### Semester-1

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*S/US*-Satisfactory/Unsatisfactory

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Program Electives

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List of Audit courses I & II

MTA101-18  English for Research Paper Writing
MTA102-18  Disaster Management
MTA103-18  Sanskrit for Technical Knowledge
MTA104-18  Value Education
MTA105-18  Constitution of India
MTA106-18  Pedagogy Studies
MTA107-18  Stress Management by Yoga
MTA108-18  Personality Development through Life Enlightenment Skills
FIRST SEMESTER

M.Tech (EMBEDDED SYSTEMS)
Course Objective: The main objective of the course to train the students for embedded C programming with concept of OOPs with introduction to Scripting Languages.

Course Outcomes

At the end of this course student will demonstrate the ability to:

1. Write an embedded C application of moderate complexity.
2. Develop and analyze algorithms in C++.
3. Differentiate interpreted languages from compiled languages.

Unit 1: Embedded ‘C’ Programming

Bitwise operations, Dynamic memory allocation, OS services - Linked stack and queue, Sparse matrices, Binary tree - Interrupt handling in C, Code optimization issues - Writing LCD drives, LED drivers, Drivers for serial port communication
- Embedded Software Development Cycle and Methods (Waterfall, Agile)

Unit 2: Object Oriented Programming

Introduction to procedural, modular, object-oriented and generic programming techniques, Limitations of procedural programming, objects, classes, data members, methods, data encapsulation, data abstraction and information hiding, inheritance, polymorphism

Unit 3: CPP Programming

‘cin’, ‘cout’, formatting and I/O manipulators, new and delete operators, Defining a class, data members and methods, ‘this’ pointer, constructors, destructors, friend function, dynamic memory allocation

Unit 4: Overloading and Inheritance

Need of operator overloading, overloading the assignment, overloading using friends, type conversions, single inheritance, base and derived classes, friend classes, types of inheritance, hybrid inheritance, multiple inheritance, virtual base class, polymorphism, virtual functions

Unit 5: Templates

Function template and class template, member function templates and template arguments, Exception Handling: syntax for exception handling code: try-catch- throw, Multiple Exceptions

Unit 6: Scripting Languages Overview of Scripting Languages
Course Objective
To introduce ARM processor which is widely used in embedded system and Digital signal processing has become a part of many embedded systems. This subject provides basic knowledge of ARM microcontrollers and DSP.

Course Outcomes
At the end of this course student will demonstrate the ability to:
1. Compare and select ARM processor core based SoC with several features/peripherals based on requirements of embedded applications.
2. Identify and characterize architecture of Programmable DSP Processors
3. Develop small applications by utilizing the ARM processor core and DSP processor-based platform.

Unit 1: ARM Cortex-M3 Processor
Processor Applications, Programming model – Registers, Operation modes, Exceptions and Interrupts, Reset Sequence Instruction Set, Unified Assembler Language, Memory Maps, Memory Access Attributes, Permissions, Bit-Band Operations, Unaligned and Exclusive Transfers. Pipeline, Bus Interfaces

Unit 2: Exceptions
Exceptions Types, Priority, Vector Tables, Interrupt Inputs and Pending behavior, Fault Exceptions, Supervisor and Pend able Service Call, Nested Vectored Interrupt Controller, Basic Configuration, SYSTICK Timer, Interrupt Sequences, Exits, Tail Chaining, Interrupt Latency.

Unit 3: LPC 17xx Microcontroller
Internal memory, GPIOs, Timers, ADC, UART and other serial interfaces, PWM, RTC, WDT

Unit 4: Programmable DSP (P-DSP) Processors: Harvard architecture, Multi port memory, architectural structure of P-DSP- MAC unit, Barrel shifters, Introduction to Ti DSP processor family
Unit 5: VLIW architecture and TMS320C6000 series
architecture study, data paths, cross paths, Introduction to Instruction level architecture of C6000 family, Assembly Instructions memory addressing, for arithmetic, logical operations

Unit 6: Code Composer
Studio for application development for digital signal processing, On chip peripherals, Processor benchmarking

References:

MTES-PE1X-18 Program Electives-I

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Course Objective
An overview of computer architecture, which stresses the underlying design principles and the impact of these principles on computer performance. General topics include design methodology, processor design, control design, memory organization, system organization, and parallel processing

Course Outcomes
At the end of this course student will demonstrate the ability to:
1. Understand parallelism and pipelining concepts, the design aspects and challenges.
2. Evaluate the issues in vector and array processors.
3. Study and analyze the high performance scalable multithreaded and multiprocessor systems.

Unit 1: Parallel Processing and Pipelining Processing
Architectural Classification, Applications of parallel processing, Instruction level Parallelism and Thread Level Parallelism, Explicitly Parallel Instruction Computing (EPIC) Architecture

Unit 2: Pipeline Architecture
Principles and implementation of Pipelining, Classification of pipelining processors, Design aspect of Arithmetic and Instruction pipelining, Pipelining hazards and resolving techniques, Data buffering
Unit 3: Vector and Array Processor

Unit 4: Multiprocessor Architecture
Loosely and Tightly coupled multiprocessors, Inter Processor communication network, Time shared bus, Multiport Memory Model, Memory contention and arbitration techniques, Cache coherency and bus snooping, Massively Parallel Processors (MPP).

Unit 5: Multithreaded Architecture
Multithreaded processors, Latency hiding techniques, Principles of multithreading, Issues and solutions, Parallel Programming Techniques: Message passing program development.

Unit 6: Parallel algorithms for multiprocessors
Classification and performance of parallel algorithms, operating systems for multiprocessors systems, Message passing libraries for parallel programming interface, PVM (in distributed memory system), Message Passing Interfaces (MPI).

References:

MTES-PE1B-18

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Course Objective
To provide an understanding of the principles and concepts digital signal processing, to introduce compressive sensing and its application to automatic target recognition, to provide an understanding of current research in advanced digital signal processing.

