Semester:	V
Course:	Control Systems					Code:	BET5414
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	IE	MTE	ETE	Total
2	-	1	3	20	30	50	100

Prior Knowledge of:

1. Integral Transforms and Partial Differential Equations. Applied Mathematics Is essential

Course Objectives:

1. To Introduce elements of control system and their modeling using various Techniques.
2. To get acquainted with the methods for analyzing the time response and Stability of System.
3. To Introduce and analyze the frequency response and Stability of System.
4. To Introduce concept of root locus, Bode plots, Nyquist plots.

Course Outcomes:

At the end of Course the students will be able to:

1. CO1: Determine and use models of physical systems in forms suitable for use in the analysis and design of control systems.
2. CO2: Determine the absolute stability of a closed-loop control system.
3. CO3: Perform time domain analysis of control systems required for stability analysis.
4. CO4: Perform frequency domain analysis of control systems required for stability analysis.

Detailed Syllabus:

Unit	Description	Duration
1.	**Introduction to Control Systems & its modeling**: Basic Elements of Control System, Open loop and Closed loop systems, Differential equations and Transfer function. Modeling of Electric systems, Translational and rotational mechanical systems. Block diagram reduction Techniques. Signal flow graph	**6**
2.	**Time domain analysis:** Time domain analysis: transient response and steady state response, standard test inputs for time domain analysis, order and type of a system.	**5**

	Transient analysis of first and second order systems. Time domain specifications of second order under damped system from its step response. Steady state error and static error constants	
3.	**Stability analysis:** Characteristic equation of a system, concept of pole and zero, response of various pole locations in s-plane, concept of stability absolute stability, relative stability, stability of system from pole locations. Routh Hurwitz stability criterion. Root locus: definition, magnitude and angle conditions, construction of root locus, concept of dominant poles, effect of addition of pole and zero on root locus. Application of root locus for stability analysis.	**6**
4.	**Frequency domain analysis:** Frequency response and frequency domain specifications. Correlation between time domain and frequency domain specifications. Polar plot. Nyquist stability criterion and construction of Nyquist plot. Bode plot, determination of frequency domain specifications and stability analysis using Nyquist plot and Bode plot. Introduction to state space representation. Advantages.	**7**
	Total	24

Text Books:

1. N. J. Nagrath and M. Gopal, "Control System Engineering", New Age International Publishers, 5 th Edition, 2014
2. K. Ogata, "Modern Control Engineering", Prentice Hall India Learning Private Limited; 5th Edition, 2014

Reference Books:

1. Benjamin C. Kuo, "Automatic control systems", Prentice Hall of India, 8th Edition,2007.
2. M. Gopal, "Control System – Principles and Design", Tata McGraw Hill, 4th Edition, 2008.
3. Schaum's Outline Series, "Feedback and Control Systems" Tata McGraw-Hill,2000

MOOC / NPTEL Courses:

1. NPTEL Course "Control System"

https://nptel.ac.in/courses/107/106/107106081/

2. NPTEL Course “Control System Design”

https://nptel.ac.in/courses/115/108/115108104/

List of Tutorials:

1. Numericals on Block diagram reduction technique.
2. Numericals on Signal Flow Graphs.
3. Computation of transfer function of Electric Circuits, Mechanical Circuits Force-Voltage and Force Current analogy
4. Time domain specifications of the given system.
5. Steady state error and error coefficients of the type 0, 1 and 2 systems for step, ramp and parabolic inputs.
6. Stability analysis using Routh Hurwitz Criterion.
7. Computation of root locus for given G(s)H(s).
8. Frequency domain specifications of the system.
9. Computation of frequency response analysis using Bode Plot for given G(s) H(s).
10. Frequency response analysis using Nyquist Plot

-Program:B. Tech. (E&TC)					Semester: V		
Course: Digital Communication					Code: BET5415		
Teaching Scheme				Evaluation Scheme			
Lecture	Tutorial	Credit	Hours	IE	MTE	ETE	Total
03	--	03	03	20	30	50	100

Prior knowledge of

Signals and Systems, Modulation Techniques are essential

Objectives:

1. To introduce students various techniques of digital transmission, reception and data formats.
2. To introduce the students with the concept of Passband modulation and demodulation techniques.
3. To Familiarize the students with the concepts of spread spectrum and multiuser communication techniques

Outcomes:

After learning the course, the students should be able to:

CO1. Apply the knowledge of waveform coding techniques and compare their performance.

CO2. Analyze the working of baseband digital transmission

CO3. Analyze the performance of baseband receiver systems in presence of noise.

CO4. Emphasize on performance of pass band digital communication systems in terms of bandwidth & bit error probability.

CO5. Examine the performance of the digital communication system with Multiuser radio communication system.

CO6. Examine the digital communication system with spread spectrum communication system.

Detailed Syllabus:

Unit	Description	Duration
1	**Digital Transmission:-**Introduction to Digital Communication System, PCM Generation and Reconstruction, Quantization Noise,Non-uniform Quantization and Companding, PCM with noise: Decoding noise, Error threshold, Delta Modulation, Adaptive Delta Modulation, Delta Sigma Modulation, Differential Pulse Code Modulation. Line Codes and their power spectra.	**07**
2	**Multiplexing & Synchronization Techniques:-** Digital Multiplexing: Multiplexers and hierarchies, Data Multiplexers, synchronization: BitSynchronization, Scramblers, Frame Synchronization.Inter-symbol interference,Equalization .	**05**
3	**Baseband Detection Techniques:-** Detection Theory: MAP, LRT, Minimum Error Test, Signal space representation : Geometric representation of signal, Likelihood functions, Optimum Filter, Matched Filter, Probability of Error of Matched Filter, Correlation receiver.	**06**

4	**Digital Passband Modulation Techniques:-** Pass band transmission model, Generation and Detection of Coherent system (BASK, BFSK, BPSK, QPSK, MSK) and their error probability ,Generation and detection of - M-ary PSK, M-ary QAM and their error probability.	**07**
5	**Multiuser radio communication:-** Multi access techniques: TDMA & CDMA wireless communication systems, Multicarrier communications: OFDM – modulation and demodulation, spectral characteristics, bit and power allocation.	**05**
6	**Spread Spectrum Communications:-** Introduction, Pseudo noise sequences, A notion of spread spectrum, Direct sequence spread spectrum with coherent BPSK, Signal space dimensionality & processing gain, Probability of error, Concept of jamming, Frequency hop spread spectrum and its types.	**06**
	Total Hrs.	**36**

Text Books:

1. Simon Haykin, "Digital Communication Systems", 'Wiley, an Indian adaption Edition.2021

2.B.P. Lathi, Zhi Ding , "Modern Analog and Digital Communication System", Oxford University Press, 4th Edition,2018

Reference Books:

1.Bernard Sklar, Fred Harris, "Digital Communications Fundamentals and Applications", Pearson Education, 3rd Edition,2021.

2. J. G. Proakis and M. Salehi, Digital Communications, McGraw-Hill, 5th edition, 2014

3. A.B Carlson and P.B. Crilly, "Introduction to Digital Communication", McGraw-Hill, 5th edition, 2015

NPTEL Course on "Digital Communications"

Link of the Course: https://nptel.ac.in/courses/108/102/108102096/

Program: B. Tech. (E&Tc)					Semester :V		
Course : Digital Communication Lab					Code : BET5416		
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	TW	OR	PR	Total
	02		1	25	--	25	50

Prior knowledge of:

Signals and Systems, Modulation Techniques are essential

Objectives:

1. To Familiarize the students with key modules of digital communication systems with an emphasis on digital modulation techniques.
2. To introduce students the performance of Spread spectrum techniques and use of software tools.

Outcomes:

At the end of Laboratory work, the students will be able to:

1. Apply the knowledge of fundamental communication systems to interpret the parameters, such as bandwidth and data rate, etc.
2. Describe and demonstrate the performance of passband communication systems.
3. Analyze digital modulation techniques by using software tools.

General Guidelines: Any Eight Experiments is to be performed.
GROUP-A any 6 and GROUP-B any 2

Detailed Syllabus:

Expt. No.	List of Experiments
	GROUP-A
1	Experimental study of PCM and companded PCM using 'A' law and 'μ'law
2	DM system Generation & detection: Calculation of bit rate and Bandwidth.
3	ADM system Generation & detection: Calculation of bit rate and Bandwidth.
4	Experimental study of line codes and their Spectral analysis.
5	BPSK Generation & detection: calculation of BW, observation of constellation diagram and coherent detection.
6	BFSK Generation & detection: calculation of BW, observation of constellation diagram and coherent detection.
7	QPSK Generation & detection: calculation of BW, observation of constellation diagram and coherent detection.
8	DS-SS with BPSK Generation & detection :Generation of PN sequence using N-bit, calculation of processing gain and coherent detection.
	GROUP-B
1	Implementation of PCM system using software tools
2	Implementation of BPSK system using software tools
3	Simulation study of constellation diagram of QPSK modulated signal.
4	Implementation of OFDM signal generation using software tools

Reference Books:

1.Bernard Sklar, Fred Harris, "Digital Communications Fundamentals and Applications", Pearson Education, 3rd Edition,2021.

2. J. G. Proakis and M. Salehi, Digital Communications, McGraw-Hill, 5th edition, 2014

3. A.B Carlson and P.B. Crilly, "Introduction to Digital Communication", McGraw-Hill, 5th edition, 2015

Virtual LAB Links:

1. Link: https://www.etti.unibw.de/labalive/index/digitalmodulation/
2. Link: https://vlab.amrita.edu/index.php?sub=59&brch=163&sim=262&cnt=970

Program: B. Tech. (E&Tc)				Semester: V			
Course: Project Based Learning-V				**Code:BET5417**			
Teaching Scheme				**Evaluation Scheme**			
Practical	**Tutorial**	**Credit**	**Hours**	**TW**	**OR**	**PR**	**Total**
2	-	1	2	50	-	-	50

Prior knowledge of:

1. Microcontroller and I/O interfaces
2. Electronics Circuit design

is essential.

Objectives:

Course Objectives:

1. To strengthen electronics and communication engineering concepts through practical implementation
2. To encourage students to develop viable solutions using multidisciplinary approach
3. To introduce fundamental steps in the prototype development

Course Outcomes:

After completion of this course students should be able to

1. Formulate a appropriate problem statement by conducting literature survey and propose a viable solution based on current trends and societal needs.
2. Apply previously acquired knowledge. of electronics to design a prototype and Conduct experimentation to evaluate the its quality .

Demonstrate good presentation and writing skills, develop ability to work as an individual and as a team member.

