Approved Syllabus of courses offered by EED
as per new Course Structure
of
3rd B. Tech. (Electrical Engineering) - Semester V

Department of Electrical Engineering

School of Engineering

Harcourt Butler Technical University

Kanpur-208 002

I. About the Department

The Department of Electrical Engineering was established in the year 1965. It is one of the oldest and premier engineering department of the university. The number of the students having completed their under graduate programme has reached the 1500 figure mark. The department has been playing a vital role in producing scientists and engineers of highest possible calibre ever since its inception. Apart from offering a bachelors degree programme in electrical engineering, the department also offers part time master degree programme in power electronics and control discipline and part time and regular doctor of philosophy programmes. The department has an annual intake of 33 students in the under graduate B.Tech. Programme. and 10 in Post Graduate M.Tech. Degree Programme and around 5 in PhD programme. The department has been playing a pioneer role in producing world-class engineers and research scholars.
The department has rich and experienced faculty members with very wide exposure. The department has distinguished faculty, all holding degrees from renowned institutes / universities. The faculty member(s) of this department hold patent, have authored good number of books and also guided good number of M. Tech. theses, Ph.D. theses. The commitment and dedication, punctuality, experience, expertise and enriched knowledge of the faculty members are few among many the distinguishing features of this department.

The passed out students have proved their mettle in various private and government organisations, public sector organisations, civil services, teaching & research, research & development and multi-national companies. Electrical Engineers rolling out of the institute are well groomed in the core areas of Advanced Control Systems / Power Electronics / Electrical Machines / Power Systems / Measurement and Instrumentation / Machine Design / Power Generation, Transmission & Distribution as well as Software Development/Handling and R&D work. The continuous updations in the course curriculum polishes the budding electrical engineers, in a way, so as to meet the challenges posed by newer technologies and reach the ever-expanding horizons and evolving challenges of industry.

The infrastructure and laboratory facilities are being upgraded from time to time so as to provide adequate opportunities to students and researchers to learn and carry out technological innovations. Financial support for this purpose if provided by the university and TEQIP World Bank. The department has Library, Basic Electrical Engineering Laboratory, Electrical Machines Laboratory, Power Electronics& Electric Drive Laboratory, Microprocessor & Control Laboratory, Power System Laboratory, Network Laboratory, Electrical Fabrication Laboratory, Simulation Laboratory, RTPESS Lab., Electrical Measurement Laboratory, Electrical Science Laboratory and Instrumentation Laboratory. The department has facilities to support teaching and learning activity The department had planned to add advanced laboratories in the areas of advanced control, machine intelligence and also personality development.

The department is continuously engaged in research and development activities. Several National and State level seminars, Technical Festivals, Faculty Development Programmes, Conferences, Symposiums, Expert Lectures, Workshops, Staff Training Programmes, Short Term Courses etc. are part of its yearly agenda. The department is applying for accreditation by National Board of Accreditation, (NBA). The department also undertakes many research projects sponsored by both the government, industry, civil societies etc..

II. Vision

Building department into a knowledge hub, through its utmost focus on relevant education, innovation and cutting edge research, and out-reach activities for the conservation, peace, happiness, well-being and prosperity of all creation.

III. Mission

- To educate and train the students equipped with knowledge of electrical engineering, analytical abilities, ethics and integrity human and social values and leadership qualities
- Capacity building, innovation and development of research capabilities through collaboration / agreements and symbiotic relationship with industry / institutes / universities and other government / private / non-government agencies and civil societies.
- Providing environment friendly, reasonable and sustainable solutions for local & global needs.
- Creating awareness and also enhancing resource generation through STCs, FDPs, SDPs, etc.
- Implementation of quality processes in teaching and learning, and research.
- Foster an ecosystem as per the need of the time well-knitted with the nature, and establishing Centre(s) of Excellence / state of art lab facilities in niche areas as per strengths of department
- Establishing the department as the leader and hand holding others institutions / universities

IV. Program Educational Objectives (PEOs)

PEO 1: Ability to exhibit memory of previously learned material by recalling fundamental facts, terms, basic concepts and answers about the selection, in the domain of electrical engineering.
PEO 2: Ability to demonstrate understanding of facts and ideas by organizing, comparing, translating, interpreting, giving descriptors and stating main ideas, in the domain of electrical engineering.
PEO 3: Ability to solve problems in new situations by applying acquired knowledge, facts, techniques and rules in a different, or new way, in the domain of electrical engineering.
PEO 4: Ability to examine and break information into parts by identifying motives or causes. Make inferences and find evidence to support generalizations, in the domain of electrical engineering.
PEO 5: Ability to compile information together in a different way by combining elements in a new pattern or proposing alternative solutions, in the domain of electrical engineering.
PEO 6: Present and defend opinions by making judgments about information, validity of ideas or quality of work based on a set of criteria, in the domain of electrical engineering.