Course Outcomes
At the end of this course student will demonstrate the ability to:
1. To understand theory of different filters and algorithms
2. To understand theory of multi rate DSP, solve numerical problems and write algorithms
3. To understand theory of prediction and solution of normal equations
4. To know applications of DSP at block level.
Unit 1: Overview of DSP
Characterization in time and frequency, FFT Algorithms, Digital filter design and structures: Basic FIR/IIR filter design & structures, design techniques of linear phase FIR filters, IIR filters by impulse invariance, bilinear transformation, FIR/IIR Cascaded lattice structures, and Parallel all pass realization of IIR.

Unit 2: Multi rate DSP
Decimators and Interpolators, Sampling rate conversion, multistage decimator & interpolator, poly phase filters, QMF, digital filter banks, Applications in sub band coding. Unit 3 Linear prediction & optimum linear filters, stationary random process, forward-backward linear prediction filters, solution of normal equations, AR Lattice and ARMA Lattice-Ladder Filters, Wiener Filters for Filtering and Prediction.

Unit 3: Adaptive Filters
Applications, Gradient Adaptive Lattice, Minimum mean square criterion, LMS algorithm, Recursive Least Square algorithm

Unit 4: Estimation of Spectra from Finite-Duration Observations of Signals

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MTES-PE1C-18
EMBEDDED SYSTEM FOR WIRELESS & MOBILE COMMUNICATION

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Course Objective
To make the student understand and apply the theory behind wireless sensor networks.

Course Outcomes
At the end of this course student will demonstrate the ability to
1. Use suitable principles and standards in design and evaluation of sensor networks and wireless communication protocols for small digital transmitters.
2. Demonstrate an ability to read, critically evaluate, analyses and present (verbally or in written form) the content and implications of research articles in the area.
3. Drawing on relevant results from research literature design and implement software and system solutions for wireless embedded systems.

**Unit 1: Introduction to wireless technologies**
WAP services, Serial and Parallel Communication, Asynchronous and synchronous Communication, FDM, TDM, TFM, Spread spectrum technology.

**Unit 2: Introduction to Bluetooth**
Specification, Core protocols, Cable replacement protocol Bluetooth Radio: Type of Antenna, Antenna Parameters, Frequency hopping

**Unit 3: Bluetooth Networking**
Wireless networking, wireless network types, devices roles and states, adhoc network, scatter net Connection establishment procedure, notable aspects of connection establishment, Mode of connection, Bluetooth security, Security architecture, Security level of services, Profile and usage model: Generic access profile (GAP), SDA, Serial port profile, Secondary bluetooth profile.

**Unit 4: Hardware**

**Unit 5: Programming with Java**

**Unit 6: Obex Package**
interfaces, classes bluetooth services registration and search application, bluetooth client and server application.Overview of IrDA, HomeRF, Wireless LANs, JINI

**BOOKS:**
- Bluetooth Technology by C.S.R. Prabhu and A.P. Reddi; PHI
Course Objective  this course will cover fundamental concepts used in soft computing. The concepts of fuzzy logic(FL) will be covered first, followed by Artificial Neural Networks(ANNs) and optimizing techniques using genetic Algorithm(GA).

Course Outcomes  At the end of this course student will demonstrate the ability to:

1. Understand importance of soft computing.
2. Understand different soft computing techniques like Genetic Algorithms, Fuzzy Logic, Neural Networks and their combination.
3. Implement algorithms based on soft computing.
4. Apply soft computing techniques to solve engineering or real life problems.

Unit 1: Introduction
History of development in neural networks, neural network characteristics, Artificial neural network technology, Model of a neuron, topology, learning, types of learning, supervised, unsupervised and reinforcement learning.

Unit 2: Supervised Learning
Basic hop field model, the perceptron, linear reparation, Basic learning laws, Hebb’s rule, Delta rule, Widroff and Huff LMS learning rule, correlation learning rule, In star and out star learning rules. Unsupervised learning, competitive learning, K mean clustering algorithm, Kolwners’s feature maps

Unit 3: Radial Basis Function
Basic learning laws in RBF network, recurrent networks, recurrent back propagation, Real time recurrent learning algorithm.

Unit 4: Counter Propagation Networks

Unit 5: Fuzzy Logic
Basic concepts of fuzzy logic, Fuzzy logic crisp set, Linguistic variable, Membership functions, Operation of fuzzy set, Fuzzy IF-THEN rules, Variable inference techniques, Defuzzification techniques, Basic fuzzy inference algorithm, Application of fuzzy logic, Fuzzy system design, Implementation of fuzzy system, Useful tools supporting design.

Unit 6: Support Vector Machines
Introduction, Support Vector classification, Support Vector regression, applications.

Unit 7: Basics of Genetic Algorithms
Evolution of Genetic and Evolutionary Algorithms, Applications.
BOOKS RECOMMENDED:

- Kosko B, *Neural Networks and Fuzzy Logic*, Prentice Hall
- Haykin S, *Neural Networks*, Pearson Education
- Anderson JA, *An Introduction to Neural Networks*, Prentice Hall
- Sivanandam S and Deepa SN, *Principles of Soft Computing*, Wiley India

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**Course Objective:** To provide knowledge levels needed for PLC programming and operating, to make the students understand various types of PLC registers and apply PLC Timers and Counters for the control of industrial processes.

**Course Outcomes:** At the end of this course student will demonstrate the ability to:

1. Ability to gain knowledge on Programmable Logic Controllers
2. Will understand different types of Devices to which PLC input and output modules are connected
3. To provide the knowledge about understand various types of PLC registers
4. Able to create ladder diagrams from process control descriptions.
5. Ability to apply PLC timers and counters for the control of industrial processes
6. Able to use different types PLC functions, Data Handling Function.

**Unit 1: Introduction**

Introduction to Programmable Logic Controllers (PLCs), history of PLCs, Characteristics, Operation, function, Types of PLC Advantages of PLCs and Comparison of PLC based control systems with computers.