Detailed Syllabus:

Unit	Description	Duration
	The project selection: Project Selection should be based on Re-engineering concepts to introduce incremental advancements in the existing technology or operations. The spectrum of the project verticals can be and not limited to industries in the domain of Automobile, Health, Energy, Transportation, Security and Consumer Electronics. The performance of the same is going to be evaluated based on technical outcomes. Emphasis should be given in the implementation of hardware related improvements in the existing system OR incremental software advancements in an application/data driven application **Project Implementation:** Hardware processing unit should be any microcontroller – Atmega, AVR with interfacing to auxiliary/ peripherals. Additionally prototype development board – Arduino/ Raspberry Pi can be used to achieve functionalities in the project. The project with the software enhancement should demonstrate UI/dashboard development, data processing and data handling unit with interfacing to appropriate I/O. The project with hardware enhancement should be demonstrated on the PCB.	24 Hrs

	General Guidelines- Project group shall consist of not more than 3 students per group. Project report should address technical parameter/s analysis and/or optimization of static/dynamic characteristics or power analysis or software performance parameters. All activities are required to be recorded in logbook. A regular assessment of PBL work is required to be maintained at the department. It is expected that the PBL log book must include following: 1. Weekly monitoring by the PBL guide, 2. Assessment sheet for PBL work review by PBL guide and PBL Evaluation Committee (PEC). The PEC structure shall consist of Head of the department, 1/2 senior faculties of the department and one industry expert (optional). Continuous Assessment Sheet (CAS) is to be maintained by the department. Project shall be reviewed twice during the tenure by industry expert/ senior faculty member	

Program Elective-I

Program:	B. Tech. (E&TC)					Semester :	V			
Course :	Power Electronics					Code:BET5501				
Teaching Scheme (Hours)				Evaluation Scheme						
Lecture	Tutorial	Practical	Credit	CE	MTE	ETE	TW	PR	OR	Total
2	-	-	2	20	30	50	-	-	-	100

Learner should have Prior knowledge of,

1. Basic electrical concepts like voltage, current, power, basic laws, Circuit/Network, etc.
2. Basic elements like Resistor, Capacitor and Inductor.
3. Semiconductor devices like Diode, BJT and MOSFET.
4. Mathematical concepts like Integration, Derivative, Fourier series, etc.

Objectives:

The objectives of this course are:

1. To introduce different power devices like SCR, Power MOSFET and IGBT with construction, V-I characteristics, device ratings and typical triggering/driver circuits.
2. To understand working, performance analysis and design of various power converter circuits such as ac to dc converters, inverter, chopper, and AC voltage controllers.
3. To introduce various applications of power converters using power devices.

Outcomes:

After Successfully completing the course, the learners will be able to:

1. Differentiate based on the characteristic parameters among SCR, Power MOSFET & IGBT and identify suitability of the power device for certain applications and understand the significance of device ratings.
2. Analyze various power converters based on their performance parameters.
3. Understand the applications of power electronics.
4. Understand case studies of power electronics in applications like electric vehicles, solar systems etc.

Detailed Syllabus:

Unit	Description	Duration (Hrs)
1	**Unit I: Study of Power Devices** Construction, VI characteristics, switching characteristics of SCR, Power MOSFET and IGBT, Performance overview of Silicon, Silicon Carbide & GaN based MOSFET and IGBT, Device ratings of SCR, Power MOSFET & IGBT and their significance, requirement of a typical triggering / driver (such as opto isolator) circuits for various power devices, importance of series and parallel operations of various power devices (no derivation and numerical), Protections to power devices.	06

2	**Unit II: AC to DC Power Converters** Concept of line & forced commutation, Single phase Semi & Full converters using SCR for R and R-L loads, its performance analysis and numerical. Effect of source inductance and freewheeling diode, Significance of power factor and its improvement using PWM based techniques, Three phase Full converters using SCR for R load and its performance analysis, Single Phase PWM Rectifier using IGBT, Three Phase Controlled Rectifier Using IGBT, Difference between SCR based conventional rectifiers and IGBT based rectifiers. Application of AC to DC converters in DC motor drive for single phase separately excited dc motor.	**06**
3	**Unit III: DC to AC Power Converters** Single phase half and full bridge square wave inverter for R and R-L load using MOSFET / IGBT and its performance analysis and numerical, Cross conduction in inverter, need of voltage control and strategies in inverters, classifications of voltage control techniques, control of voltage using various PWM techniques and their advantages, concept and need of harmonic elimination / reduction in inverters, Three Phase voltage source inverter for balanced star R load with 120 and 180 degree mode of operation. Applications of Inverter in Electronic Ballast, BLDC motor drive, Variable voltage & variable frequency three phase induction motor drive, On-line and Off- line UPS.	**06**
4	**Unit IV: DC to DC and AC to AC Power Converters** **DC to DC Power Converters:** Classification of choppers, Step down chopper for R and RL load and its performance analysis, Step up chopper, various control strategies for choppers, types of choppers (isolated and non-isolated). Applications of DC Chopper in DC Motor drive. **AC to AC Power Converter:** Single phase AC Voltage Controller using IGBT & SCR for R load. Application of AC Voltage controller in FAN regulator, Electric Furnace. Case study of power electronics in electric vehicle and photovoltaic solar system.	**06**
	Total	**24**

Text Books:

1) M. H. Rashid, “Power Electronics Circuits Devices and Applications”, PHI,4th Edition 2017 New Delhi.

2) M. D. Singh and K. B. Khanchandani, “Power Electronics”, TMH, 2 nd Edition 2006.

Reference Books:

1) Ned Mohan, T. Undeland & W. Robbins, “Power Electronics Converters Applications and Design, John Willey & sons, Singapore, 2 nd Edition Oxford University Press, New Delhi, 2005

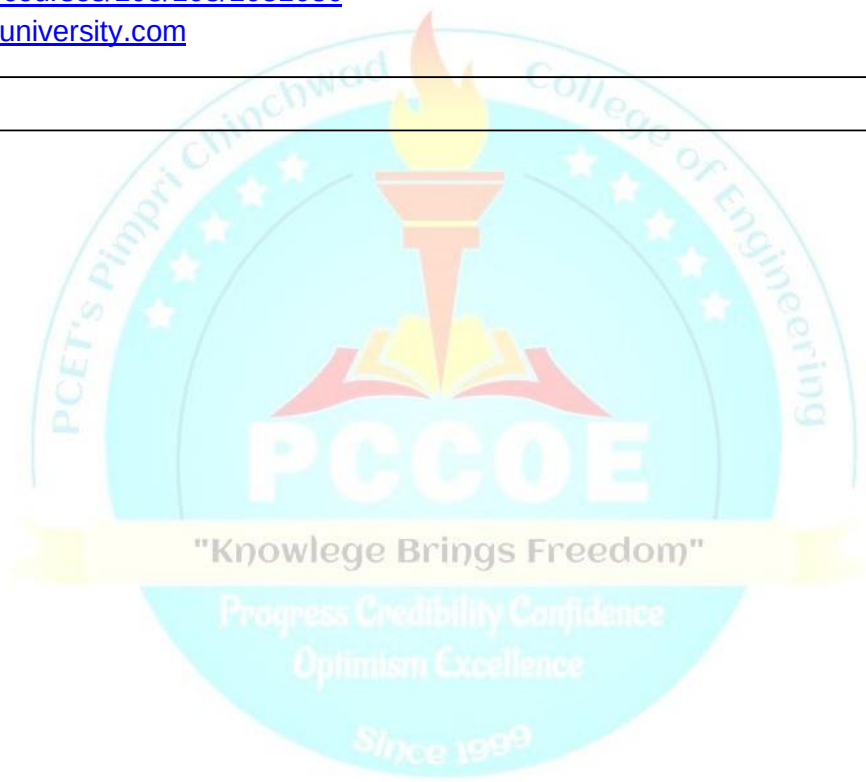
2) Muhammad H. Rashid , “Power Electronics Handbook”, Academic Press, 2nd Edition, 2001.

3) Bogdan M. Wilamowski, J. David Irwin, “The Power Electronics and Motor Drives Handbook”, CRC Press, 1 st Edition, 2011. ; eBook: ISBN 9780429165627, 2019.

4) SCR Manual by GE Company

NPTEL Course on “Power Electronics:

Link of the Course:
https://nptel.ac.in/courses/108/105/108105066/
https://nptel.ac.in/courses/108/102/108102145/
https://nptel.ac.in/courses/108/107/108107128/
https://nptel.ac.in/courses/108/108/108108077/ https://batteryuniversity.com



Program: B. Tech. (E&TC)							Semester : V			
Course : Power Electronics Lab							Code:BET5502			
Teaching Scheme (Hours)				Evaluation Scheme						
Lecture	**Tutorial**	**Practical**	**Credit**	**CE**	**MTE**	**ETE**	**TW**	**PR**	**OR**	**Total**
-	-	02	01	-	-	-	25	25	-	50

Learner should have Prior knowledge of,

1. Basic electrical concepts like voltage, current, power, basic laws, Circuit/Network, etc.
2. Basic elements like Resistor, Capacitor, and Inductor.
3. Semiconductor devices like Diode, BJT and MOSFET.
4. Mathematical concepts like Integration, Derivative, Fourier series, etc.
5. Use of equipment's such as Power supply, CRO, Function Generator, DMM, etc.

Objectives:

The objectives of this course are:

1. To understand the V-I characteristics and working of different power devices like SCR, Power MOSFET and IGBT and their important device ratings.
2. To understand the working and performance of various power converter circuits such as ac to dc converters, inverter, chopper, and AC voltage controllers.
3. To understand the applications of Power Electronics.

Outcomes:

After Successfully completing the course, the learners will be able to:

1. Understand the working of different power devices like SCR, Power MOSFET, IGBT and also their specifications.
2. Analyze various performance parameters of the different power converters.
3. Understand the power electronics converters used in various applications.

List of Laboratory Experiment	
Group A (Power Device Characteristics), 1 compulsory, from 2 or 3 any one	
1	VI Characteristics of SCR i) Plot output V-I characteristics to measure IH, IL and voltage before and after breakdown, ii) Observe the effect of gate current on forward break down iii) gate characteristics iv) compare with datasheet specifications
2	V-I Characteristics of Power MOSFET i) Plot output characteristics and calculate output resistance ii) Plot transfer characteristics and measure threshold voltage iii) compare with datasheet specifications
3	V-I Characteristics of IGBT i) Plot output characteristics and calculate output resistance ii) Plot transfer characteristics and measure threshold voltage iii) compare with datasheet specifications
Group B (Power Converters)	
Simulation of the power converters mentioned in group B using Powersim (PSIM) simulation software is compulsory and the performance on trainer kits.	

4	Single phase Semi and Full Converter using SCR with R & R-L load i) Observe load voltage waveform, ii) Measurement of average o/p voltage across loads, iii) Verification of theoretical values with practically measured values.
5	Single-Phase PWM Power MOSFET / IGBT based bridge inverter for R and motor load i) Observe output voltage waveforms and measure set of rms output voltage for varying pulse width and variable input dc voltage for R and motor load, ii) compare measured output voltages with the theoretical findings
6	Step down / Step up chopper using power MOSFET / IGBT i) Measure duty cycle and observer effect on average load voltage for DC chopper
7	Single phase AC voltage controller using SCR for R and RL load i) Observe output rms voltage waveforms, ii) Measurement output voltage across load, iii) Verification of theoretical values with practically measured values.
Group C (Applications of Power Electronics Converters), Any Two Students can use PSIM Software	
8	SMPS /UPS Performance Evaluation i) find load & line regulation characteristics for no load condition and at 500 mA & 1A load ii) compare the performance with supplier specifications
9	To study speed control of DC / single phase AC motor
10	To design and implement a solar cell operated emergency lighting system.