V. Program Outcomes

Engineering Graduates will be able to:

1. Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
2. Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
4. Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
5. Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.
6. The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
8. Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
9. Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
10. Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11. Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12. Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

VI. Program Specific Outcomes (PSOs)

PSO 1: Students should be able to apply the acquired knowledge of core Electrical Engineering in the analysis, design, solution and implementation in real life for betterment of humanity and other creation.
PSO 2: Student should have ability to remember, understand, apply, analyse, evaluate and create latest electrical designs POs, PEOs, elements of Mission and Vision along with Consistency / Justification of Correlation.

PEOs and Elements of Mission along with Consistency/ Justification of Correlation

PEO Statement	M1	M2	M3	M4	M5	M6	M7
PEO 1: The students will have ability to exhibit memory of previously learned material by recalling fundamental facts, terms, basic concepts and answers about the selection, in the domain of electrical engineering.	**3**	**1**	**1**	**1**	**2**	**1**	**1**
Justification: Which is concerned with the students ability to exhibit memory of previously learned material by recalling fundamental facts, terms, basic concepts and answers about the selection **maps substantially with M1, moderately with M5, slightly with M2, M3, M4, M6 and M7** as it is concerned with the student's memory.							
PEO 2: The students will have ability to demonstrate understanding of facts and ideas by organizing, comparing, translating, interpreting, giving descriptors and stating main ideas, in the domain of electrical engineering.	**2**	**3**	**2**	**2**	**1**	**1**	**1**
Justification: Which is concerned with the students with the ability to demonstrate understanding of facts and ideas by organizing, comparing, translating, interpreting, giving descriptors and stating main ideas **maps substantially with M2, moderately with M1, M3 and M4, slightly with M5, M6 and M7** as it is concerned with student's understanding and demonstration capability.							
PEO 3: Ability to solve problems in new situations by applying acquired knowledge, facts, techniques and rules in a different, or new way, in the domain of electrical engineering.	**3**	**3**	**1**	**2**	**3**	**3**	**3**
Justification: Which is concerned with the students ability to solve problems in new situations by applying acquired knowledge, facts, techniques and rules in a different, or new way **maps substantially with M1, M2, M5, M6 and M7, moderately with M4, and maps slightly with M3** as it is concerned with the problem solving capability of a student.							
PEO 4: Ability to examine and break information into parts by identifying motives or causes. Make inferences and find evidence to support generalizations, in the domain of electrical engineering.	**3**	**3**	**3**	**2**	**2**	**3**	**2**
Justification: Which is concerned with the students ability to examine and break information **maps substantially with M1, M2, M3 and M6, moderately with M4, M5 and M7** as it is concerned with the inference making and finding evidence to support generalizations capability of students.							
PEO 5: Ability to compile information together in a different way by combining elements in a new pattern or proposing alternative solutions , in the domain of electrical engineering.	**2**	**1**	**3**	**2**	**3**	**3**	**3**
Justification: Which is concerned with the preparation of students with their ability to compile information together in a different way by combining elements in a new pattern or proposing alternative solutions **maps substantially with M3, M5, M6 and M7, moderately with M1 and M4, and maps slightly with M2** as it is concerned with the professional and responsible behavior of a student.							
PEO 6: Present and defend opinions by making judgments about information, validity of ideas or quality of work based on a set of criteria, in the domain of electrical engineering.	**3**	**2**	**2**	**1**	**3**	**2**	**2**
Justification: Which is concerned with the preparation of students with the ability to present and defend opinions by making judgments about information, validity of ideas or quality of work based on a set of criteria **maps substantially with M1 and M5, moderately with M2, M3, M6 and M7 and slightly with M4** as it is concerned with the professional and responsible behaviour of a student.							

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High)

EEE - 301	Electrical Machines - II	3L: 1T: 2P	5 Credits	Course Type: PCC

Preamble:

This course will provide a good understanding and hold to the students in the area of electrical machine. The course includes: Basic Concepts, Modelling, Components, Analysis of synchronous machines and induction machines.

Prerequisites:

Engineering Mathematics, Engineering Physics, Basic Electrical Engineering, Electrical Circuit Analysis and Electrical Machine - I.