**Unit 2: PLC Hardware**

Block diagram of PLC, Internal architecture of PLC, The I/O section, Digital and Analog Input output modules of PLCs, special I/O Modules, I/O specifications, CPU, Memory design and human machine interfaces.

**Unit 3: PLC Instructions**

Number system and codes, fundamental of logic, Bit Logic Instructions, Instruction set: Bit level instructions, Compare, Move/Logical, Math, Program Control Instructions etc.
Unit 4: Basics of PLC programming-Ladder
Diagram of logic gates, program files, program scan, PLC programming languages, branch instructions.

Unit 5: PLC Timers and Counter Instruction
Various types of PLC timers with detailed timing diagrams: On delay timer, Off delay timer, Retentive on delay timer, Pulse timer. Various types of PLC counters: Up counter, Down counter, Up-Down counter, Programming of various applications using timers and counters using Ladder diagram only.

Unit 6: PLC communications

Unit 7: Industrial Automation

Books Recommended:
- Programmable Logic Controllers by Frank D. Petruzella, McGraw-Hill Education; 4 edition (1 October 2010)
- Programmable Logic Controllers by John W. Webb: Principles and Applications (Fifth Edition)

MTES-PE2C-18

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Course Objective: This course provides an introduction to the design of electronic systems that incorporate both hardware and software components. Techniques for modeling hardware and software components at different levels of abstraction and at their interfaces are investigated

Course Outcomes
At the end of this course student will demonstrate the ability to:
1. To provide a strong theoretical background and practical experience in the design and development of sophisticated embedded systems of moderate complexity through the use of contemporary tools and formal design methodologies.
2. To understand the importance of safety and reliability in contemporary embedded systems.
3. To investigate and apply techniques for performance optimization.
4. To introduce the growing area of distributed embedded systems.
Unit 1: Co-Design Issues

Unit 2: Prototyping and Emulation
Prototyping and emulation techniques, prototyping and emulation environments, future developments in emulation and prototyping architecture specialization techniques, system communication infrastructure Target Architectures: Architecture Specialization techniques, System Communication infrastructure, Target Architecture and Application System classes, Architecture for control dominated systems (8051-Architectures for High performance control), Architecture for Data dominated systems (ADSP21060, TMS320C60), Mixed Systems.

Unit 3: Compilation Techniques and Tools for Embedded Processor Architectures
Modern embedded architectures, embedded software development needs, compilation technologies, practical consideration in a compiler development environment.

Unit 4: Design Specification and Verification
Design, co-design, the co-design computational model, concurrency coordinating concurrent computations, interfacing components, design verification, implementation verification, verification tools and interface verification

Unit 5: Languages for System
Level Specification and Design-I: System – level specification, design representation for system level synthesis, system level specification languages, Languages for System – Level Specification and Design-II: Heterogeneous specifications and multi-language co-simulation, the cosyma system and lycos system.

Books Recommended:
MTES-111-18

**Advance Microcontroller lab**

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**Course Objective:** To demonstrate programming proficiency using the various addressing modes and data transfer instructions of the ARM microcontroller and to interface the controller to external devices.

**Course Outcomes**

At the end of this course student will demonstrate the ability to:
1. Install, configure and utilize tool sets for developing applications based on ARM processor core SoC and DSP processor.
2. Develop prototype codes using commonly available on and off chip peripherals on the Cortex M3 and DSP development boards.

**List of Assignments:**

Experiments to be carried out on Cortex-M3 development boards and using GNU toolchain

1. Blink an LED with software delay, delay generated using the SysTick timer.
2. System clock real time alteration using the PLL modules.
3. Control intensity of an LED using PWM implemented in software and hardware.
4. Control an LED using switch by polling method, by interrupt method and flash the LED once every five switch presses.
5. UART Echo Test.
6. Take analog readings on rotation of rotary potentiometer connected to an ADC channel.
7. Temperature indication on an RGB LED.
8. Mimic light intensity sensed by the light sensor by varying the blinking rate of an LED.
9. Evaluate the various sleep modes by putting core in sleep and deep sleep modes.
10. System reset using watchdog timer in case something goes wrong.
11. Sample sound using a microphone and display sound levels on LEDs.

MTES-112-18

**Advanced Digital Signal Processing lab**

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**Course Objective:** To demonstrate programming proficiency for the filter design for both time and frequency domains.

**Course Outcomes**

At the end of this course student will demonstrate the ability to:
1. Design different digital filters in software
2. Apply various transforms in time and frequency
List of Assignments:
1. Basic Signal Representation
2. Correlation Auto and Cross
3. Stability Using Hurwitz Routh Criteria
4. Sampling FFT Of Input Sequence
5. Butterworth Lowpass and high pass Filter Design
6. Chebychev Type I, II Filter
7. State Space Matrix from Differential Equation
8. Normal Equation Using Levinson Durbin
9. Decimation and Interpolation Using Rationale Factors
10. Maximally Decimated Analysis DFT Filter
11. Cascade Digital IIR Filter Realization
12. Convolution and M Fold Decimation &PSD Estimator
13. Estimation Of PSD
14. Inverse Z Transform

Course Objective
To enable student to acquire knowledge of research process: gather data, implement the proposed work and collect the results and publish them.

Course Outcomes
After the completion of the course, students will be able to
1. Understand research, research process, define and redefine research problem through literature survey.
2. Know the primary and secondary sources of data collection and select sample size based on the requirement.
3. Utilize the resources efficiently.
4. Critically analyse the data through various statistical measures, perform experiment, gather data and reach to a conclusion based on some hypothesis.
5. Know the intellectual property rights.
6. Write up the report and research article.

Unit I Overview of Research: Meaning of Research, Objectives of research, Types of research, Research approaches, Significance of research, Criteria of good research. Defining the research problem: research problem, Necessity of defining the problem, Technique involve in defining a problem.