Visit to Solar power generation plant or Electric Vehicle manufacturing plant is recommended

Text Books:

1) M. H. Rashid, "Power Electronics Circuits Devices and Applications", PHI,4th Edition 2017 New Delhi.

2) M. D. Singh and K. B. Khanchandani, "Power Electronics", TMH, 2 nd Edition 2006.

Reference Books:

1) Ned Mohan, T. Undeland & W. Robbins, "Power Electronics Converters Applications and Design, John Willey & sons, Singapore, 2 nd Edition Oxford University Press, New Delhi, 2005

2) Muhammad H. Rashid , "Power Electronics Handbook", Academic Press, 2nd Edition, 2001.

3) Bogdan M. Wilamowski, J. David Irwin, "The Power Electronics and Motor Drives Handbook", CRC Press, 1 st Edition, 2011. ; eBook: ISBN 9780429165627, 2019.

4) SCR Manual by GE Company

Program:	B. Tech. (E&TC)				Semester:	V	
Course:	Advanced Microcontroller				Code:	BET5503	
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	IE	MTE	ETE	Total
2	1		2	20	30	50	100

Prior Knowledge of:

Microcontroller is essential

Course Objectives:

1. To understand need and application of ARM Microprocessors in embedded system.
2. To study the architecture of ARM series microprocessor.
3. To understand architecture and features of typical ARM7 Processors.
4. To learn interfacing of real world input and output devices.

Course Outcomes:

1: Students will be able to describe the different ARM processors.

2: Students will be able to explain the ARM microprocessor architectures and its feature.

3: Students will be able to design and write programs for the advanced peripherals interfaced with ARM based microcontroller

4: Students will be able to develop embedded system with available resources.

Detailed Syllabus:

Unit	Description	Duration
1.	**Unit I: Introduction to ARM processors and its versions -**ARM7, ARM9 & ARM11 features, advantages & suitability in embedded application ARM7 registers, CPSR, SPSR, ARM and RISC design philosophy, ARM7 data flow model, programmer's model, modes of operations	**6**
2.	**Unit II: -ARM7 Based Microcontroller LPC2148:** Features, Architecture (Block Diagram and Its Description), System Control Block (PLL and VPB divider), Memory Map, GPIO, Pin Connect Block, Timer, simple LPC2148 GPIO Programming examples using timers of LPC2148 to generate delay	**6**
3.	**Unit III: ARM Real World Interfacing Part I (6Hrs)**: Interrupt structure of LPC2148, Interfacing with LED, LCD, GLCD, KEYPAD, simple LPC2148 USART Programming, on-chip ADC, Waveform generation using DAC All programs in embedded C.	**6**
4.	**Unit IV: ARM Real World Interfacing Part II (6Hrs)**: **–** GSM, GPS module interfacing, Study of protocols I2C, SPI, RTC (DS1306) with I2C, and EEPROM with SPI, All programs in embedded C. Introduction to	**6**

	ARM cortex series, CORTEX A, R, M processors, Firmware development using CMSIS Standard.	
	Total	24

Text Books:

1. Barry Bray The Intel Microprocessors: Architecture, Programming and Interfacing 8th Edition by Pearson Education
2. Andrew Sloss ARM System Developer's Guide by ELSEVIER

Reference Books:

1. LPC 214x User manual (UM10139) :- www.nxp.com
2. ARM architecture reference manual : - www.arm.com

Program: B. Tech. (E&Tc)					V		
Course : Advanced Microcontroller Lab					**Code :BET5504**		
Teaching Scheme				**Evaluation Scheme**			
Lecture	**Practical**	**Tutorial**	**Credit**	**TW**	**OR**	**PR**	**Total**
	1			25		25	50

Prior knowledge of:

1. Microcontroller is essential

Objectives:

3. To understand architecture of typical ARM7 Processors.
4. To learn utilization of hardware and software tools
5. To learn interfacing of real world input and output devices.

Outcomes:

At the end of Laboratory work, the students will be able to:

1: Students will be able to demonstrate the use of hardware and software tools.

2: Students will be able to integrate peripherals and microcontroller to design an application.

3: Students will be able to develop real time application**.**

General Guidelines: Any Eight Experiments is to be performed.

Detailed Syllabus:

Expt. No.	List of Experiments
1	LED Blinking using TIMER
2	Interfacing with 16x2 LCD
3	KEYPAD & LCD interfacing
4	Interfacing LPC2148 with GLCD to display image on it.
5	Using UART of LPC2148 for serial reception and transmission from/to computer.
6	Interfacing GSM with LPC2148 for sending and receiving message and voice call.
7	Interfacing GPS with LPC2148 for finding current location latitude and longitude values.
8	Using built-in ADC of LPC2148 for displaying its values (Programming built-in ADC with interrupt and without interrupt)

9	Waveform Generation using DAC
10	Interfacing EEPROM to LPC2148 using I2C protocol

Reference Books:

1. Andrew Sloss ARM System Developer's Guide by ELSEVIER
2. LPC 214x User manual (UM10139) :- www.nxp.com
3. ARM architecture reference manual : - www.arm.com

Program:	B. Tech. (E&TC)				Semester:	V	
Course:	Multidimensional Signal Simulation				Code:	BET5505	
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	IE	MTE	ETE	Total
2			2	20	30	50	100

Prior Knowledge of: Basic Signals and Signal Processing is essential

Course Objectives:

1. Make the students familiar to different dimensional signals.
2. Develop an ability to design an 2D, 3D, 4D and 5D applications.

Course Outcomes: The students are able to

1. Identify the difference between different dimensional signals.
2. Apply 3D builder to design an application.
3. Design an 4D application.
4. Design an 5D application.

Detailed Syllabus:

Unit	Description	Duration
1.	Introduction to Dimension: 0D, 1D, 2D, 3D, 4D, and 5D. Difference between vector and tensor, Variables/parameters, Representation	**2**
2.	0D and 1D vectors: Introduction, representation, difference between 0D and 1D, applications, Case study: Application to battery ageing, Software tool Modelica /Python/ GT-SUITE	**6**
3.	2D and 3D vectors: Introduction, representation, difference between 0D 1D, 2D and 3D, applications, Case study: geological/geophysical exploration, Software tool 3D builder, Catia /Inventor	**8**
4.	4D and 5D vectors: Introduction, representation, difference between 3D, 4D and 5D, applications, Case study: Satellite/Medical Imaging	**8**
	Total	24

Text Books:

1. One-Dimensional Digital Signal Processing (Electrical and Computer Engineering) 1st Edition by C. Chen
2. Two-dimensional Signal and Image Processing by Jae S. Lim, Prentice Hall
3. Recent Advances of 4D Printing Technologies Toward Soft Tactile Sensors by Yuneng Tang1, Baiqian Dai1, Bin Su2 and Yusheng Shi2, REVIEW article
4. Reservoir Monitoring, 4D Signal, And Fiber-Optic Technology, by Steve Maas, Rune Tenghamn, Brett Bunn
5. https://rukshanpramoditha.medium.com/real-world-examples-of-0d-1d-2d-3d-4d-and-5d-tensors-100b0837ced4
6. https://medium.com/secure-and-private-ai-writing-challenge/introduction-to-tensors-1-de7dded35fea
7. http://www.differencebetween.info/difference-between-2d-3d-and-4d

8. https://www.academia.edu/41739709/Fifth_Dimension_5D_Science
9. http://dusk.geo.orst.edu/gis/lec14_3d.html
10. https://www.insightsonindia.com/2015/11/21/5-write-note-4-d-5-d-imaging-technologies-applications-150-words/

Program: B. Tech. (E&Tc)						Semester :V	
Course : Multidimensional Signal Simulation Lab						Code : BET5506	
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	TW	OR	PR	Total
	2		1	25		25	50

Prior knowledge of: Programming language **is essential**.

Course Objectives:

1. To design the specific application for 1 to 5 dimensional signal.

Outcomes: At the end of Laboratory work, the students will be able to:

1. Design an application using 3D builder.
2. Design an 4D application.
3. Design an 5D application

General Guidelines: Any Eight Experiments is to be performed. Experiments will be conducted on Modelica /Python/ GT-SUITE.

Detailed Syllabus:

Expt. No.	List of Experiments
1.	Study of 1 D and 2 D Library
2.	Design and Implementation of the battery ageing
3.	Verification of the battery ageing
4.	Study of 3D Library from 3D builder/ Catia/Inventor
5.	Design and Implementation of geological/geophysical exploration using 3D builder
6.	Verification of geological/geophysical exploration using 3D builder
7.	Study of 4D Library from 4D Satellite/Medical Imaging Application.
8.	Design and Implementation of 4D Satellite/Medical Imaging Application.
9.	Verification of 4D Satellite/Medical Imaging Application.
10.	Design and Implementation of 5D electronics/electrical based Application
11.	Verification of 5D electronics/electrical based Application

Text Books:

1. One-Dimensional Digital Signal Processing (Electrical and Computer Engineering) 1st Edition by C. Chen
2. Two-dimensional Signal and Image Processing by Jae S. Lim, Prentice Hall
3. Recent Advances of 4D Printing Technologies Toward Soft Tactile Sensors by Yuneng Tang, Baiqian Dai1, Bin Su and Yusheng Shi, REVIEW article
4. Reservoir Monitoring, 4D Signal, And Fiber-Optic Technology, by Steve Maas, Rune Tenghamn, Brett Bunn
5. https://rukshanpramoditha.medium.com/real-world-examples-of-0d-1d-2d-3d-4d-and-5d-tensors-100b0837ced4
6. https://medium.com/secure-and-private-ai-writing-challenge/introduction-to-tensors-1-de7dded35fea
7. http://www.differencebetween.info/difference-between-2d-3d-and-4d
8. https://www.academia.edu/41739709/Fifth_Dimension_5D_Science
9. http://dusk.geo.orst.edu/gis/lec14_3d.html
10. https://www.insightsonindia.com/2015/11/21/5-write-note-4-d-5-d-imaging-technologies-applications-150-words/

Program:	B. Tech. (E&TC)			Semester:	V		
Course:	Information Theory and Coding			Code:	BET5507		
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	IE	MTE	ETE	Total
2			2	20	30	50	100

Prior Knowledge of:

2. Basic concepts of Probability and communication system is essential

Course Objectives:

1. To introduce the terminology and basic concepts of information theory.
2. To encourage the students to study the different data compression methods.
3. To motivate the students to study the different error coding techniques
4. To make the students familiar with different types of error correcting codes

Course Outcomes:

Student will be able

1. To apply the basics concept of information theory.
2. To analyze the different data compression methods.
3. To construct the different error coding techniques
4. To identify the different types of error correcting codes

Detailed Syllabus:

Unit	Description	Duration
1.	**Introduction to Information theory**:- Probability, Uncertainty, self-information, Entropy and information rate, mutual information and their properties, Discrete memory less channel, Channel capacity	**6**
2.	**Source Coding**:-Source coding theorem, Data compression, Huffman coding, Lempel-Ziv coding, Run-length encoding, Introduction to cryptography Review on recent Research Papers	**5**
3.	**Channel Coding:-** Channel coding theorem, Introduction to Error control codes, Block codes, linear block codes, cyclic codes, BCH and RS codes Review on recent Research Paper	**7**
4.	**Convolution Code** :- Introduction to Convolution Codes, Properties, convolution encoder and Decoder, Turbo codes, Repetition code, Golay code, LDPC code, ARQ	**6**

	Total	24

Text Books:

3. Simon Haykin, “Communication Systems”, 4th Edition, John Wiley and Sons, 2001.
4. Ranjan Bose, ―Information Theory coding and Cryptography‖, McGraw-Hill, 2nd E, 4th Edition

Reference Books:

4. Shu lin and Daniel j, Cistello jr., ―Error control Coding‖ Pearson, 2nd Edition.
5. Todd Moon, ―Error Correction Coding : Mathematical Methods and Algorithms‖, Wiley, ISBN: 978-0-471-64800-0,2nd Edition
6. Khalid Sayood, ―Introduction to Data compression‖, Morgan Kaufmann Publishers, 2nd Edition

NPTEL/ MOOC courses

1. An Introduction to Information Theory
https://onlinecourses.nptel.ac.in/noc22_ee49/preview

2. Information Theory
https://onlinecourses.nptel.ac.in/noc20_ee96/preview

Program: B. Tech. (E&Tc)					Semester :V		
Course : I T C T Lab					Code :BET5508		
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	TW	OR	PR	Total
	2		1	25	-	25	50

Prior knowledge of:

1. Basic concepts of Probability and communication system
2. MATLAB /Simulink/ Open source platform is essential

Objectives:

1. To introduce the basics of Information theory
2. To inculcate the implementation of source coding techniques for data compression
3. To instill the knowledge of various channel coding techniques and their implementation.

