MAHATMA GANDHI UNIVERSITY

SCHEME AND SYLLABI

FOR

M. Tech. DEGREE PROGRAMME

IN

ELECTRICAL AND ELECTRONICS ENGINEERING

WITH SPECIALIZATION IN

INDUSTRIAL DRIVES AND CONTROL

(2013 ADMISSION ONWARDS)
## SCHEME AND SYLLABI FOR M. Tech. DEGREE PROGRAMME IN ELECTRICAL AND ELECTRONICS ENGINEERING WITH SPECIALIZATION IN INDUSTRIAL DRIVES AND CONTROL

### SEMESTER - II

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Course No.</th>
<th>Subject</th>
<th>Hrs / Week</th>
<th>Evaluation Scheme (Marks)</th>
<th>Credits (C)</th>
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<td>Digital Control Systems</td>
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### Electives:
- **Elective – III (MEEID 205)**
  - MEEID 205 - 1: Adaptive Control
  - MEEID 205 - 2: Soft Computing techniques
  - MEEID 205 - 3$^3$: Robotics and Automation
  - MEEID 205 - 4$^4$: Power Quality
- **Elective – IV (MEEID 206)**
  - MEEID 206 - 1: Embedded Controllers
  - MEEID 206 – 2$^5$: Flexible AC Transmission Systems
  - MEEID 206 – 3: Power Electronics Applications in Power Systems
  - MEEID 206 – 4$^6$: Digital Signal Processing

**L** – Lecture, **T** – Tutorial, **P** – Practical
**TA** – Teacher’s Assessment (Assignments, attendance, group discussion, Quiz, tutorials, seminars, etc.)
**CT** – Class Test (Minimum of two tests to be conducted by the Institute)
**ESE** – End Semester Examination to be conducted by the University

$^1$– Common for MEEID 202, MEEPC 202
$^2$– Common for MEEID 204, MEEPC 205-4, MEEES 205-4
$^3$– Common for MEEID 205-3, MEEPC 205-3
$^4$– Common for MEEID 205-4, MEEPC 204, MEEPS 202
$^5$– Common for MEEID 206-2, MEEPE 203, MEEPS 203, MEEPC 206-2
$^6$– Common for MEEID 206-4, MEEPE 206-4

**Electives:** New Electives may be added by the department according to the needs of emerging fields of technology. The name of the elective and its syllabus should be submitted to the University before the course is offered.
Module 1: Modeling
Dynamic d-q modeling of induction machines - stator, rotor and synchronously rotating reference frame models, state space equations and dynamic simulation, Space Phasor model – control principle of the induction motor

Module 2: Vector Control

Module 3

Module 4
Sensor less Control: Principles for speed sensor less control - Sensor less methods for scalar control, Sensor less methods for vector control, Introduction to observer based techniques, Basic principle of DTFC.
References

1. R Krishnan, Electric Motor Drives, PHI.
Module 1: Basic concepts in sampled data systems
Discrete time signals-sampling process-effect of sampling-loss of information and noise due to sampling-signal reconstruction-sampling theorem-hold circuits (ZOH,FOH)-z transforms-inverse z transform-difference equations- solution using z transform-system transfer function-poles and zeros-influence of pole location on time response-effect of zeros

Module 2: Analysis in z-domain

Module 3: Digital Controller Design

Module 4: Estimator/Observer Design
Full and reduced order observers-regulator design –case with reference input –separation principle Case Studies

Case Studies

References:
1. Gene F Franklin, J David Powell, Michael Workman, Digital control of dynamic systems, Pearson education
5. K Ogata, Discrete – Time control systems, Pearson education, Asia
Module 1: PWM Strategies for Inverters


Module 2: DC-DC Switch Mode Converters


Module 3: Resonant Converters

Classification of Resonant Converters, Basic Resonant Circuit Concepts, Load Resonant Converter, Resonant Switch Converter, Zero Voltage Switching - Zero current switching – ZVS Clamped Voltage Topologies, Resonant dc-link inverters