Unit II Research Design: Need for research design, Features of a good design, Basic principles of Experimental design. Data Collection: Methods of Data Collection; Primary data and Secondary Data.

Unit III Data preparation: Data preparation process, designing questionnaires and schedules. Descriptive statistics: Measures of central tendency, Mean, Median, Mode etc. Sampling and
non-sampling errors, Testing of Hypotheses: Parametric (t, z and F) Chi Square, ANOVA, and non-parametric tests.


Suggested Readings/ Books:

- Krishnaswami K. N., Sivakumar A. I., Mathirajan M., Management Research Methodology, Pearson Education, New Delhi
- Asimov, Introduction to Design, Prentice Hall.
- T. Ramappa, Intellectual Property Rights Under WT, S. Chand
SECOND SEMESTER

M.Tech (EMBEDDED SYSTEMS)
Course Objective: Students will understand the concepts of Internet of Things and can able to build IoT applications.

Course Outcomes: At the end of this course student will demonstrate the ability to:
1. Understand the concept of IOT and M2M
2. Study IOT architecture and applications in various fields
3. Study the security and privacy issues in IOT.


Unit 2: M2M to IoT – A Basic Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, an emerging industrial structure for IoT, M2M to IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.


Unit 5: Internet of Things Privacy, Security and Governance
Introduction, Overview of Governance, Privacy and Security Issues.

Unit 6: Contribution from FP7 Projects

References:
- Cuno Pfister, “Getting Started with the Internet of Things”, OReilly Media, 2011.
Course Objective: The objective of the course is to provide understanding of the techniques essential to the design and implementation of embedded systems with embedded operating systems.

Course Outcomes: At the end of this course student will demonstrate the ability to:
1. Familiarity of the embedded Linux development model.
2. Write, debug, and profile applications and drivers in embedded Linux.
3. Understand and create Linux BSP for a hardware platform.

Unit 1: Embedded Linux Vs Desktop Linux, Embedded Linux Distributions

Unit 2: Embedded Linux Architecture: Kernel Architecture _HAL, Memory manager, Scheduler, File System, I/O and Networking subsystem, IPC, User space, Start-up sequence


Unit 4: Porting Applications Real-Time Linux: Linux and Real time, Programming, Hard Real-time Linux

Unit 5: Building and Debugging: Kernel, Root file system Embedded Graphics

Unit 6: Case study of uClinux

References:
Karim Yaghmour, “Building Embedded Linux Systems”, O'Reilly & Associates
Course Objective
The objective of this course is to provide students with opportunities to learn different types of digital systems and to understand and deal with various practical issues related to their design.

Course Outcomes
At the end of this course student will demonstrate the ability to:
1. This is an advanced course on digital design techniques.
2. The students will be able to appreciate the advantages/disadvantages between the implementations using standard logic (SSI, MSI) and programmable logic (PLDs, PGAs).
3. A great deal of emphasis will be given to Hardware Description language- VHDL and its design styles so that students can describe digital systems using HDL.

Unit 1: Introduction to Digital Design Concepts
Review of digital design fundamentals, minimization and design of combinational circuits, sequential machine fundamentals

Unit 2: VHDL
Why VHDL? Basic Language Elements, Data objects, classes and data types, operators, overloading, logical operators, VHDL representation of Digital design entity and architectural declarations, introduction to behavioural, dataflow and structural models

Unit 3: Clocked Sequential Finite State Machines
State diagram, analysis of synchronous circuits, derivation of state graphs and tables, reduction of state tables, state assignment, design of sequence detectors, serial data code conversion, design of synchronous sequential state machine, design and applications of counters and shift registers

Unit 4: Multi-input System Controllers Design
System controller, controller design principles, timing and frequency considerations, DFD development, controller architecture design, asynchronous input handling, state assignment concepts, flip-flop level implementation using VEM’s

Unit 5: Sequential Design using LSI & MSI circuits
Using decoders, multiplexers in sequential circuits, sequential network design using ROMs, PLAs and PALs, Programmable gate Arrays (PGAs)

Unit 6: Asynchronous Sequential Finite State Machines
Introduction, analysis of asynchronous networks, races and cycles, derivation of primitive flow tables, reduction of primitive flow tables, state assignments, hazards, asynchronous sequential network design.
Recommended Books


Course Objective: This course provides an introduction to the fundamentals of artificial intelligence. It contains a theory component about the concepts and principles that underlie modern AI algorithms.

Course Outcomes
At the end of this course student will demonstrate the ability to:
1. Understand the concept of Artificial Intelligence, search techniques and knowledge representation issues
2. Understanding reasoning and fuzzy logic for artificial intelligence
3. Understanding game playing and natural language processing.

Unit 1: What is AI (Artificial Intelligence)? : The AI Problems, The Underlying Assumption, What are AI Techniques, The Level Of The Model, Criteria For Success, Some General References, One Final Word


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Course Objective:

Course Outcomes: At the end of this course student will demonstrate the ability to:
1. Demonstrate technical competence in the field of mechatronics engineering including problem identification and formulation, as well as dynamic and control analysis of mechatronic systems.
2. Demonstrate the practical skills associated with the use of modern modelling and simulation tools.
3. Design electronic and embedded systems for mechatronic applications including robotic, computer vision and control systems.

Unit 1: Introduction
Definition of Mechatronics, Mechatronics in manufacturing, Products, and design. Comparison between Traditional and Mechatronics approach.

Unit 2: Review of fundamentals of electronics
Data conversion devices, sensors, microsensors, transducers, signal processing devices, relays, contactors and timers. Microprocessors controllers and PLCs.

Unit 3: Drives
Stepper motors, servo drives. Ball screws, linear motion bearings, cams, systems controlled by camshafts, electronic cams, indexing mechanisms, tool magazines, transfer systems.
Unit 4: Hydraulic systems
Flow, pressure and direction control valves, actuators, and supporting elements, hydraulic power packs, pumps. Design of hydraulic circuits. Pneumatics: production, distribution and conditioning of compressed air, system components and graphic representations, design of systems. Description.