Outcomes:

At the end of Laboratory work, the students will be able to:

1. To analyze the different terminologies related to information theory
2. Design and verify the source coding algorithm for data compression
3. Design and verify the Channel coding algorithm for error detection and correction.

General Guidelines: Any Eight Experiments is to be performed.

Detailed Syllabus:

Expt. No.	List of Experiments
1	Write a program to find the entropy for the given source
2	Write a program to find different entropies , Mutual information and channel capacity for given channel
3	Write a program to find the coding efficiency using Huffman source coding
4	Write a program to encode and decode using LBC
5	Write a program to encode and decode using Cyclic code
6	Write a program to encode and decode using BCH code
7	Write a program encode and decode using RS code
8	Write a program encode and decode using Convolution code
9	Case study on Data compression
10	To study the applications of different types of code
11	To study the Cryptography techniques

Reference Books:

1. Ranjan Bose, ―Information Theory coding and Cryptography‖, McGraw-Hill, 2nd Ed
2. Murlidhar Kulkarni, K.S.Shivaprakasha, ―Information Theory & Coding‖, Wiley Public
3. Simon Haykin, ―Communication Systems‖, John Wiley & Sons, Fourth Edition.
4. Shu lin and Daniel j, Cistello jr., ―Error control Coding‖ Pearson, 2nd Edition.
5. Todd Moon, ―Error Correction Coding : Mathematical Methods and Algorithms‖, Wiley Publication
6. Khalid Sayood, ―Introduction to Data compression‖, Morgan Kaufmann Publishers

Program:	B. Tech. (E&TC)				Semester:	V		
Course:	Object Oriented Programming				Code:	BET5509		
Teaching Scheme					Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	Hours	IE	MTE	ETE	Total
2	--	--	2	2	20	30	50	100

Prior Knowledge of:

1Data Structures

2. C programming

Course Objectives:

1. Make the students familiar with basic concepts and techniques of object oriented programming
2. Develop an ability to write programs in C++ for problem solving.
3. Make the students familiar with modern C++.

Course Outcomes: On completion of the course, learner will be able to -

CO1: Describe the principles of object oriented programming.
CO2: Apply the concepts of classes and methods to write programs in C++.
CO3: Apply the concepts of inheritance and polymorphism to write programs C++.

CO4: Write the programs in C++11 and C++14.

Detailed Syllabus:

Unit	Description	Duration
1.	**Fundamental of Object Oriented Programming** Introduction to object-oriented programming, Limitations of procedural programming, Fundamentals of object-oriented programming: objects, classes, data members, methods, messages, data encapsulation, data abstraction and information hiding, inheritance, polymorphism. Inline function, Function overloading. Dynamic initialization of variables, memory management operators, Member dereferencing operators, operator precedence, typecast operators, Scope resolution operators.	6
2.	**Classes & Objects:** Defining class, Defining member functions, static data members, static member functions, private data members, public member functions, arrays of objects, objects as function arguments. Constructors and Destructors: types of constructors, handling of multiple constructors, destructors.	6
3.	**Operator Overloading** Fundamentals of Operator Overloading, Restrictions on Operators Overloading, Friend Functions, Overloading Unary Operators, Overloading Binary Operators, Overloading of operators using friend functions. **Inheritance & Polymorphism**	6

	Introduction to inheritance, base and derived classes, types of inheritance, hybrid inheritance, member access control, static class, multiple inheritance, ambiguity, virtual base class, Introduction to polymorphism, virtual functions, pure virtual functions, abstract base class, Polymorphic class, virtual destructors, early and late binding.	
4.	**Introduction to C++11 and C++14** Summary of the standard C and C++ libraries, Container classes, Container adapters, Creating and accessing containers, Initializer lists, Common Container Methods, Custom allocators, std::array, Lambda Functions, Filling a container, Non-modifying operations.	**6**
	Total	**24**

Text Books:

1. E Balagurusamy, "Programming with C++", Tata McGraw Hill, 3rd Edition.
2. Herbert Schildt, "The Complete Reference C++", 4th Edition.

3. Scott Meyers, " Effective Modern C++ (2014)"

Reference Books:

1. Robert Lafore, "Object Oriented Programming in C++", Sams Publishing, 4th Edition.
2. Parasons, "Object Oriented Programming with C++", BPB Publication, 1999.

3. Yashwant Kanethkar, "Object Oriented Programming using C++", BPB, 2004

4. Paul Laurence, "Effective Modern C++ - C++ 11, - C++ 14".

MOOC / NPTEL Courses:

1. NPTEL Course "Programming in C++"
https://nptel.ac.in/courses/106/105/106105151/

2**. Udemy course "Complete Modern C++ (C++11/14/17)"**
https://www.classcentral.com/course/udemy-beg-modern-cpp-23507

Program: B. Tech. (E&Tc)					Semester :V		
Course : Object Oriented Programming Lab					Code : BET5510		
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	TW	OR	PR	Total
	2		1	25		25	50

Prior knowledge of:

1. Data Structures
2. C programming

Course Objectives:

Faculty need to :

2. Develop an ability to write programs in C++ by applying object oriented programming concepts.
3. Develop an ability to write programs in C++ 11 and C++14.

Outcomes: At the end of Laboratory work, the students will be able to:

CO1: Apply the concepts of classes and methods to write programs in C++.
CO2: Apply the concepts of inheritance and polymorphism to write programs C++.

CO3: Write the programs in C++11 and C++14.

General Guidelines: Any Five Experiments from group A and Any Three Experiments from group B are to be performed.

Expt. No.	List of Experiments
Group A:	
1.	Write a program in C++ to sort the numbers in an array using separate functions for read, display, sort and swap
2.	Write a C++ program that illustrates the concept of Function over loading.
3.	Write a program in C++ to perform following operations on complex numbers Add, Subtract, Multiply, Divide, Complex conjugate.
4.	Write a program in C++ to implement Stack. Design the class for stack and the operations to be performed on stack. Use Constructors and destructors.
5.	Write a program in C++ to perform following operations on complex numbers Add, Subtract, Multiply, Divide. Use operator overloading for these operations.
6.	Write a program in C++ to Read and Display the information of Employee Using Multiple Inheritance. Use Basic Info and Department Info as a base classes of Employee class.
7.	Write a C++ program that illustrates run time polymorphism by using virtual functions.
Group B:	
8.	Write a C++ 11 program for Lamba Expressions of Lambda Functions.
9.	Write a C++ 14 program for Lamba Expressions of Lambda Functions.
10.	Write a C++ 11 program for Uniform Initialization.

11.	Write a C++ 14 program for Uniform Initialization.

Text Books:

1. E Balagurusamy, “Programming with C++”, Tata McGraw Hill, 3rd Edition.
2. Herbert Schildt, “The Complete Reference C++”, 4th Edition.

3. Scott Meyers, “ Effective Modern C++ (2014)”.

Reference Books:

1. Robert Lafore, “Object Oriented Programming in C++”, Sams Publishing, 4th Edition.
2. Parasons, “Object Oriented Programming with C++”, BPB Publication, 1999.

3. Yashwant Kanethkar, “Object Oriented Programming using C++”, BPB, 2004

4. Paul Laurence, “Effective Modern C++ - C++ 11, - C++ 14”.

MOOC / NPTEL Courses:
1. NPTEL Course “Programming in C++”
https://nptel.ac.in/courses/106/105/106105151/

2**. Udemy course “Complete Modern C++ (C++11/14/17)”**
https://www.classcentral.com/course/udemy-beg-modern-cpp-23507

Program Elective-II

Program: B. Tech.(E&TC)						Semester: V	
Course: Robotics and Automation (Program Elective-II)						Code: BET5511	
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	CIE		ETE	Total
				IE	MTE		
2	-	-	2	20	30	50	100

Prior knowledge of:

Basic engineering mathematics, Differential equations and Integration, Basic coordinate system,

Objectives:

The objectives of this course are:

1. To familiarize the students with the significance of robotic systems in agile and automated manufacturing processes.
2. To prepare the students to be conversant with robotic elements/ peripherals, their selection, and interface with manufacturing equipment's.
3. TO analyze and classify the different types of end effectors and actuators for different types of robot applications
4. To learn the fundamentals of kinematics and programming methods of robotics

Outcomes:

After learning the course, the students should be able to:

1. Understand the basic classification of robots with specification
2. Apply the knowledge of robot drivers and vision systems to understand the design of the robot
3. Compare & select appropriate grippers, actuators, and driving motors for particular robotics applications
4. Apply programming logic to develop an industrial robotic system.

Detailed Syllabus:

Unit	Description	Duration (Hrs.)
I	**Basic concepts in robotics Definition;** anatomy of the robot, the basic structure of robot, Specifications and Classification of the robot, Safety Measures in robotics, Industrial Applications of Robots	6
II	**Robot drivers, Sensors and Vision Drives for robots:** Electric, hydraulic and pneumatic. Sensors: Internal-External, Contact-noncontact, position, velocity, force, torque, proximity and range. Vision: Introduction to techniques, Image acquisition and processing. Introduction of Machine Vision in Robotics, Low level & High-level Vision, Sensing & Digitizing, Image Processing & analysis, Segmentation, Edge detection, Machine vision algorithms, Applications.	6

III	**End Effectors and Actuators:** Different types of grippers- Mechanical, Magnetics, vacuum, Adhesive, Gripper force Analysis & Gripper Design, an overview of actuators, Power and torque, Acceleration and velocity Specifications and characteristics of Stepper motors, AC motors, DC motors and servomotors.	**6**
IV	**Robot Kinematics and Programming Methods** Basic fundamentals of direct and inverse kinematics for industrial robots for position and orientation, Redundancy, and Manipulators. Robot language classification, Robot language structure, elements and its functions. Simple programs on Sensing distance and direction., Line Following Algorithms.	**6**
	Total Hrs.	**24**

Text Books:

- Introduction to Robotics By S.K.Saha , Tata McGraw Hill
- Robotics Control, Sensing, Vision and Intelligence by K.S. Fu, R.C. Gonzalez, C.S.G.Lee , Tata McGraw Hill
- Frank D. Petruzella, "Programmable Logic Controllers", 5th Edition, McGraw- Hill, New York, 2016.