Course Outcomes:

On the successful completion of this course, students will be able to:

COs	Course Outcomes	Bloom's Level
CO1	Understand the basics and needs of electrical machines	Remembering, Understanding
CO2	Able to solve problems of electrical machines	Applying, Analysing
CO3	Understand and analyse the basic operation of synchronous machine	Understanding, Analysing, Evaluating
CO4	Understand and analyse the basic operation of induction machine	Understanding, Analysing, Evaluating
CO5	Understand and analyze the basic operation of single phase induction motor and to understand basic operation of universal motor	Understanding, Analysing, Evaluating
CO6	Able to learn electrical machine and implement its concepts for life long	Remembering, Understanding, Analysing, Creating

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	3	-	-	-	2	-	-	1	-	-	2
CO2	3	3	1	1	1	3	1	-	2	-	-	2
CO3	3	3	1	2	1	3	1	-	2	-	-	2
CO4	3	3	1	1	1	3	1	-	2	-	-	2
CO5	3	3	1	2	1	3	1	-	2	-	-	2
CO6	3	3	2	2	2	3	1	-	3	-	1	3
Avg.	3.0	3.0	1.0	1.3	1.0	2.8	0.8	0.0	2.0	-	0.2	2.7

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) if there is no correlation, put "-"

Course Level Assessment Questions

Course Outcome 1:

1. Explain the generation of electromagnetic torque in electric machines.
2. Compare the performance of three phase induction motor and DC motor.
3. Why three phase synchronous motor is not self starting?.

Course Outcome 2:

1. Two three phase alternators operate in parallel. The rating of one machine is 200 MW and that of other is 400 MW. The droop characteristics of their governors are 4% and 5%, respectively from no load to full load. Assuming that the governors are operating at 50 Hz. at no load, how would a load of 600 MW be shared between them. What will be the system frequency at this load?
2. A 4 pole, 50 Hz., 3-phase induction motor has a rotor resistance of 0.02 ohm per phase and standstill reactance of 0.5 ohms per phase. Determine the speed at which the maximum torque is developed.
3.A 4 pole, 3300 Volts, 50 Hz. induction motor runs at the rated frequency and voltage. The frequency of the rotor current is 2.5 Hz.. Find the per unit slip and the running speed.

Course Outcome 3:

1. Why is a rotating field system used in preference to a stationary field in synchronous machine?
2. Explain the effect of distribution of winding and use of short pitch coil on the magnitude of the generated voltage of an alternator.
3.Explain the hunting in synchronous motor. How it can be minimized?

Course Outcome 4:

1.Explain the principle of operation of three phase induction motor.
2. Discuss any one method to control the speed of three phase induction motor from stator side.
3. What do you understand by crawling in three phase induction motor?

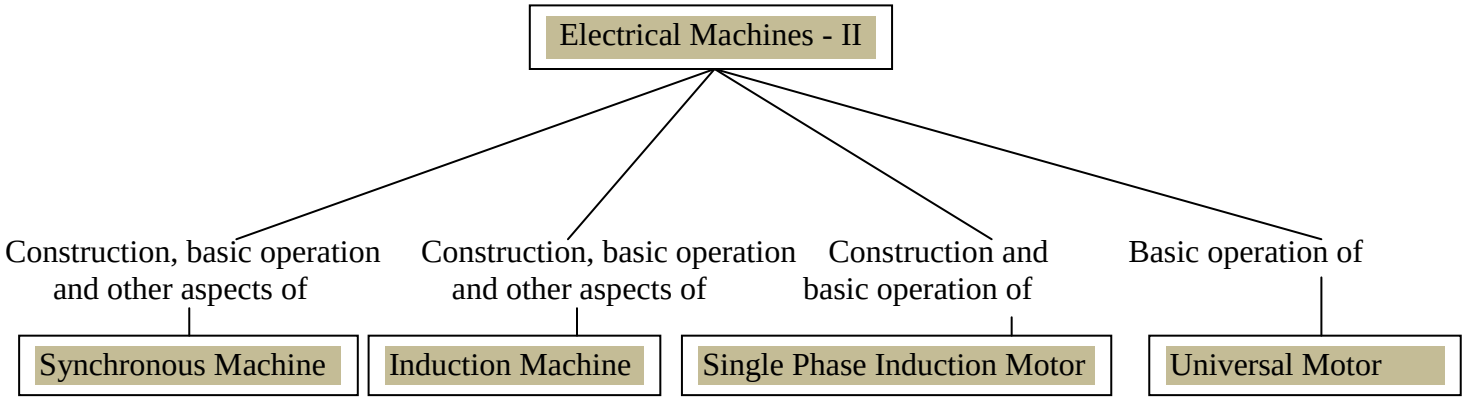
Course Outcome 5:

1. How starting torque is developed in single phase induction motor?
2. Write the applications of capacitor start capacitor run motor.
3. Briefly explain the operation of universal motor.

Course Outcome 6:

1. Give a list of industrial application of electrical machines.
2. Design and develop an electrical machine based application solving a real life problem.
3. Suggest electrical motor for electric traction system.