Unit 5: Controllers
Description of PID controllers, CNC machines and part programming.

Industrial Robotics

BOOKS:

MTES-PE4Y-18 Programme Electives-IV

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Course Objective: To learn how to use Cloud Services, to implement Virtualization, to implement Task Scheduling algorithms, Apply Map-Reduce concept to applications, To build Private Cloud, Broadly educate to know the impact of engineering on legal and societal issues involved

Course Outcomes: At the end of this course student will demonstrate the ability to:
1. Analyze the Cloud computing setup with its vulnerabilities and applications using different architectures.
2. Design different workflows according to requirements and apply map reduce programming model.
3. Apply and design suitable Virtualization concept, Cloud Resource Management and design scheduling algorithms.

Unit 1: Introduction to Cloud Computing-Online Social Networks and Applications, Cloud introduction and overview, Different clouds, Risks, Novel applications of cloud computing


Unit 5: Audit and Compliance—Internal Policy Compliance, Governance, Risk, and Compliance (GRC), Regulatory/External Compliance, Cloud Security Alliance, Auditing the Cloud for Compliance, Security-as-a-Cloud.

Unit 6: Advanced Topics—Recent developments in hybrid cloud and cloud security.

BOOKS RECOMMENDED:

2. Cloud Security and Privacy: An Enterprise perspective on Risks and Compliance (Theory in Practice), 2009

MTES-PE4B-18  C  L  T  P  Int  Ext
DESIGNING WITH POWER DEVICES  3  3  0  0  40  60

Course Objective: acquire an understanding of the nature of power semiconductor devices and their control and use in switch-mode; understand the arrangement and topology of the circuits in which switch-mode devices.

Course Outcomes

At the end of this course student will demonstrate the ability to:

1. Understand basic operation of various power semiconductor devices and switching circuits.
2. Analysis and design Transformers for PWM converters
3. Study principle and operation switch mode power supplies.
4. Study and analyze ups and other power supplies.
Unit 1: POWER SEMICONDUCTOR DEVICES
General characteristics of Power devices such as GTOs, Power BJT, Power MOSFET, IGBT, MCT.

Unit 2: TRANSFORMER DESIGN
Fundamentals, Selection of core material, Insulating material and wires, Design Methodology of pulse transformers, High Frequency transformers, Design of Transformers for PWM converters.

Unit 3: COILS
Fundamentals, Selection of core material, Insulating materials and wires, Design of inductors for power frequency, Radio frequency & High frequency.

Unit 4: SWITCH MODE POWER SUPPLIES
Basic regulators, Buck, Boost, Buck Boost, Derived topologies, flyback, forward, Push-pull, half & full bridge converter, Special converters like Cuk™ converter, PWM control techniques, Study of PWM control ICs Design of base derive circuits, Design of input section, output section & control section, Thermal design concepts, EMI/EMC considerations, Protection circuit design for power supplies.

Unit 5: UPS AND OTHER POWER SUPPLIES
Concept of Uninterrupted power supplies, Inverter preferred (online UPS), Line preferred UPS system (offline UPS system), Line interactive UPS system, Reliability of UPS system, Solar cells as power source devices & their characteristics.

BOOKS RECOMMENDED:

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Course Objective: students are introduced to advanced concepts in sensing and actuation for mechatronic systems, including both traditional sensors and actuators, an introduction to advanced topics in microelectromechanical system (MEMS) sensing, and smart material.

Course Outcomes: At the end of this course student will demonstrate the ability to:
1. Understand the underlying physical principles of the basic transduction mechanisms of different sensors and actuators.

2. Understand the evolution of emerging sensor and actuator technologies such as micro electromechanical systems (MEMS).

3. Understand the fundamental principles of data acquisition.

4. Demonstrate the ability to apply self-directed learning skills by researching a sensor or actuator not discussed in class.

**Unit 1: MEASUREMENT TERMINOLOGY**
Input and output, range, accuracy, precision, resolution, sensitivity, linearity, repeatability, reproducibility, calibration and traceability, Testing, quality assurance and safety.

**Unit 2: TRANSDUCERS AND SENSORS**
Sensors and transducers: Temperature sensors, resistive sensors, capacitive sensors, electrostatic sensors, piezoelectric sensors, ultrasonic sensors, radiological sensors and MEMS. Optical sensing techniques: Common electromagnetic sensors, IR sensors, passive IR sensors, photo-resistive sensors, photovoltaic sensors, photodiodes, photoelectric detectors, solid state lasers, CCD and CMOS sensors.

**Unit 3: SMART SENSORS**

**Unit 4: ACTUATORS**

**Unit 5: EMERGING TOPICS**
Introduction to sensor networks, sensor fusion, soft and intelligent sensors. System on module, Virtual instrumentation, Intelligent instrumentation, Fault tolerance, Real time systems introduction, reference model, scheduling approaches.

**BOOKS:**
8. K.D. (Guest Editor) “Integrated Sensors, Microp-actuators and micro-systems
9. MEMS, Special Issue of proceedings of IEEE, Vol. 86, No.8, August 1998
Course Objective
This is laboratory course meant to to explore different aspects and develop different applications in IoT field.

Course Outcomes
At the end of this course student will demonstrate the ability to:
1. Understand the concept of embedded programming and RF Experiments.
2. Study the Experiments on interfacing with raspberry pi/Arduino board/Ubisense
3. To Study the WSN and IOT Applications.

Experiments

Embedded Programming
Toggling LEDs, transmitting a string through UART, Controlling LEDs blinking pattern through UART, Echo each character typed on serial terminal, Digital IO configuration, Timer based LED Toggle, On-chip Temperature measurement through AD.