Reference Books:

- J. Hirchhorn: Kinematics and Dynamics of Machinery, McGraw Hill book co.
- Robert J. Schilling , Fundamentals of Robotics- Analysis and Control, Prentics Hall india.
- Robotics Technology and Flexible Automation by S.R.Deb, S. Deb, Tata McGraw Hill.
- Robot Motion and Control (Recent Developments) by M.Thomas & M. Morari

NPTEL Video:

1. **Robotics (IIT Kharagpur) : https://nptel.ac.in/courses/112105249**
2. **Robotics Automation (IIT Bombay): https://nptel.ac.in/courses/112101098**
3. **Introduction to robotics (IIT Madras): https://nptel.ac.in/courses/107106090**

Program: B. Tech. (E&Tc)					Semester: V		
Course: Robotics and Automation Lab (Program Elective II Lab)					Code: BET5512		
Teaching Scheme				**Evaluation Scheme**			
Lecture	**Practical**	**Tutorial**	**Credit**	**TW**	**OR**	**PR**	**Total**
	2		1	25	25		50

Prior knowledge of Sensors, Control Systems and basic programming is essential

Objectives:

The main objective of this course is to

6. To learn and understand the basics of fundamentals of robotics systems.
7. To be acquainted with a different configuration of the robotics system
8. To design MATLAB program for robotic configuration

Outcomes:

At the end of Laboratory work, the students will be able to:

4. Identify and understand the unique characteristics and components of robotics systems
5. Compare and understand various types of robotics systems
6. Design, simulate and test kinematic equations for robotic systems in MATLAB
7. Compare and understand the various industrial applications of robotics systems

General Guidelines: Any Six Experiments is to be performed.

Detailed Syllabus:

Exp. No.	List of Experiments
1	Study and analysis of robot grippers (includes the problems based on gripper force)
2	Demonstration of various robotic configurations using an industrial robot
3	MATLAB program for simple kinematics of simple robot configuration
4	MATLAB program for inverse kinematics of simple robot configuration
5	To demonstrate a simple robotic system using Matlab/ MscAdam / RoboAnalyser software
6	Study of the configuration of robots and motion of robot manipulator
7	Study of pick and place industrial robot
8	One Industrial visit for Industrial robotic application

Text Books:

- Introduction to Robotics By S.K.Saha , Tata McGraw Hill
- Robotics Control, Sensing, Vision and Intelligence by K.S. Fu, R.C. Gonzalez, C.S.G.Lee , Tata McGraw Hill

Frank D. Petruzella, “Programmable Logic Controllers”, 5th Edition, McGraw- Hill, New York, 2016.

Reference Books:

- J. Hirchhorn: Kinematics and Dynamics of Machinery, McGraw Hill book co.
- Robert J. Schilling , Fundamentals of Robotics- Analysis and Control, Prentics Hall india.
- Robotics Technology and Flexible Automation by S.R.Deb, S. Deb, Tata McGraw Hill.

Robot Motion and Control (Recent Developments) by M.Thomas & M. Morari

Virtual Lab Links

1. Mechanisms & Robotics Lab
   http://vlabs.iitkgp.ernet.in/mr/
2. Robotics Application Lab
   https://vlab.amrita.edu/?sub=3&brch=271&sim=1642&cnt=3525
3. Bio Inspired Robotics Virtual Lab
   https://vlab.amrita.edu/?sub=3&brch=257

Program:	B. Tech. (E&TC)				Semester:	V	
Course:	Digital Design with VERILOG HDL				Code:	BET5513	
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	IE	MTE	ETE	Total
2	--		2	20	30	50	100

Prior Knowledge of:

3. Digital Logic Design **Is essential**

Course Objectives:

1. To learn the concepts of modeling a digital system using Verilog hardware description Language.
2. To familiarize with different levels of abstraction in Verilog.
3. Understand concepts of logic synthesis and basics of verification.

Course Outcomes:

After studying this course, students will be able to:

1. Understand evolution of CAD and HDL environment and Verilog basics.
2. Write Verilog codes using date level and Dataflow modelling.
3. Write Verilog codes using Behavioural modelling.
4. Develop a test bench model for design under test.

Detailed Syllabus:

Unit	Description	Duration
1.	**Introduction: Evolution of Cad and HDL environment.** Verilog as HDL, Levels of Design Description, Concurrency, Simulation and Synthesis. Basics concepts: Lexical conventions, Datatypes, systems tasks and compiler directives. Module definition, Port declaration and connecting ports, hierarchical referencing	**4**
2.	**Gate Level Modeling:** Modelling of basic Verilog gate primitives, description of various gates, rise, fall and turn off delays, min, max and typical delays. **Data flow modelling:** continuous assignments, delay specifications, expressions, operator and operands.	**7**
3.	**Behavioral Modeling:** Introduction, Operations and Assignments, Functional Bifurcation, Initial Construct, Always Construct, Design at Behavioral Level, Blocking and Non-Blocking Assignments, The 'Case' Statement, 'If' and 'if-Else' Constructs, 'Assign- De-Assign' Constructs,	**7**

	'Repeat' Construct, for loop, 'The Disable' Construct, 'While Loop', Forever Loop, sequential and Parallel Blocks.	
4.	**Test bench:** Test bench for sequential and combinational circuits, Test pattern generation, test bench with initial block. Introduction to score boards, verification model and verification environment.	**6**
	Total	24

Text Books:

5. T.R. Padmanabhan and B. Bala Tripura Sundari, “Design through Verilog HDL’’, WSE, IEEE Press 2008.
6. 2. J. Bhaskar, “A Verilog Primer’’, BSP, 2nd edition 2003.

Reference Books:

1. Samir Palnitkar, “Verilog HDL”, Pearson Education, 2nd Edition,2003.
2. Thomas and Moorby, “The Verilog Hardware Description Language”, kluwer academic publishers, 5th edition, 2002
3. Stephen Brown and Zvonko Vranesic, “Fundamentals of Logic Design with Verilog”, TMH publications, 2007.
4. Charles.H.Roth,Jr., Lizy Kurian John “Digital System Design using VHDL” , Thomson, 2nd Edition, 2008

Program: B. Tech. (E&Tc)					**Semester : V**		
Course : Digital Design with VERILOG HDL -Lab					**Code: BET5514**		
Teaching Scheme				**Evaluation Scheme**			
Lecture	**Practical**	**Tutorial**	**Credit**	**TW**	**OR**	**PR**	**Total**
	2		**1**	**25**			**25**

Prior knowledge of:
is essential

Objectives:

- Designing digital circuits, behaviour and RTL modeling of digital circuits usin verilog HDL, verifying these Models and synthesizing RTL models to FPGAs.
- Students ain practical experience by designing, modeling, implemeting and verfying several digital circuits.

Outcomes:
At the end of Laboratory work, the students will be able to:

1. Demonstrate the function of adder/subtractor circuits using Verilog.
2. Design and analyse the Multiplexers Decoders, Encoders circuits using Verilog.
3. Design and analysis of different Flip-flops and counters using Verilog.
4. Able to use FPGA/CPLD kits for down loading Verilog codes for shift registers and counters and check output.

General Guidelines: First 4 assignments are compulsory and any two assignment from 4,5,6 can be chosen by students.

Detailed Syllabus:

Expt. No.	**List of Experiments**
1	A. Design and implement Adder – Full/half using Verilog in dataflow Modelling
	B. Write a test bench for 4-bit ALU and Implement on PLD
2	A. Design and implement 4:1 Multiplexer and 1:8 Demux using verilog in behavioural modelling.
	B. Write a test bench for 4:1 Multiplexer and 1:8 Demux and Implement on PLD
3	A. Design and implement D FF (active low-asynchronous reset) using verilog in behavioural modelling.
	B. Write a test bench for D FF and Implement on PLD
4	A. Design and implement 4 bit Up-Down counter using verilog in behavioural modelling.
	B. Write a test bench for 4 bit Up-Down counter and Implement on PLD
5	A. Write Verilog Description for sequence detector FSM to detect alternate 1's and 0's till 4 bits.
	B. Write a test bench for 4 bit Up-Down counter and Implement on PLD
6	A. Write Verilog Description for 4 bit Universal Shift Register

	B. Write a test bench for 4 bit Universal Shift Register and Implement on PLD	
	A. Write Verilog Description for Random Number Generator using linear feedback shift register.	
	B. Write a test bench for Random Number Generator using linear feedback shift register. and Implement on PLD	
	Total Hrs	**24**

Reference Books:

1. Fundamentals of Digital Logic with Verilog Design - Stephen Brown,Zvonkoc Vranesic, TMH, 2nd Edition.
2. Advanced Digital Logic Design using Verilog, State Machines & Synthesis for FPGA - Sunggu Lee, Cengage Learning, 2012.
3. Verilog HDL - Samir Palnitkar, 2nd Edition, Pearson Education, 2009.
4. Advanced Digital Design with Verilog HDL - Michel D. Ciletti, PHI,2009

Program:	B. Tech. (E&TC)				Semester:	V	
Course:	Digital Image Processing				Code:	BET5515	
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	IE	MTE	ETE	Total
2			2	20	30	50	100

Prior Knowledge of: Basic Signals and Signal Processing is essential

Course Objectives:

1. Understand the fundamental concepts of Digital Image Processing with basic relationship of pixels and mathematical operations on 2-D data.
2. Learn design and integrate image enhancement.
3. Learn the need for effective use of resources such as storage and bandwidth and ways to provide effective use of them by data compression techniques
4. Understand object segmentation and image analysis techniques

Course Outcomes: The students are able to

On completion of the course, student will be able to

1. Develop and implement basic mathematical operations on digital images.
2. Analyze and solve image enhancement problems.
3. Apply 2-D data compression techniques for digital images.
4. Design & Develop image processing Algorithms for object segmentation

Detailed Syllabus:

Unit	Description	Duration
1.	**Fundamentals of Image Processing**: Steps in Image processing, Human visual system, Sampling & quantization, Representing digital images, spatial and gray level resolution, Image file formats, Basic relationships between pixels, Distance Measures, Basic operations on images – image addition, subtraction, logical operations, scaling translation, rotation.	**5**
2.	**Image Enhancement Point**:Log transformation, Power law transformation, Piecewise linear transformation, Image histogram, histogram equalization, Mask processing of images, filtering operations-Image smoothing, image sharpening, frequency domains image	**7**

	enhancement: 2D DFT, smoothing and sharpening in frequency domain, Pseudo coloring.	
3.	**Image Compression**: Types of redundancy, Fidelity criteria, Compression models - Information theoretic perspective – Fundamental coding theorem, Lossless Compression: Huffman Coding- Arithmetic coding. Introduction to DCT, Lossy compression: DCT based compression; Wavelet based compression	**5**
4.	**Image Segmentation**: Pixel classification, Bi-level thresholding, Multi-level thresholding, Adaptive thresholding, Otsu's method, Edge detection – First order derivative Prewitt and Sobel, Second order derivative – LoG, DoG, Canny. Edge linking, Hough transform, Region growing and region merging. Morphological operators: Dilation, Erosion, Opening, Closing, Hit or Miss transforms Boundary detection,	**7**
	Total	24

Text Books:

1. Gonzalez and Woods, "Digital Image Processing", Pearson Education, 3rd edition

2. Iain E. G. Richardson, ―H.264 and MPEG

3. Video Compression: Video Coding for Next Generation Multimedia, John Wiley and Son's Publication, 3rd Edition.

Reference Books:

1. A. K. Jain, Fundamentals of digital image processing, Prentice Hall of India, 1989.

2. Pratt William K. "Digital Image Processing", John Wiley & sons

3. A. Bovik, Handbook of Image & Video Processing, Academic Press, 2000

Program: B. Tech. (E&Tc)						Semester :V	
Course : Digital Image Processing Lab						Code : BET5516	
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	TW	OR	PR	Total
	2		1	25	25		50

Prior knowledge of: Programming language **is essential**.