Concept Map



Syllabus:

Module 1: Synchronous Machine I (10 Lectures):
Constructional features, EMF Equation, Winding coefficients, equivalent circuit and phasor diagram, Armature reaction, O. C. & S. C. tests, Voltage Regulation using Synchronous Impedance Method, MMF Method, Potier's Triangle Method, Parallel Operation of synchronous generators, operation on infinite bus, synchronizing power and torque co-efficient

Module 2: Synchronous Machine II (7 Lectures):
Two Reaction Theory, Power flow equations of cylindrical and salient pole machines, operating characteristics Synchronous Motor: Starting methods, Effect of varying field current at different loads, V- Curves, Hunting & damping, synchronous condenser

Module 3: Three phase Induction Machine I (9 Lectures):
Constructional features, Rotating magnetic field, Principle of operation Phasor diagram, equivalent circuit, torque and power equations, Torque- slip characteristics, no load & blocked rotor tests, efficiency, Induction generator & its applications.

Module 4: Three phase Induction Machine II (7 Lectures):
Starting, Deep bar and double cage rotors, Cogging & Crawling, Speed Control (with and without emf injection in rotor circuit.)

Module 5: Single phase Induction Motor (7 Lectures):
Double revolving field theory, Equivalent circuit, No load and blocked rotor tests, Starting methods, Universal motor

Electrical Machines - II Laboratory

Note: The minimum of 08 experiments are to be performed from the following.

Hardware based experiments

1. To perform no load and blocked rotor tests on a three phase squirrel cage induction motor and determine equivalent circuit.

2. To perform load test on a three phase induction motor and draw: (i) Torque -speed characteristics (ii) Power factor -line current characteristics
3. To perform no load and blocked rotor tests on a single phase induction motor and determine equivalent circuit.
4. To study speed control of three phase induction motor by keeping V/f ratio constant
5. To study speed control of three phase induction motor by varying supply voltage.
6. To perform open circuit and short circuit tests on a three phase alternator and determine voltage regulation at full load and at unity, 0.8 lagging and leading power factors by (i) EMF method (ii) MMF method.
7. To determine V-curves and inverted V-curves of a three phase synchronous motor.
8. To determine X_d and X_q of a three phase salient pole synchronous machine using the slip test and draw the power-angle curve.
9. To study synchronization of an alternator with the infinite bus by using (i)dark lamp method (ii) two bright and one dark lamp method

Software based experiments (Develop Computer Program in 'C' language or use MATLAB or other commercial software)

1. To determine speed-torque characteristics of three phase slip ring induction motor and study the effect of including resistance, or capacitance in the rotor circuit.
2. To determine speed-torque characteristics of single phase induction motor and study the effect of voltage variation.
3. To determine speed-torque characteristics of a three phase induction motor by (i) keeping v/f ratio constant (ii) increasing frequency at the rated voltage.
4. Draw O.C. and S.C. characteristics of a three phase alternator from the experimental data and determine voltage regulation at full load, and unity, 0.8 lagging and leading power factors.
5. To determine steady state performance of a three phase induction motor using equivalent circuit.

Text Books:

1. D.P.Kothari & I.J.Nagrath, "Electric Machines", Tata Mc Graw Hill
2. P.S.Bimbhra, "Electrical Machinery", Khanna Publisher
3. Ashfaq Hussain"Electric Machines" Dhanpat Rai & Company

Reference Books:

1. Fitzerald,A.E.,Kingsley and S.D.Umans"Electric Machinery", MC Graw Hill.
2. P.S. Bimbhra, " Generalized Theory of Electrical Machines", Khanna Publishers
3. M.G.Say, "Alternating Current Machines", Pitman & Sons

Course Contents and Lecture Schedule

Module No.	Topic(s)	No. of Lectures
1	Constructional features, EMF Equation, Winding coefficients, equivalent circuit and phasor diagram	3
1	Armature reaction, O. C. & S. C. tests, Voltage Regulation using Synchronous Impedance Method, MMF Method, Potier's Triangle Method	4
1	Parallel Operation of synchronous generators, operation on infinite bus, synchronizing power and torque co-efficient	3
2	Two Reaction Theory, Power flow equations of cylindrical and salient pole machines, operating characteristics	3

2	Synchronous Motor: Starting methods, Effect of varying field current at different loads, V- Curves,	3
2	Hunting & damping, synchronous condenser	1
3	Constructional features, Rotating magnetic field, Principle of operation	3
3	Phasor diagram, equivalent circuit, torque and power equations, Torque-slip characteristics	3
3	No load & blocked rotor tests, efficiency, Induction generator & its applications	3
4	Starting, Deep bar and double cage rotors,	2
4	Cogging & Crawling,	2
4	Speed Control (with and without emf injection in rotor circuit.)	3
5	Double revolving field theory, Equivalent circuit	3
5	No load and blocked rotor tests,	1
5	Starting methods, Universal motor	3

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EEE - 303	Control System	3L: 1T: 2P	5 Credits	Course Type: PCC

Preamble:

This course will provide a good understanding and hold to the students in the area of control system. The course includes: Basic Concepts, Modelling, Components, Response Analysis, Stability, Analysis and Design of Control Systems.