RF experiments
Point-to-Point communication of two Motes over the radio frequency, Multi-point to single point communication of Motes over the radio frequency.

Experiments on interfacing with raspberry pi/Arduino board/Ubisense
I2C protocol study, Reading Temperature and Relative Humidity value from the sensor, Reading Light intensity value from light sensor, reading of atmospheric pressure value from pressure sensor, Proximity detection with IR LED, Generation of alarm through Buzzer, Transmitting the measured physical value over the Air.

WSN Applications
Demonstration of a Peer-to-Peer network topology using Coordinator and end device network device types, Demonstration of Peer-to-Peer communication between Coordinator and end device through Router, Establishing Many-to-One Communication (Star Network Topology), Establishing Tree Network Topology, Establishing Cluster Tree Network.

IOT applications
IK Gujral Punjab Technical University, Kapurthala

Porting 6LoWPAN stack on mote for enabling it with IPv6, 6LoWPAN network formation with motes and PC, IP based lighting control through Data Acquisition Card, IP based sensor monitoring.

Students are required to do one case study from the following:

Smart Cities and Smart Homes, Connected Vehicles: Smart Grid: Industrial IoT, Agriculture, Healthcare, Activity Monitoring

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Course Objective This is laboratory course meant to realize the system design with embedded Linux for real time applications

Course Outcomes At the end of this course student will demonstrate the ability to:
1. Familiarity of the embedded Linux development model.
2. Write, debug, and profile applications and drivers in embedded Linux.
3. Understand and create Linux BSP for a hardware platform

Experiments

1. Create processes using different system calls like fork, exec, wait etc.
2. Develop program for a Orphan and Zombie process.
3. Develop programs to create threads, passing data to threads, joining threads and using thread attributes.
4. Develop programs to interface system call.
5. Develop programs to use different IPC“s- Pipes, Message Queues, FIFO and Sockets
6. Develop programs to use different synchronization techniques – Semaphore, Shared Memory, Mutex.
7. Write Device Driver modules that registers a character device with major no and with File Operations -Open, Release, Read, Write etc.
8. Develop programs to implement Realtime FIFO.
9. Using socket program develop a simple file transfer programs.
10. Write programs to determine CPU usage in a multitasking environment in µCOS-II.
11. Develop programs to demonstrate stack- checking feature of µCOS-II
THIRD SEMESTER

M.Tech (EMBEDDED SYSTEMS)
**Course Objective:** Students are introduced to concepts of reliability, Reliability Data and Analysis Data, System Reliability and Modeling, Maintainability and Availability.

**Course Outcomes**

At the end of this course student will demonstrate the ability to:

1. Demonstrate understanding of basic reliability measures such as failure rate, availability, MTTR, etc.
2. Compute and evaluate reliability for redundant, series, and parallel systems.
3. Develop fault trees and apply various reliability models to identify and analyze possible faults in machine systems and assess their impact on overall system reliability & maintainability.
4. Use reliability improvement techniques and undertake product testing.

**Unit 1: Concept of reliability** Failures of systems and its modes. Measure of Reliability, Reliability function, Hazard rate MTBF and their interrelations.

**Unit 2: Reliability Data and Analysis Data** sources, Data collection, use of Reliability Data, Reliability Analysis, Performance Parameters, calculation of failure rate, Application of Weibull distribution.

**Unit 3: System Reliability and Modeling** Series systems, Parallel system, series parallel systems. Time dependence, Reliability Determination, stand by systems, r out of n, Configurations, Methods of tie set and cut sets of or reliability evaluation, simulation and Reliability prediction. Monte Carlo method, concepts of network topology. Overall reliability evolution.


**Unit 6: Value Engineering** Techniques in value Engg; Structure of value Engg. Reliability Management.
Books Recommended:
3. Related IEEE/IEE publications

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<th>MTES-PE5B-18</th>
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Course Objective: The objective of this course is to make students to gain basic knowledge on overview of MEMS (Micro electro Mechanical System) and various fabrication techniques. This enables them to design, analysis, fabrication and testing the MEMS based components. And to introduce the student’s various opportunities in the emerging field of MEMS.

Course Outcomes: At the end of this course student will demonstrate the ability to:
1. Design fabrication process plan for development of MEMS.
2. Identify characterization and assembly techniques for developed MEMS.
3. Develop physics-based model of MEMS.

Unit 1: Introduction

Unit 2: Micromachining techniques
Introduction to Bulk Micromachining, Isotropic and Orientation-Dependent Wet Etching, Dry Etching, Buried Oxide Process, Silicon Fusion Bonding, Sacrificial Layer Technology, Surface Micromachining using Plasma Etching, Combined 1C Technology and Anisotropic Wet Etching, Processes Using Both Bulk and Surface Micromachining, Adhesion Problems in Surface Micromachining, Surface Versus Bulk Micromachining.

Unit 3: MICROSYSTEMS DESIGN AND PACKAGING

Unit 4: Smart Sensors and Modeling.
Introduction to Smart Sensors, Integrated Smart sensors and smart systems, MEMS and NEMS devices, Elastic structures in MEMS and NEMS, Modeling of Thermal Elastic systems, Electrostatic-elastic systems, magnetically actuated systems, Microfluidics (Membrane Pumps, Nanolithography, Nano jets)

BOOKS:
1. Modeling MEMS and NEMS John A. Pelesko and David H. Bernstein Chapman & Hall/CRC
2. MEMS Fundamental Technology and Applications vikas Choudhary and Krzysztof Iniewski CRC press

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Course Objective: The objective of this course is to introduce student to basic biomedical engineering technology and introduce different biological signals, their acquisition, measurements and related constraints.

Course Outcomes At the end of this course student will demonstrate the ability to:
1. Define basic medical terms and physical values that can be handled by medical instrumentation.
2. Describe methods and implementation of electrical and nonelectrical medical parameters diagnostic
3. Demonstrate measuring of basic medical parameters calculate basic parameters of the equipment for using in electro diagnostic and electro therapy.
4. Recommend problem solving and service procedures for electrical equipment.
5. Apply safety standards and select disposal method and procedures for electrical diagnostic equipment.