Module 4: PWM Rectifiers


References:

1. B W Williams, Principles and Elements of Power Electronics, University of Strathclyde Glasgow, 2006
4. Prof. Ramnarayanan, Course Material on Switch Mode Power Conversion, Electrical Department, IISc, Bangalore, 2006.
7. Kazmierkowski, Krishnan, Blaabjerg, Control in Power Electronics, Academic Press,02
Module 1
Stepper Motors - Constructional features, principle of operation, modes of excitation, single phase stepping motors, torque production in variable Reluctance (VR) stepping motor, Dynamic characteristics, Drive systems and circuit for open loop control, Closed loop control of stepping motor, microprocessor based controller.

Module 2

Module 3
Permanent Magnet Brushless DC Motors - Commutation in DC motors, Difference between mechanical and electronic commutators, Hall sensors, Optical sensors, Multiphase Brushless motor, Square wave permanent magnet brushless motor drives, Torque and emf equation, Torque-speed characteristics, Controllers-Microprocessor based controller. Sensorless control.

Module 4
Permanent Magnet Synchronous Motors - Principle of operation, EMF, power input and torque expressions, Phasor diagram, Power controllers, Torque speed characteristics, Self control, Vector control, Current control schemes. Sensor less control.

References:
Module 1: Introduction

Module 2: Model-Reference Adaptive Systems

Module 3: Self-Tuning Regulators
Introduction-Pole Placement Design-Indirect Self-tuning Regulators-Continuous Time Selftuners-Direct Self-tuning Regulators-Disturbances with Known Characteristics-Relations between MRAS and STR

Module 4: Gain Scheduling

Case Studies

References:
Module 1: System Identification
Least Square Method-LSE for non linear load- Validation of simulation model-computer simulation of continuous and discrete system.

Module 2: Neural Network

Module 3: Fuzzy Logic
Basic concepts-set theoretic operations-membership function-fuzzy rules-fuzzy reasoning-fuzzy inference systems-Mamdani and Sugeno type-defuzzification- fuzzy controllers-applications in electric drives.

Module 4: Neuro Fuzzy

References:
Module 1: Introduction
Geometric configuration of robots – Manipulators – Drive systems – Internal and external sensors – End effectors – Control systems – Robot programming languages and applications – Introduction to robotic vision

Module 2: Robot Arm Kinematics

Module 3: Robot Arm Dynamics

Module 4: Planning of Manipulator Trajectories
General consideration on trajectory planning joint interpolation & Cartesian path trajectories. Control of Robot Manipulators-PID control computed, torque technique – Near minimum time control – Variable structure control – Non-linear decoupled feedback control – Resolved motion control and adaptive control.

References:
Module 1

Module 2
Harmonics-individual and total harmonic distortion-RMS value of a harmonic waveform-tripl ex harmonics-important harmonic introducing devices-SMPS- Three phase power converters-arcing devices-saturable devices-harmonic distortion of fluorescent lamps-effect of power system harmonics on power system equipment and loads. Modeling of networks and components under non-sinusoidal conditions-transmission and distribution systems-shunt capacitors-transformers-electric machines-ground systems-loads that cause power quality problems-power quality problems created by drives and its impact on drives

Module 3

Module 4
Active Harmonic Filtering-Shunt Injection Filter for single phase , three-phase three-wire and three-phase four-wire systems . d-q domain control of three phase shunt active filters uninterruptible power supplies-constant voltage transformers- series active power filtering techniques for harmonic cancellation and isolation . Dynamic Voltage Restorers for sag , swell and flicker problems. Grounding and wiring-introduction-NEC grounding requirements-reasons for grounding-typical grounding and wiring problems-solutions to grounding and wiring problems.
References:

Module 1: C Programming of microcontrollers

Review of 8051 assembly language-Introduction to C51 language-keywords-structures-superloop-timer and interrupt programming-single programs for interfacing LED,LCD display,keyboard and stepper motor control

Module 2: PIC processors


Module 3: DSP architecture

Introduction to DSP architecture- computational building blocks - Address generation unit-Program control and sequencing- Speed issues- Harvard Architecture, Parallelism, Pipelining.