Prerequisites:

Engineering Mathematics, Engineering Physics, Basic Electrical Engineering and Electrical Circuit Analysis.

Course Outcomes:

On the successful completion of this course, students will be able to:

COs	Course Outcomes	Bloom's Level
CO1	Explain the needs and effects of control system	Remembering, Understanding
CO2	Obtain mathematical model of a given control system in transfer functions and state space, and apply the same	Applying, Analysing
CO3	Identify and also justify the type of a given control system from its model, characteristics and responses	Analysing, Evaluating
CO4	Understand Time - response analysis and time-domain analysis	Understanding
CO5	Understand Frequency - response analysis	Understanding
CO6	Analyze the system's stability and performance in terms of the key characteristics and practical implementation, compensation.	Analysing, Creating

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	-	1	-	2	2	2	-	1	1	-	3
CO2	3	2	2	2	1	2	2	-	2	1	1	3
CO3	3	2	2	3	2	2	2	-	2	1	1	3
CO4	3	3	3	2	2	2	2	-	1	1	1	3
CO5	3	3	2	3	2	2	2	-	2	1	1	3
CO6	3	3	3	2	2	2	2	-	2	1	1	3
Avg.	3.0	2.2	2.2	2.0	1.8	2.0	2.0	0.0	1.7	1.0	0.8	3.0

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) if there is no correlation, put "-"

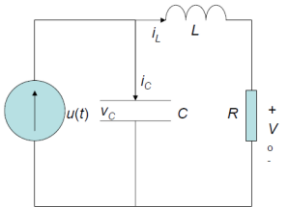
Course Level Assessment Questions

Course Outcome 1:

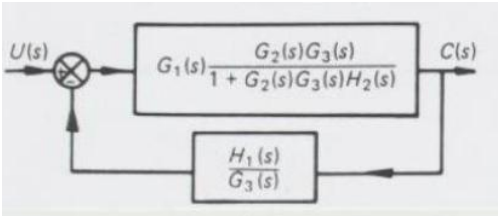
1. List various differences between closed loop control systems and open loop control systems with examples.
2. Explain the technical issues involved in ON/OFF and Hysteresis controls in dynamical systems.
3. Explain reduction of parameter variation and effects of disturbance by using negative feedback.

Course Outcome 2:

1. Obtain state space model of given electrical circuit.



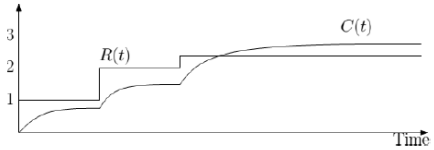
2.Obtain state space model of armature controlled DC motor.
3.Find C(s) / U(s) of the block diagram as shown below.



Course Outcome 3:

1. Identify the causality and linearity of the systems modelled with the differential equation $\frac{d^2y(t)}{dt} + 2y^2(t) = 3u(t-2)$

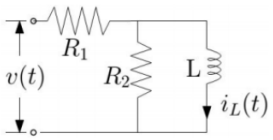
2. Series of step input r(t) is applied to a system and the response c(t) is recorded as below. Identify the linearity of the system.



3.What is difference between type and order of a control system?

Course Outcome 4:

1. Obtain unit step response of a first order control system.
2. Find i(t) if input v(t) is a unit ramp input of the given electrical circuit.



3. Consider a third order polynomial as given below.
$s^3 + Ps^2+Qs+K = 0$.
Do its time response analysis by approximating it as a second order system using the concept of dominant poles.