Unit 1: Human Body Subsystems
Brief description of neuronal, muscular, cardiovascular and respiratory systems; their electrical, mechanical and chemical activities.

Unit 2: Cardiovascular System
Measurement of blood pressure, blood flow, cardiac output, cardiac rate, heart sounds; Electrocardiograph, Phonocardiograph, Plethysmograph.
Unit 3: Respiratory System
Measurement of gas volume, flow rate, carbon-dioxide and oxygen concentration in exhaled air.

Unit 4: Electrical Activity in Neuromuscular System and Brain
Neuron potential, muscle potential, electromyography, brain potentials, electroencephalograph.

Unit 5: Medical Imaging
Fundamentals of imaging, Computed tomography, MRI, Nuclear Medicine, Single photon emission computed tomography, PET, Ultrasonography, Electrical Impedance, Tomography.

Unit 6: Medical Safety
Electrical Safety, Electrical safety codes and standards; Radiation safety, Chemical safety, Biological safety, Fire and explosive safety, Environmental Safety.

Unit 7: Assisting and Therapeutic Equipment’s
Pacemakers, Defibrillators, Ventilators, Nerve and Muscle stimulators, Diathermy, Heart-Lung machine, Infant incubators, Audio meters, Dialyzers.

Books Recommended:
- Webster JG (Ed.), *Medical Instrumentation, Application and Design*, Wiley India
- Carr JJ and Brown JM, *Introduction to Biomedical Equipment Technology*, Pearson Education
- Webster JG (Ed.), *Encyclopedia of Medical Devices and Instrumentation*, Vols. 1-4, Wiley
- Bronzino JD (Ed.), *The Biomedical Engineering Handbook*, CRC Press

MTOE-301X-18 Open Electives

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Course Objective
This course deals with strategic cost management for engineering projects and useful quantitative techniques to implement

Course Outcomes
At the end of this course student will demonstrate the ability to:
1. Understand the cost calculation for decision-making about an engineering research project
2. Able to define Role of each member in the project team
3. Manage the project by applying Quantitative techniques for cost management
Unit 1
Introduction and Overview of the Strategic Cost Management Process

Unit 2:
Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost. Objectives of a Costing System; Inventory valuation; Creation of a Database for operational control; Provision of data for Decision-Making.

Unit 3:

Unit 4:

Recommended Books:
1. Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi
2. Charles T. Horngren and George Foster, Advanced Management Accounting
3. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting
5. N.D. Vohra, Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd.

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Course Objective
This course deals with Composite Materials and preparation/manufacturing of Metal Matrix Composites.
Course Outcomes
At the end of this course student will demonstrate the ability to:
1. Understand the characteristics of Composite materials and their advantages and applications
2. Get exposure to Manufacturing of Metal Matrix Composites: Knitting, Braiding, Weaving and estimate Strength

Unit 1

Unit 2:

Unit 3:

Unit 4:

Unit 5:
Strength: Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength- ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

Recommended Books:

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<th>MTOE-301C-18</th>
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<tbody>
<tr>
<td>Open Elective Waste to Energy</td>
<td>3</td>
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<td>40</td>
<td>60</td>
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Course Objective
This course deals with effective and cheap methods to convert waste into useful energy.

Course Outcomes
At the end of this course student will demonstrate the ability to:
1. Understand various methods to convert agro, forest and industrial residue to useful energy
2. Get exposure Biomass Combustion, Biomass Gasification etc.

Unit 1
Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

Unit 2:

Unit 3:

Unit 4:
Biomass Combustion: Biomass stoves – Improved chullahs, types, some exotic designs,Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

Unit 5:
Biogas: Properties of biogas (Calorific value and composition) - Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications – Alcohol production from biomass - Bio diesel production -Urban waste to energy conversion - Biomass energy programme in India.

Recommended Books:
## English for research paper writing

### Course Objective
This course is to develop skills in effective English writing to communicate the research work.

### Course Outcomes
At the end of this course Students will be able to:
1. Understand that how to improve your writing skills and level of readability
2. Learn about what to write in each section
3. Understand the skills needed when writing a Title
4. Ensure the good quality of paper at very first-time submission

### Unit 1
Planning and Preparation, Word Order, breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

### Unit 2

### Unit 3
Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

### Unit 4
Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature.

### Unit 5
Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

### Unit 6
Useful phrases, how to ensure paper is as good as it could possibly be the first-time submission

### Recommended Books:
Course Objective

This course is to develop skills in helping society during natural disasters and how to manage.

Course Outcomes

At the end of this course students will be able to:
1. Learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. Critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. Develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. Critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in.

Unit 1
Introduction: Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Types And Magnitude.

Unit 2

Unit 3
Disaster Prone Areas In India Study Of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics.

Unit 4
Disaster Preparedness And Management Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.

Unit 5
Risk Assessment Disaster Risk: Concept And Elements, Disaster Risk Reduction, Global And National Disaster Risk Situation. Techniques Of Risk Assessment, Global Co-Operation In Risk Assessment And
Unit 6
Disaster Mitigation Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

Recommended Books:
2. Sahni, PardeepEt.Al. (Eds.),” Disaster Mitigation Experiences And Reflections”, Prentice Hall Of India, New Delhi.

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<th>MTA103-18</th>
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<td>Sanskrit For Technical Knowledge</td>
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Course Objective
This course is to develop
1. A working knowledge in illustrious Sanskrit, the scientific language in the world
2. Learning of Sanskrit to improve brain functioning
3. Learning of Sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power
4. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

Course Outcomes
At the end of this course students will be able to
1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood
3. Being a logical language will help to develop logic in students

Unit 1
Alphabets in Sanskrit, Past/Present/Future Tense, Simple Sentences.