Module 4: TMS 320F2407


References:
1. Mazidi and Mazidi. Embedded system design using 8051 Microcontroller, Pearson- 2005
2. I Scott McKenzie,8051 Microcontroller programming,Pearson Education
4. H.A. Toliyat, S.Campbell, DSP based Electro Mechanical Motion Control, CRC Press-2004
Module 1. Power transmission problems and emergence of facts solutions
Fundamentals of ac power transmission, transmission problems and needs, emergence of FACTS- FACTS controllers-FACTS control considerations

Module 2: Shunt compensation
Principles of shunt SVC-TCR, TSC, combined TCR and TSC configurations, static synchronous compensator (STATCOM) configuration and control, application of SVC and STATCOM

Module 3: Series compensation
Variable Impedance Type series compensators: Thyristor Switched Series Capacitor (TSSC), Thyristor Controlled Series Capacitor (TCSC) - Sub synchronous characteristics- Basic NGH SSR Damper. Static Synchronous Series Compensator (SSSC): Principle of operation, configuration and control.

Module 4: Unified power flow controller (UPFC)
Principles of operation and characteristics, independent active and reactive power flow control, comparison of UPFC to the controlled series compensators, control and dynamic performance. Interline Power Flow Controller (IPFC) – Basic operating Principles and Characteristics

References:

Module 1: Introduction
Concept and General System Considerations. Power Flow in AC System. Definitions on FACTS.
Multi-Level Inverters - Diode Clamped Type, Flying Capacitor and cascade multilevel inverters.

Module 2: Static Shunt and Series Compensators
SVC and STATCOM, Operation and Control of TSC and TCR, direct and indirect control of STATCOM. Decoupled control strategy - Compensators- Comparison between SVC and STATCOM - transient and dynamic stability enhancement using STATCOM. Static Series Compensators-TSSC, TCSC and SSSC, Operation and Control, External System Control for SeriesCompensators, SSR and its damping - Static Voltage and Phase Angle Regulators, TCVR and TCPAR, Operation and Control.

Module 3: UPFC and IPFC:
The Unified Power Flow Controller - operation, comparison with other FACTS devices -control of P and Q - dynamic performance - Special Purpose FACTS Controllers -Interline Power Flow Controller - operation and control.

Module 4: Power Quality and introduction to custom power devices:

References:
Module 1: Introduction to FFT
Discrete Fourier transform - Properties – Efficient computation of DFT-FFT algorithms-Radix-2 FFT algorithms-Decimation in time-Decimation in frequency algorithms-Use of FFT algorithms in Linear filtering, convolution and correlation.

Module 2: Digital filter design and realization structures

Module 3: Analysis of finite word-length effects
Quantization process and errors- Coefficient quantization effects in IIR and FIR filters- A/D conversion noise- Arithmetic round-off errors- Dynamic range scaling- Overflow oscillations and zero input limit cycles in IIR filters

Module 4: Digital signal processors
References:
Experiments

1. Closed loop control of high frequency of DC – DC converters

2. Closed loop control of BLDC motors.

3. Closed loop control of Switched reluctance motors.


5. Vector control of three phase synchronous motors.

6. Closed loop control of PMSM.

7. Sensor less control of motors.

8. Use of Microcontrollers, DSP and FPGA for the control motors.

(At least 5 experiments in the list are to be conducted in the laboratory. Additional experiments and simulation assignments can also be given by the department)

Each student is required to present a technical paper on a subject approved by the department. The paper should be on a recent advancement/trend in the field of Power Electronics, drives, Control etc. He/she shall submit a report of the paper presented to the department.