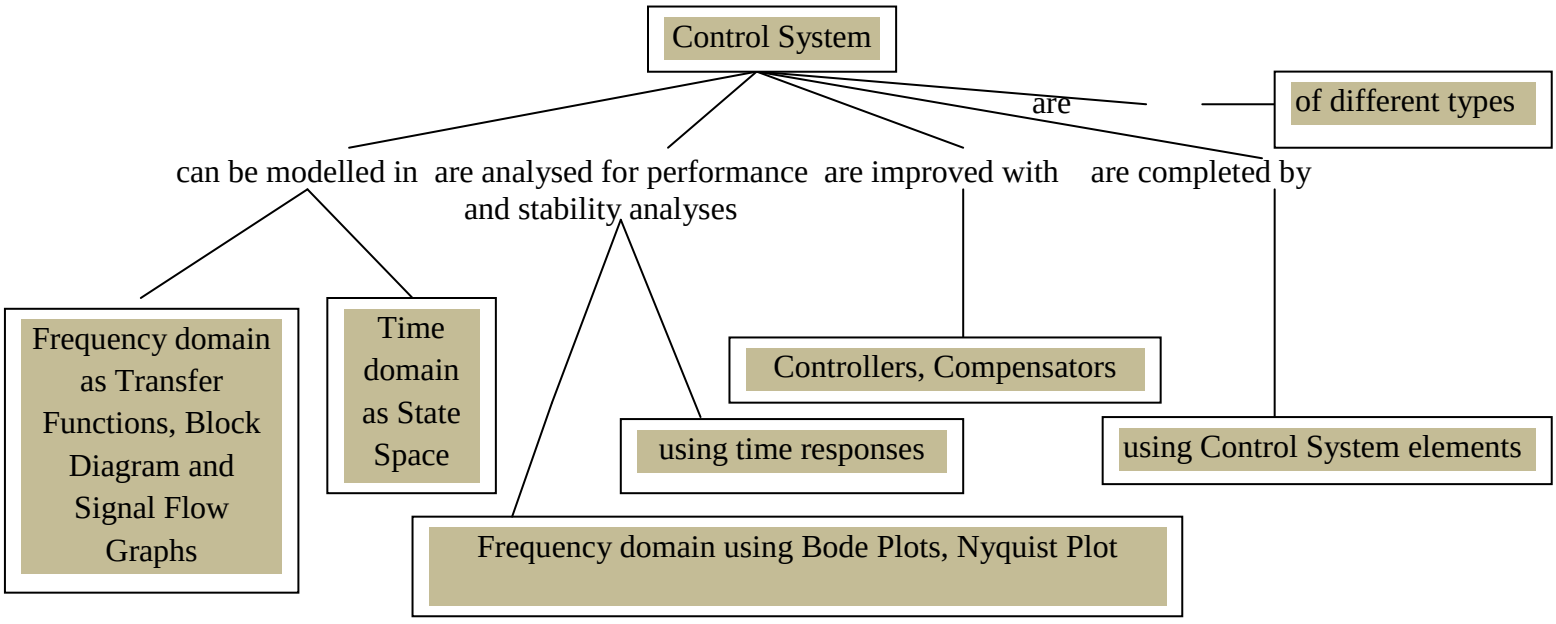
Course Outcome 5:

1. Sketch the Bode Plots of the system G(s) H(s) = 20 / (s (s +2) (s +5)), and determine gain margin and phase margin and comment on stability of the system.
2. Consider the transfer function of a general second order closed loop control system and make derivations of frequency domain specifications like resonant peak, resonant frequency and bandwidth.
3.What is correlation between time domain and frequency domain?

Course Outcome 6:

1. Sketch the Root Locus for system G(s) H(s) = K / (s(s +2) (s^2 +5)), and find the value of K for damping of 0.6.
2. Consider a unity feedback system given as G(s) = 2 / (s (s+20) (s+40)). Find out the lead compensator such that (a) the maximum overshoot allowed is about 20% (b) the settling time improves by a factor of five.
3. Do a practical realization of a Lag Compensator with the help of resistors and capacitor.

Concept Map



Syllabus:

Module 1: Basic Concepts (7 Lectures): Systems - Types of control systems, Notion of feedback, Open and Closed loop systems, Fundamental control actions (ON/OFF, Hysteresis control), Servomechanism, Physical examples, Reduction of parameter variation and effects of disturbance by using negative feedback, Digital Control vs. Analog Control.

Module 2: Control System Components and Modelling (8 Lectures): Servo Motors and actuators (control valves, solenoids), Stepper Motor , Modelling and representations of control systems: Ordinary differential equations, Transfer functions, Block diagrams, Signal flow graphs, Brief introduction of State-space representations.

Module 3: Time - Response Analysis (9 Lectures): Test Signals, Time response of first order and second order systems, Time domain specifications, Steady state errors and error constants, Effect of addition of Poles and Zeros, Dominant poles and zeros of Transfer function, PID Controllers - Derivative error, derivative output, integral error, Design specifications of second order systems, Design considerations for higher order systems, Performance indices.

Module 4: Time - Domain Analysis and Stability(7 Lectures): Review of State variable technique, conversion of State variable model to Transfer Function model and vice-versa, Diagonalization, Controllability and Observability and their Testing, Solution of state equations, Stability: Concept, Algebraic criteria and conditions, Characteristic equation, Routh-Hurwitz criteria and limitations, Root locus concept and construction.

Module 5: Frequency - Domain Analysis and Stability (9 Lectures): Frequency responses and Frequency domain specifications - Concepts of gain margin and phase margin, Correlation between time and frequency responses, Nyquist stability criterion, Nyquist plot, Bode plots, Nichol's chart, Concepts of Lead, Lag and Lead-lag compensators and their implementation.

Control System Laboratory

Note: The minimum of 08 experiments are to be performed from the following.