Course Objectives:

1. Understand the fundamental concepts of Digital Image processing with basic relationship of pixels and mathematical operations on 2-D data.
2. Learn design and integrate image enhancement.
3. Learn the need for effective use of resources such as storage and bandwidth and ways to provide effective use of them by data compression techniques
4. Understand object segmentation and image analysis techniques

Outcomes:

On completion of the course, student will be able to

1. Develop and implement basic mathematical operations on digital images.
2. Analyze and solve image enhancement problems.
3. Apply 2-D data compression techniques for digital images.
4. Design & Develop image processing Algorithms for object segmentation

General Guidelines: Any Eight Experiments is to be performed.

Detailed Syllabus:

Expt. No.	List of Experiments
1.	Perform basic operations on images.
2.	Perform histogram equalization.
3.	Perform image filtering in spatial domain.
4.	Perform image filtering in frequency domain.

5.	Perform image compression using DCT / Wavelet transform.
6.	Perform edge detection using various masks.
7.	Perform global and adaptive thresholding.
8.	Apply morphological operators on an image.
9.	Perform basic operations on images.
10.	Perform histogram equalization.
11.	Perform image filtering in spatial domain.
12.	Design and Implementation of image processing based case study

Text Books:

1. Gonzalez and Woods, "Digital Image Processing", Pearson Education, 3rd edition

2. Iain E. G. Richardson, ―H.264 and MPEG

3. Video Compression: Video Coding for Next Generation Multimedia‖, John Wiley and Son's Publication, 3rd Edition.

Reference Books:

1. A. K. Jain, Fundamentals of digital image processing, Prentice Hall of India, 1989.

2. Pratt William K. "Digital Image Processing", John Wiley & sons

3. A. Bovik, Handbook of Image & Video Processing, Academic Press, 2000

Program:B. Tech. (E&TC)					Semester: V		
Course: Antenna and Wave Propagation					Code: 5517		
Teaching Scheme				Evaluation Scheme			
Lecture	Tutorial	Credit	Hours	IE	MTE	ETE	Total
2		02	2	20	30	50	100

Prior knowledge of
1.Electromagnetics. Is essential

Objectives:

1. To apply concept and properties of electromagnetism to obtain parameters of antennas.
2. To understand basic concepts and operating principles of antenna array.
3. To gain knowledge about HF and VHF, UHF antennas.
4. To identify appropriate antenna for specific application.

Outcomes:

After learning the course, the students should be able to:

1. Understand antenna basics, antenna parameters and types of antennas.
2. Design and analyze antenna array with different parameters.
3. Design various types of antennas.
4. Identify and analyze various types of antennas for specific applications.

Detailed Syllabus:

Unit	wave propagation mechanism	Duration
1	**Antenna Basics**: radiation mechanism, efficiency, directivity, beam efficiency, intensity, gain, power theorem and its application, radiation pattern, far field and near field, antenna aperture, effective height, bandwidth, VSWR, radio communication link, antenna impedance. Different types of antennas e.g., Microstrip patch antenna, Dipole antenna, array antenna, wire antenna etc	**06**
2	**Antenna array**: Concept of antenna arrays, Two element arrays and their directional characteristics, Principles of pattern multiplication & their application, Linear array analysis (uniforn antenna array), Broadside and end fire arrays**.** **Array Antenna types:** Yagi-Uda antenna, Aperture array, Slotted wave guide array.	**06**
3	**Wire Antennas** - Dipole antenna, Short Dipole antenna, radiation resistance of short diploe antenna, folded dipole, Helix antenna, Loop antenna. Applications of all antennas. **Reflector Antenna**: Parabolic reflectors, Corner reflectors, Applications of all antennas. **Aperature Anenna**: Horn Antenna,Ultra-wideband antenna, MIMO antenna.	**06**

4	**Antenna for modern wireless communication:** Antennas for Biomedical applications, Wearable antenna, Antennas for Terrestrial communication - mobile handsets and base station, vehicle to vehicle communication.	06
	Total Hrs.	**24**

Text Books:

1.C.A. Balanis, Antenna Theory - Analysis and Design, 2016, 3rd edition, Wiley & Sons, New York, USA.

2.K.D. Prasad ,"Antennas and Wave Propagation", Khanna or Satya Publications

Reference Books:

1. R.K. Shevgaonkar, "Electromagnetic Waves", TMH

2 Peter S. Hall," Antennas and propagation for body centric wireless communication", Artech house.

3 e book By Albert Sabban" Novel Wearable Antennas for Communication and Medical Systems", CRC press.

4. Albert Sabban, "Wideband RF Technologies and Antennas in Microwave Frequencies", 2016, Wiley, New York USA

Program: B. Tech. (E&Tc)					Semester :V		
Course: A W P Lab					Code: BET5518		
Teaching Scheme				Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	TW	OR	PR	Total
	2hr/week		2	25	25		50

Prior knowledge of:

1.Electromagnetics and uniform plane wave **is essential**.

Objectives:

1.To Analyze radiation pattern of different antennas
2.To Evaluate VSWR at various conditions.
3.To Design and Simulate antenna using antenna simulation tools.
4.To Work in a team and learn modern tools

Outcomes:

At the end of Laboratory work, the students will be able to:

1.Analyze radiation pattern of different antennas
2.Evaluate VSWR at various conditions
3.To learn modern tools.
4.Design and Simulate antenna using antenna simulation tools

General Guidelines: Any Eight Experiments is to be performed.

Detailed Syllabus:

Expt. No.	List of Experiments
1	To Measure Radiation pattern, Return Loss, Impedance, Gain, Beam width for Dipole Antenna.
2	To Measure Radiation pattern, Return Loss, Impedance, Gain, Beam width for Folded Dipole Antenna.
3	To Measure Radiation pattern, Return Loss, Impedance, Gain, Beam width for Yagi Uda Antenna.
4	To Measure Radiation pattern, Return Loss, Impedance, Gain, Beam width for Horn Antenna.
5	To Measure Radiation pattern, Return Loss, Impedance, Gain, Beam width for Parabolic Reflector Antenna.
6	Plot Standing Wave pattern and Measure SWR for open, short, and matched termination.

7	MATLAB simulation of Broad side linear array with uniform spacing and amplitude
8	MATLAB simulation of End fire linear array with uniform spacing and amplitude.
9	Design Of Rectangular Microstrip Patch Antenna Using Strip Line Feed.
10	Design Of Rectangular Microstrip Patch Antenna Using Coaxial Feed.

Reference Book:

1. C.A. Balanis, Antenna Theory - Analysis and Design, 2016, 3rd edition, Wiley & Sons, New York, USA.
2. K.D.Prasad ,"Antennas and Wave Propagation",Khanna or Satya Publications

Program:	B. Tech. (E&TC)				Semester:	V		
Course:	Computational Tools for Data Analytics				Code:	BET5519		
Teaching Scheme					Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	Hours	IE	MTE	ETE	Total
2	-	-	2	2	20	30	50	100

Prior Knowledge of:

Basic knowledge of MATLAB and Python Programming is **essential**

Course Objectives: This course aims at enabling students to,

1. **Apply** the data analytics concepts using MATLAB and Python.
2. **Demonstrate** the applicability using statistical analysis of data analytics.
3. **Graphical Analysis** using Data Processing and Visualization.
4. **Demonstrate** the basics concept of Machine Learning.

Course Outcomes:

On completion of the course, student will be able to

1. **Demonstrate the** data analytics concepts using MATLAB and Python.
2. **Apply and Analyze** algorithms using statistical methods
3. **Demonstrate the applicability** of graphical analysis using Data processing and Visualization.
4. **Understand and apply** the concept of Regression, Classification and clustering algorithms

Detailed Syllabus:

Unit	Description	Duration
1.	**Introduction to MATLAB & Python for Data analytics** Data Analytics Introduction,Understanding the data, accessing data set Introduction to MATLAB for Data analytics: MATLAB libraries for Data analytics, importing & exporting data in MATLAB Introduction to Python for Data analytics:Python packages for Data science, importing & exporting data in Python	**5**

2.	**Introduction to Statistical Methods** Overview of statistical analysis,Introduction to descriptive statistics and data distributions. Visualizing Data Sets, Measures of Centrality and Spread, Distributions, Fit line to data-Linear Regression, Evaluating Goodness of Fit, Interpolate values from a data set-Linear Interpolation.	**7**
3.	**Data Processing and Visualization** Overview of the content-Importing Hurricane Data, Getting Started with the Data, Preprocessing data- Importing data from multiple files -Read large data stored in multiple files using datastores - visualizing the multivariate data	**5**
4.	**Introduction to Machine Learning** Introduction to Machine Learning example and its applications, Supervised Learning: Regression and Classification Unsupervised Learning: Clustering, Reinforcement Learning	**7**
	Total Hrs.	**24**

Text Books:

1. Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning", Springer 2009.
2. Wes McKinney and O'Reilly, "Python for Data Analysis", 2nd Edition.

Reference Books:

1. EthemAlpaydın ,"Introduction to Machine Learning", Second Edition, MIT Press 2010.
2. Jake Vander Plas and O'Reilly, "Python Data Science Handbook: Essential Tools for Working with Data"
3. Joel Grus and O'Reilly, "Data Science from Scratch: First Principles with Python".

Online courses

1. https://www.mathworks.com/academia/courseware/teaching-data-science-with-matlab.html
2. https://swayam.gov.in/nd1_noc20_cs46/
3. https://onlinecourses.nptel.ac.in/noc21_cs33/

Program: B. Tech. (E&Tc)					Semester:V			
Course: Computational Tools for Data Analytics Lab					Code:BET5520			
Teaching Scheme					Evaluation Scheme			
Lecture	Practical	Tutorial	Credit	Hours	TW	OR	PR	Total
	2		1	2	25	25		50

Prior knowledge of:

Basic knowledge of MATLAB and Python Programming**is essential.**

Course Objectives: This course aims at enabling students to,

1. **Apply** the data analytics concepts using MATLAB and Python.
2. **Demonstrate** the applicability using statistical analysis of data analytics.
3. **Graphical Analysis** using Data Processing and Visualization.
4. **Demonstrate** the basics concept of Machine Learning.