Unit 2

Unit 3
Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

Recommended Books:
1. “Abhyaspustakam” – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
This course is to develop
1. Value of education and self-development
2. Imbibe good values in students
3. Let the should know about the importance of character

At the end of this course students will be able to
1. Knowledge of self-development
2. Learn the importance of Human values
3. Developing the overall personality


Importance of cultivation of values, Sense of duty, Devotion, Self-reliance, Confidence, Concentration, Truthfulness, Cleanliness, Honesty, Humanity, Power of faith, National Unity, Patriotism, Love for nature, Discipline.

Personality and Behavior Development - Soul and Scientific attitude, Positive Thinking. Integrity and discipline, Punctuality, Love and Kindness, Avoid fault Thinking, Free from anger, Dignity of labour, Universal brotherhood and religious tolerance, True friendship, Happiness Vs suffering, love for truth, Aware of self-destructive habits, Association and Cooperation, Doing best for saving nature.

Character and Competence – Holy books vs Blind faith, Self-management and Good health, Science of reincarnation, Equality, Nonviolence, Humility, Role of Women, All religions and same message, Mind your Mind, Self-control, Honesty, Studying effectively.
Course Objective

This course is to
1. Understand the premises informing the twin themes of liberty and freedom from a civilrights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals’ constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Course Outcomes

Students will be able to:
1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.

Unit 1:

Unit 2:
Philosophy of the Indian Constitution:Preamble, Salient Features.

Unit 3:
Contours of Constitutional Rights & Duties:Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion Cultural and Educational Rights, Right to
Unit 4:
Organs of Governance: Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

Unit 5:
Local Administration: District’s Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO of Municipal Corporation, Pachayati raj: Introduction, PRI: ZilaPachayat, Elected officials and their roles, CEO ZilaPachayat: Position and role, Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

Unit 6:
Election Commission: Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners, State Election Commission: Role and Functioning, Institute and Bodies for the welfare of SC/ST/OBC and women.

Recommended Books:
1. The Constitution of India, 1950 (Bare Act), Government Publication.

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<td>Pedagogy Studies</td>
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Course Objective

This course is to inculcate better teaching methods/tools for future teachers to build a better education system to compete with the developed nations pedagogical practices.

Course Outcomes

Students will be able to understand:
1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

Unit 1:
Introduction and Methodology: Aims and rationale, Policy background, Conceptual framework and terminology, Theories of learning, Curriculum, Teacher education, Conceptual framework, Research questions, Overview of methodology and Searching.

Unit 2: Thematic overview: Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries, Curriculum, Teacher education.

Unit 3: Evidence on the effectiveness of pedagogical practices, Methodology for the in depth stage: quality assessment of included, studies, How can teacher education (curriculum and practicum) and the school, curriculum and guidance materials best support effective pedagogy? Theory of change, Strength and nature of the body of evidence for effective pedagogical practices, Pedagogic theory and pedagogical approaches, Teachers’ attitudes and beliefs and Pedagogic strategies.

Unit 4: Professional development: alignment with classroom practices and follow-up support Peer support, Support from the head teacher and the community, Curriculum and assessment, Barriers to learning: limited resources and large class sizes.

Unit 5: Research gaps and future directions- Research design, Contexts, Pedagogy, Teacher education, Curriculum and assessment, Dissemination and research impact.

Recommended Books:

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<th>MTA107-18</th>
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<tr>
<td>Stress Management By Yoga</td>
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Course Objective
This course helps to achieve overall health of body and mind and overcome stress

Course Outcomes
Students will be able to:
1. Develop healthy mind in a healthy body thus improving social health also
2. Improve efficiency

**Unit 1:**
Definitions of Eight parts of yog. (Ashtanga)

**Unit 2:**
Yam and Niyam, Do’s and Don’t’s in life. i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Shaucha, santosh, tapa, swadhyay, ishwarpriyanidhan.

**Unit 3:**
Asan and Pranayam, i) Various yog poses and their benefits for mind & body ii) Regularization of breathing techniques and its effects-Types of pranayam.

**Recommended Books:**
1. “Yogic Asanas for Group Training-Part-I” : Janardan Swami Yogabhyasi Mandal, Nagpur
2. “Rajayoga or conquering the Internal Nature” by Swami Vivekananda, Advaita Ashrama(Publication Department), Kolkata

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<td>Personality Development Through Life Enlightenment Skills</td>
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**Course Objective**

This course helps to learn to achieve the highest goal happily, become a person with stable mind, pleasing personality and determination and awaken wisdom in students

**Course Outcomes**

Students will be able to
1. Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity
3. Study of Neetishatakam will help in developing versatile personality of students.

**Unit 1:**
Neetisatakam-Holistic development of personality, Verses- 19,20,21,22 (wisdom), Verses- 29,31,32 (pride & heroism), Verses- 26,28,63,65 (virtue), Verses- 52,53,59 (dont’s), Verses- 71,73,75,78 (do’s).

**Unit 2:**
Approach to day to day work and duties, Shrimad BhagwadGeeta : Chapter 2-Verses 41, 47,48, Chapter 3-Verses 13, 21, 27, 35, Chapter 6-Verses 5,13,17, 23, 35, Chapter 18-Verses 45, 46, 48.

**Unit 3:**
Statements of basic knowledge, Shrimad Bhagwad Geeta: Chapter 2 - Verses 56, 62, 68 Chapter 12 - Verses 13, 14, 15, 16, 17, 18, Personality of Role model. Shrimad Bhagwad Geeta: Chapter 2 - Verses 17, Chapter 3 - Verses 36, 37, 42, Chapter 4 - Verses 18, 38, 39, Chapter 18 – Verses 37, 38, 63.

Recommended Books:
1. “Srimad Bhagavad Gita” by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata
2. Bhartrihari’s Three Satakam (Niti-sringar-vairagya) by P. Gopinath, Rashtriya Sanskrit Sansthanam, New Delhi.