Hardware based experiments

1. To determine response of first order and second order systems for step input for various values of constant 'K' using linear simulator unit and compare theoretical and practical results.
2. To study P, PI and PID temperature controller for an oven and compare their performance.
3. To study and calibrate temperature using resistance temperature detector (RTD)
4. To study DC position control system
5. To determine speed-torque characteristics of an ac servomotor.
6. To study Solar and Wind Energy Systems on FESTO set up LabVolt Series 8960 - 2A
7. To study Industrial Training Control System on FESTO set up LabVolt Series 3103 - 40

Software based experiments (Use MATLAB)

1. To determine time domain response of a second order system for step input and obtain performance parameters.
2. To convert transfer function of a system into state space form and vice-versa.
3. To plot root locus diagram of an open loop transfer function and determine range of gain 'k' fir stability.
4. To plot a Bode diagram of an open loop transfer function.
5. To draw a Nyquist plot of an open loop transfer functions and examine the stability of the closed loop system.

Text Books

1. B.C. Kuo, and F.Golnaraghi, Automatic Control Systems, 9th Edition. Wiley India Pvt limited 2014. (Student edition)
2. Yaduvir Singh & S. Janardhanan, "Modern Control Engineering", Cengage Learning
3. I J Nagrath and M Gopal, Control Systems engineering, 5th Edition, New Age International, 2007

Reference Books

1. Katsuhiko Ogata, Modern Control Engineering, 5th edition, PHI, 2010
2. Norman S. Nise, Control Systems Engineering, 6th edition, John Wiley, 2010. (Indian edition)
3. M Gopal, Control Systems-Principles and Design, 4th Edition, McGraw Hill India, 2012

Course Contents and Lecture Schedule

Module No.	Topic(s)	No. of Lectures
1	Systems - Types of control systems, Notion of feedback, Open and Closed loop systems	2
1	Fundamental control actions (ON/OFF, Hysteresis control), Servomechanism, Physical examples	3
1	Reduction of parameter variation and effects of disturbance by using negative feedback	1
1	Control vs. Analog Control	1
2	Servo Motors and actuators (control valves, solenoids), Stepper Motor	1
2	Modelling and representations of control systems: Ordinary differential equations	2
2	Transfer functions, Block diagrams	2
2	Signal flow graphs	2
2	Brief introduction of State-space representations	1
3	Test Signals, Time response of first order and second order systems, Time domain specifications	2
3	Steady state errors and error constants,	1
3	Effect of addition of Poles and Zeros, Dominant poles and zeros of Transfer function,	2
3	PID Controllers - Derivative error, derivative output, integral error,	2
3	Design specifications of second order systems,	1
3	Design considerations for higher order systems, Performance indices	1
4	Review of State variable technique, conversion of State variable model to	1

	Transfer Function model and vice-versa	
4	Diagonalization, Controllability and Observability and their Testing, Solution of state equations	1
4	Stability: Concept, Algebraic criteria and conditions	1
4	Characteristic equation, Routh-Hurwitz criteria and limitations	2
4	Root locus concept and construction	2
5	Frequency responses and Frequency domain specifications - Concepts of gain margin and phase margin Correlation between time and frequency responses,	2
5	Nyquist stability criterion, Nyquist plot,	2
5	Bode plots,	2
5	Nichol's chart,	1
5	Concepts of Lead, Lag and Lead-lag compensators and their implementation	2

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EEE - 305	Power System - I	3L: 1T: 0P	4 Credits	Course Type: PCC

Preamble:

This course will provide a good understanding and hold to the students in the area of power system. The course includes calculations of resistance, inductance, capacitance of transmission line, power system components, performance analysis of transmission lines, various aspects of insulators and tower of Power Systems.

Prerequisites:

Engineering Mathematics, Engineering Physics, Basic Electrical Engineering and Electrical Circuit Analysis.

Course Outcomes:

On the successful completion of this course, students will be able to:

COs	Course Outcomes	Bloom's Level
CO1	Able to know about various components of power system and supply system	Remembering, Understanding
CO2	Able to calculate inductance and capacitance of various configurations of transmission lines	Understanding, Applying, Analysing
CO3	Evaluating various aspects of insulators used in power system network	Analysing, Evaluating
CO4	Understand various aspects of corona and interference, and their effects on transmission line performance	Understanding, Analysing,
CO5	Able to do mechanical and electrical design calculations of transmission line	Understanding, Analysing, Applying
CO6	Able to identify various aspects of grounding and familiarization with EHVAC, HVDC systems	Remembering, Understanding

Mapping with Programme Outcomes:

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	3	1	-	-	-	2	1	-	-	-	-	3
CO2	3	1	2	1	1	2	1	-	1	-	1	2
CO3	3	1	1	-	1	2	1	-	1	-	2	2
CO4	3	2	1	1	1	2	1	-	2	-	1	3
CO5	3	2	2	1	1	2	1	-	2	-	2	3
CO6	3	1	1	1	1	1	1	-	1	-	1	2
Avg.	3.0	1.3	1.2	0.7	0.8	1.8	1.0	0.0	1.2	0.0	1.2	2.5

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) if there is no correlation, put "-"

Course Outcome 1:

1.What do you understand by different types of supply systems?
2. Briefly describe bus bar in an electrical system.
3. Explain proximity effect.