Course Outcomes:

On completion of the course, student will be able to

1. **Demonstrate the** data analytics concepts using MATLAB and Python.
2. **Apply and Analyze** algorithms using statistical methods
3. **Demonstrate the applicability** of graphical analysis using Data processing and Visualization.
4. **Understand and apply** the concept of Regression, Classification and clustering algorithms

General Guidelines: Any Eight Experiments is to be performed in MATLAB or Python

Detailed Syllabus:

Expt. No.	List of Experiments
	Group A: Any 3 Experiments are Compulsory
1	Introduction to Python Programming
2	Perform different measures of central tendency on data set with Python

3	Implement data exploration and visualization with Python
4	Implement Linear regression analysis for housing prices dataset using Python
	Group B: Any 3 Experiments are Compulsory
5	Introduction to MATLAB Programming
6	Perform different measures of central tendency on data set with MATLAB
7	Implement data exploration and visualization with MATLAB
8	Implement Linear regression analysis for housing prices dataset using
	Group C: Any Two Experiments are Compulsory
9	Implement classification using Support Vector Machine (SVM) for binary class using Python or MATLAB
10	Implement Sensor data collection through smart phone and processing data with MATLAB
11	Implement temperature data capturing and prediction using curve fitting with MATLAB

Text Books:

1. Trevor Hastie, Robert Tibshirani, Jerome Friedman, "The Elements of Statistical Learning", Springer 2009.
2. Wes McKinney and O'Reilly, "Python for Data Analysis", 2nd Edition.

Reference Books:

1. EthemAlpaydın ,"Introduction to Machine Learning", Second Edition, MIT Press 2010.
2. Jake Vander Plas and O'Reilly, "Python Data Science Handbook: Essential Tools for Working with Data"
3. Joel Grus and O'Reilly, "Data Science from Scratch: First Princip les with Python".

Online courses

1. https://www.mathworks.com/academia/courseware/teaching-data-science-with-matlab.html
2. https://swayam.gov.in/nd1_noc20_cs46/
3. https://onlinecourses.nptel.ac.in/noc21_cs33/

Open Elective-II

Program:B. Tech. (E&TC)				**Semester: V**			
Course: Smart City: An Electronic Perspective				**Code:** BET5601			
Teaching Scheme				**Evaluation Scheme**			
Lecture	**Tutorial**	**Credit**	**Hours**	**IE**	**MTE**	**ETE**	**Total**
3	-	3	3	20	30	50	100

Prior knowledge of

1. Basic Electronics
2. Basics of electronic communications. Is essential.

Objectives:

1. To explore need and basics of smart city and fundamental concepts of IoT.
2. To elucidate the roles of sensors and protocols in IoT
3. To explain different IoT framework and networking protocols.

Outcomes:

After learning the course, the students will be able to:

1. realize the need of smart city and its implementation challenges .
2. Comprehend the various concepts, terminologies and architecture of IoT systems.
3. Use sensors and actuators for design of IoT system for smart city.
4. Apply various wireless protocols for design of IoT systems.
5. Identify the impact of distributed Intelligence and Central Planning on city.
6. Design IoT framework based applications used in smart city.

Detailed Syllabus:

Unit	**Description**	**Duration**
1	**Necessity of SMART CITY**: The Smart City Philosophy, Development of Asian Cities, Megacities of India, : Current Challenges, The India Story of Smart Cities, Conceptual Basis of a Smart City, Global Smart City Programs, Recommendations for Smart City Framework.	**06**
2	**Fundamentals of IOT:** History of IoT, Introduction, definition and characteristics of IoT, architecture of IoT, Physical & logical design of IoT, Enabling technologies in IoT, Identifiers in IoT,M2M communication verses IoT.	**06**
3	**Sensor Networks:**Definition, types of sensors & actuators, examples & working, RFID Principles and components, Wi-Fi, Bluetooth, etc. ireless sensor network: History, sensor node, networking nodes, WSN versus IoT.	**06**

4	**Wireless Protocols for Smart Cities:** IPv6overLow-Power Wireless Personal Area Network: Features, Addressing, Packet fragmentation, Operation, Security. ZigBee: Architecture Objectives, Wireless NetworkingBasics, Wireless Networking Assumptions, Bluetooth Low Energy, IoT data protocols: MQTT Protocol. COAP Protocol, AMQP Protocol.	**06**
5	**Distributed Intelligence and Central Planning:** On the Interplay between Humans and Smart Devices, Theoretical Tools, Intelligence-artificial Intelligence (Machine Intelligence), Information Dynamics, Synergetic, Information Dynamics and Algometry in Smart Cities.	**06**
6	**Applications of IoT in smart city: TheRoleof ICTs,** Applications in smart city & their distinctive advantages -smart environment, smart street light and smart water & waste management. Smart transportation and hospitality, Roleand scopeofIOT inpresent andfuturemarketplace. Industrial IoT.	**06**
	Total Hrs.	**36**

Text Books:

1. Surjeet Dalal ,Vivek Jaglan "Green Internet of Things for Smart Cities: Concepts, Implications, and Challenges", CRC Press; 1st edition.
2. Sudip Misra, Anandarup Mukherjee, Arijit Roy, "Introduction to IoT" Cambridge University Press.
3. HakimaChaouchi,"TheInternetofThingsConnectingObjectstotheWeb"ISBN:978-1-84821-140-7, Wiley Publications
4. OlivierHersent,DavidBoswarthick,andOmarElloumi,"TheInternetofThings:KeyApplications and Protocols", Wiley Publications

Reference Books:

1. Vincenzo Piuri, Rabindra Nath Shaw,"AI and IoT for Smart City Applications" ,Springer; 1st ed. 2022 edition.
2. Alfredo Barton, Raymond Manning, "Smart Cities:Technologies, Challenges and Future Prospects" Nova Science Pub Inc
3. Ibrahim El Dimeery, Moustafa Baraka, Syed M. Ahmed, "Design and Construction of Smart Cities" Amin Akhnoukh,Springer; 1st ed. 2021 edition
4. Ricardo Armentano, Robin Singh Bhadoria ,Parag Chatterjee , "The Internet of Things: Foundation for Smart Cities", eHealth, and Ubiquitous Computing" Chapman and Hall/CRC; 1st edition
5. DanielMinoli,"BuildingtheInternetofThingswithIPv6andMIPv6:TheEvolvingWorldofM2MCommunications",ISBN:978-1-118-47347-4,WillyPublications
6. PethuruRajandAnupamaC.Raman,"TheInternetofThings:EnablingTechnologies,Platforms,andUseCases",CRCPress

Online Link/Courses:

1. http://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/index.html
2. https://onlinecourses.nptel.ac.in/noc17_cs22/course

Program:B. Tech. (E&TC)				**Semester: V**			
Course: Modeling and Simulation				**Code:** BET5602			
Teaching Scheme				**Evaluation Scheme**			
Lecture	**Tutorial**	**Credit**	**Hours**	**IE**	**MTE**	**ETE**	**Total**
3	-	3	3	20	30	50	100

Prior knowledge of

1. Engineering Mathematics
2. Basics of OOPs is essential

Objectives:

1. To explain basic modeling techniques and tools.
2. To demonstrate role of Model in continuous and discrete systems.
3. To explore with neural networks and its modeling.
4. To illustrate with fuzzy set and its modeling.

Outcomes:

After learning the course, the students should be able to:

1. Understand the basic requirements of Modeling and tools used in simulation
2. Analyze the physical models and their criteria as per knowledge of the system.
3. Compare different types of deterministic models and their applications.
4. Use optimization method; Genetic algorithms for model optimization.
5. Design the Neural Network based models using appropriate software tools.
6. Design and simulate the Fuzzy controllers to solve engineering problems.

Detailed Syllabus:

Unit	**Description**	**Duration**

1	**Introduction:** Programming environment, input and output variables, State variables, basic syntax; Deterministic linear model, Array mathematics in Matlab, Plotting, Static and Dynamic systems; Hierarchy of knowledge about a system and Modeling Strategy.	**06**
2	**Physical Modeling:** Dimensions analysis, Dimensionless grouping of input and output variables of find empirical relations, similarity criteria and their application to physical models. Stochastic modeling, Review of conservation laws and the governing equation for heat, mass and momentum transfer.	**06**
3	**Modeling of System with Known Structure:** Deterministic model: distributed parameter models in terms of partial identification and their solutions and lumped parameter models in terms of differential and difference equations, state space model, transfer functions block diagram and sub systems, stability of transfer functions, modeling for control.	**06**
4	**Optimizations and Design of Systems:** Summary of gradient based techniques : Nontraditional Optimizations techniques, genetic Algorithm (GA)- coding, GA operations, elitism, Application using MATLAB: Simulated Annealing, Introduction to GUI,GUI Programming.	**06**
5	**Introduction to Neural Network Modeling**: Basics of Neural Network, Neural Network Modeling of Systems only with Input-output Database: Neurons, architecture of neural networks, knowledge representation, learning algorithm. Multilayer feed forward network and its back propagation learning algorithm,	**06**
6	**Modeling Based on Expert Knowledge**: Fuzzy sets, Membership functions, Fuzzy Inference systems, Expert Knowledge and Fuzzy Models, Design of Fuzzy Controllers, Simulation of Engineering Systems: Monte-Carlo simulation, Simulation of continuous and discrete processes with suitable examples from engineering problems.	**06**
	Total Hrs.	**36**

Text Books:

1. Zeigler B.P. Praehofer. H. and Kim I.G. "Theory of modeling and simulation", 2 nd Edition. Academic press 2000
2. Jang J.S.R. sun C.T and Mizutani E,, "Neuro-Fuzzy and soft Computing ", 3 rd edition, Prentice hall of India 2002

Reference Books:

1. Steven I Gordon. Brian Guilfoos."Introduction to modeling and simulation using MATLAB & Python" CRC press.
2. Dr.Shailendra Jain." Modeling and simulation using MATLAB-Simulink ",2 nd Edition,Wiley
3. Shannon, R. E., "System Simulation: the Art and Science", Prentice Hall Inc. 1990
4. Pratab.R " Getting started with MATLAB" Oxford university Press 2009

Online course link: https://in.mathworks.com/learn/training/simulink-fundamentals.html

Proficiency Courses

Program: B. Tech. (E&TC)				**Semester: V/ VI**			
Course: Basics of LabVIEW				**Code: BET5911/ BET6911**			
Teaching Scheme				**Evaluation Scheme**			
Practical	**Tutorial**	**Credit**	**Hours**	**TW**	**OR**	**PR**	**Total**
2	-	-	2	-	-	-	-

Prior knowledge of:

1. Basics of programming
2. Electronics Device and Circuits

is essential.

Objectives:

1. To introduce to students, the fundamental components of LabVIEW Virtual Instruments
2. To demonstrate features of LabVIEW with implementation of basic application.

Outcomes:

After completion of this course, the students will be able to,

1. Understand the applications of LabVIEW Virtual Instrument
2. Build basic Virtual Instrument for an application.

Detailed Syllabus

Unit	**Description**	**Duration (H)**
1	**Introduction** Features of Virtual Instrumentation with LabVIEW, LabVIEW Installation, LabVIEW Environment Basics, Fundamental Tools, Debugging tools, Graphical Programming, Execution Structures	**08**
2	**Programming Components in LabVIEW** Data Structures in LabVIEW, Passing Data Between Loop Iterations in LabVIEW Loops and Charts – For, While, Charts, Multiplots, Wiring Data into Charts Building LabVIEW VI application for parameter conversion.	**08**
3	**Introduction to Data Acquisition in VI** VI Application- Implementation of Data Acquisition System for Temperature measurement	**08**
	Total	**24**

Reference Books:

1. Jeffrey Travis, Jim Kring, “LabVIEW for Everyone”, Pearson Education, Third edition-2006
2. Gary W. Johnson, Richard Jennings, “LabVIEW Graphical Programming”, McGraw-Hill Education, Forth Edition-2006
3. Behzad Ehsani, “Data Acquisition using LabVIEW”, Packt Publishing, First edition- 2016
4. Marco Schwartz, Oliver Manickum, “Programming Arduino with LabVIEW”, Packt Publishing,First edition-2015

Program: B. Tech. (E&TC)					**Semester:** V/VI		
Course: MATLAB Scripting					**Code:** BET5912/ BET6912		
Teaching Scheme				**Evaluation Scheme**			
Practical	**Tutorial**	**Credit**	**Hours**	**TW**	**OR**	**PR**	**Total**
2	-	-	2	-	-	-	-

Prior knowledge of:

1. Engineering Mathematics
2. Software operational skills

is essential.

Objectives:

1. To promote new teaching model that will help to develop programming skills and technique to solve mathematical problems.
2. To use MATLAB as a simulation tool.

Outcomes:

After learning the course, the students should be able to:

1. Learn the MATLAB interface and various methods
2. Build a program in MATLAB for implementing desired application or solving a mathematical equation.
3. Create a GUI application using MATLAB
4. Implement the given algorithm and simulate in MATLAB.

Detailed Syllabus:

Unit	Description	Duration
1.	**Introduction to MATLAB** The MATLAB Environment, MATLAB Basics – Variables, Data types, Operators, Expressions, Input and output, Vectors, Arrays – Matrices, MATLAB Functions, Built-in Functions, User defined Functions, Aabstraction and encapsulation	**06**
2.	**Programming with MATLAB**	**06**

	Conditional Statements, Loops, MATLAB Programs – Programming and Debugging, Profiling Tools and Report Generation, Applications of MATLAB Programming, GUI Development in MATLAB.	
3	**Graphics with MATLAB** Files and File Management – Import/Export, Basic 2D, 3D plots, Graphic handling, parametric plots, contour lines and implicit plots, field plots, multiple graphics display function, multivariate data, data analysis	**06**
4	**Mathematical Computing with MATLAB** Polynomials, Curve fitting, Interpolation, solving algebraic equations, Differentiation, Integration, Basic Symbolic Calculus and Differential equations, Solving an ordinary differential equation, Numerical Techniques and Transforms.	**06**
	Total	**24**

Text Books:

1. S. J. Chapman. MATLAB Programming for Engineers. Thomson, 4th edition 2016.
2. C. F. Van Loan. Introduction to Scientific Computing. Prentice Hall, 2nd edition, 2000.

Reference Books:

1. C. B. Moler, Numerical Computing with MATLAB, Cengage Learning, Edition: 2012.
2. D. J. Higham and N. J. Higham. MATLAB Guide. Siam, 2nd edition, 2005.
3. K. R. Coombes, B. R. Hunt, R. L. Lipsman, J. E. Osborn, and G. J. Stuck. Differential Equations with MATLAB. John Wiley and Sons, 1st edition, 2000.
4. A. Gilat. MATLAB: An introduction with Applications. John Wiley and Sons, 6th edition, 2017

Program: B. Tech. (E&TC)				**Semester:** V/VI			
Course: Embedded Product Design				**Code:** BET5913/ BET6913			
Teaching Scheme				**Evaluation Scheme**			
Practical	**Tutorial**	**Credit**	**Hours**	**TW**	**OR**	**PR**	**Total**
2	-	-	2	-	-	-	-

Prior knowledge of:

1. Basic electronics, Printed circuit board design.
2. System Programming and OS, Microcontroller programming,

is essential.

Objectives:

1. To make students aware of embedded product development process.
2. To impart knowledge and skills required for embedded product development.

Outcomes:

After learning the course, the students should be able to:

1. Learn the fundamentals of embedded product development.
2. Learn about the hardware elements of embedded product.
3. Acquire programming skills for software development of embedded product.
4. Design, test and debug embedded product.

Detailed Syllabus:

Unit	Description	Duration
1.	**Fundamentals of Embedded Product development** Characteristics and quality attributes (Design Metric) of embedded system, Safety and reliability, ethical practice, real time system's requirements, real time issues.	**06**
2.	**Hardware Elements of Embedded Product** Core of the embedded system, Microcontroller, Memory, Sensors and Actuators, Communication Interface, Power-supply (Battery technology, Solar), PCB and Passive components.	**06**

3.	**Software Elements of Embedded Product** Program Modelling, Embedded C-programming concepts, Embedded firmware (RTOS, Device drivers, Application programs).	**06**
4	**System Integration, Testing and Debugging Methodology** Embedded Product Design Life Cycle (EDLC), Hardware Software Codesign Testing & Debugging, Blackbox testing, White Box testing, Hardware emulation, Logic analyzer.	**06**
	Total	**24**

Text Books:

1. Frank Vahid and Tony Givargis, ― Embedded System Design – A Unified hardware/ Software introduction, 3rd edition, Wiley, 2006.
2. Karl Ulrich, Steven Eppinger, "Product Design and Development", McGraw Hill / Irvin, 3rd Edition 2009.
3. Parag H Dave, Himanshu. H. Dave, Embedded systems: Concepts, design and programming, Pearson India, 2015

Reference Books:

1. K.V. Shibu, "Introduction to Embedded Systems", McGraw Hill Education India Private Limited, 2nd Edition, 2017.
2. Ajay Deshmukh, "Microcontrollers Theory and Applications", TATA McGraw Hill, 4th Edition, 2005.
3. Raj Kamal, ―Embedded Systems – Architecture, Programming and Design" 3rd edition, 2014

Program: B. Tech. (E&TC)					**Semester:** V/VI		
Course: Model-Based Development using MATLAB					**Code:** BET5914/BET6914		
Teaching Scheme				**Evaluation Scheme**			
Practical	**Tutorial**	**Credit**	**Hours**	**TW**	**OR**	**PR**	**Total**
2	-	-	2	-	-	-	-

Prior knowledge of:

1. MATLAB environment
2. Control Systems
3. Embedded System Design

is essential.

Objectives:

1. To make students aware of Model Based Development.
2. To impart knowledge of MATLAB and Simulink

Outcomes:

After learning the course, the students should be able to:

1. Use Design of Experiment methods to create models of physical systems.
2. Apply basic control algorithms to a real physical system.
3. Connect component models together to model a larger more complex system.
4. Deploy a control algorithm on a real-time target.

Detailed Syllabus:

Unit	Description	Duration
1.	**Automotive Control Systems**	**06**

	Analog and digital control methods, Modelling of linear systems, System responses, Introduction to Automotive Control Systems and Model Based Development.	
2.	**Development in MATLAB environment** Introduction to MATLAB, Simulink and SIMSCAPE tool boxes, Model-Based Design for a small system: Motor Model, Generator Model, Controller Model.	**06**
2.	**Tuning and Refining Models** SimDriveline Introduction, Exploring the system response using different control methods, Tuning the system, exploring system limitations, Modelling and simulation of Automotive Systems with simple examples.	**06**
4	**Real time implementation of MBD** Real time simulations on a simple target (Arduino / Raspberry Pi etc), Plant on Real-Time Target like Freescale, Infineon, etc. Display Performance on Virtual Gauge Display.	**06**
	Total	**24**

Text Books:

1. Shailendra Jain, Modeling and Simulation using MATLAB - Simulink, 2editoin, 2015.
2. Agam Kumar Tyagi, Matlab and Simulink for Engg, Oxford, 2011.

Reference Books:

1. Eshkabilov Sulaymon L., Practical MATLAB Modeling with Simulink, APress,
2. Wu Wei, Model-Based Design for Effective Control System Development, IGI Global
3. Zander, Schieferdecker, Mosterman, Model-Based Testing for Embedded Systems, CRC Press, Inc., 2012.

Program: B. Tech. (E&TC)				**Semester:** V/VI			
Course: PCB Designing Skills				**Code:** BET5915/BET6915			
Teaching Scheme				**Evaluation Scheme**			
Practical	**Tutorial**	**Credit**	**Hours**	**TW**	**OR**	**PR**	**Total**
2	-	-	2	-	-	-	-

Prior knowledge of:

1. Basic understanding of electronic devices and circuits, Digital Electronics

is essential

Objectives:

1. To make students aware of various hardware and software tools used for circuit simulation, PCB design and fabrication.
2. To impart in-depth practical skills required for the development of PCB.

Outcomes:

After learning the course, the students should be able to:

1. Identify Electronic Components Symbols & Footprints
2. Construct Component libraries & use them effectively
3. Create a schematic of an analog and digital circuit
4. Simulate schematic and design a Printed circuit board for it.

Detailed Syllabus:

Unit	Description	Duration
1.	**Introduction to Electronic Circuit Simulation and PCB:** Basics of circuit simulation, Electrical rules, PCB design rules for various applications, various open source and commercial EDA tools for circuit design, simulation and PCB design	**06**

2.	**PCB Design software:** Schematic Entry, Netlist Creation, Component libraries, Design of Boards, Layout of Parts, Optimizing Parts Placements, Pads and Via, Manual and Auto Routing, Handling Multiple Layers, Gerber files.	**06**
3.	**Electromagnetic Interference.:** Overview of Electromagnetic Interference and Electromagnetic Compatibility, Reduction techniques for EMI, Line Impedance Stabilization Network (LISN), Conducted Noise, Common Mode Noises (CM), Differential Mode Noises (DM), EMI filter Design	**06**
4	**Understanding the manufacturing process of PCB**: Overview of various PCB manufacturing machines, post-processing methods, Study of soldering defect and rectification, Advanced technologies in Manufacturing, assembly and soldering.	**06**
	Total	**24**

Text Books:

1. Bossart, Printed Circuit Boards: Design and Technology, Tata McGraw Hill, 2002.
2. Farid N. Nazm, Circuit Simulation, Wiley-IEEE Press, 1st edition, 2010.

Reference Books:

1. Franco, Design with Operational Amplifiers & Analog Integrated Circuits, Tata McGraw Hill, 3rd Edition, 2002.
2. Horowitz & Hill, The Art of Electronics; Cambridge University Press, 3rd edition, 2015.
3. Mitzner.K, Complete PCB Design Using Orcad Capture and Layout. Elsevier Newnes, 1st edition, 2007.