Course Outcome 2:

1.Derive an expression for the capacitance per kilometer of a single phase line taking into account the effect of ground .
2.Show that the inductance per unit length of an overhead transmission line due to internal flux linkages in constant and is independent of the size of the conductor.
3. Derive expression for the inductance of a three phase line with conductors un-transposed.

Course Outcome 3:

1. Explain various types of insulators used in transmission line.
2. What do you beam by term, "String Efficiency" in overhead line insulators?
3.A string of six insulator unit has mutual capacitance ten times the capacitance to ground. Determine the voltage across each unit as a fraction of the operating voltage. Also, determine the string efficiency.

Course Outcome 4:

1. Discuss inductive interference between power and communication lines.
2. Write advantages and disadvantages of corona.
3. What are methods to reduce corona loss?

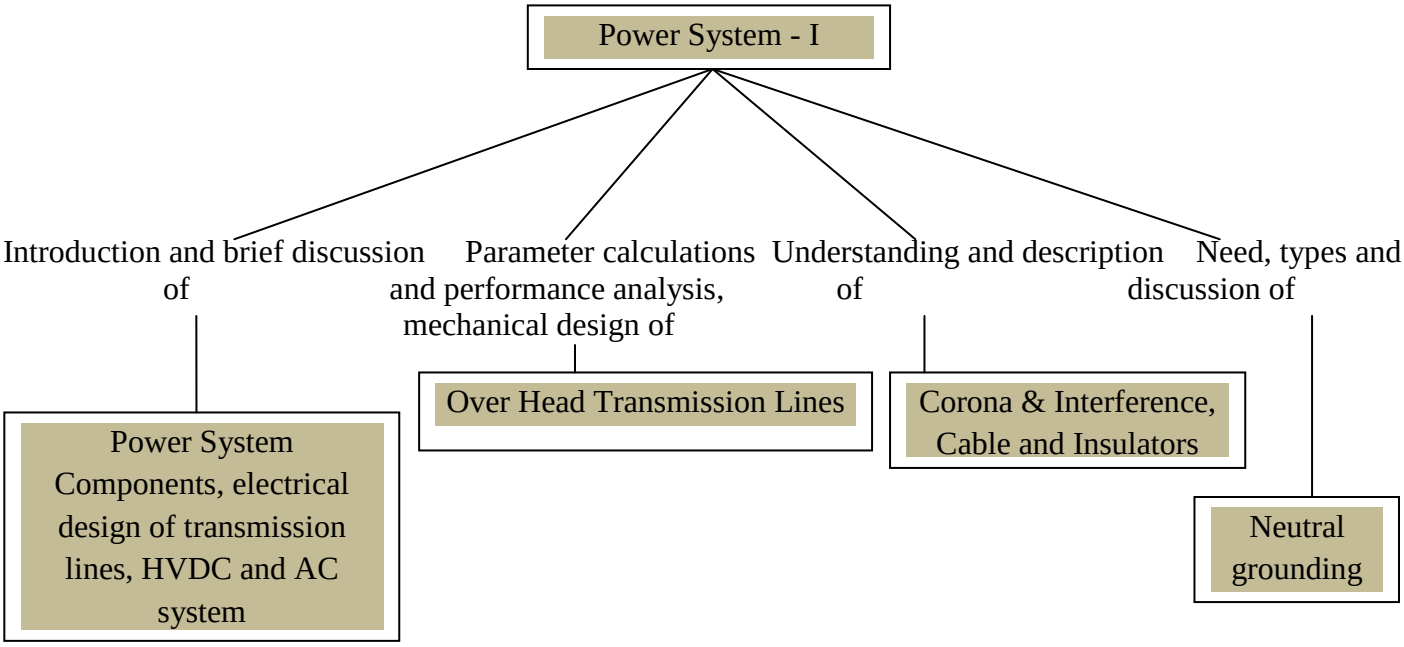
Course Outcome 5:

1. Derive expressions for sag and tension in a power conductor strung between two supports at equal heights taking into account the wind and ice loading also.
2. What is sag template? How it useful for location of towers and stringing of power conductors.
3.What is basis of selection of ground wire in transmission line design?

Course Outcome 6:

1. What is the necessity of neutral grounding?
2. What are different grounding practices?
3. Compare EHV AC and HVDC transmission systems.

Concept Map



Syllabus:

Module 1: Power System Components (8 Lectures):
Single line Diagram of Power system, Brief description of power system Elements: Synchronous machine, transformer, transmission line, bus bar, circuit breaker and isolator, Supply System, Different kinds of supply system and their comparison, choice of transmission voltage, Transmission Lines: Configurations, types of conductors, resistance of line, skin effect, Kelvin's law, Proximity effect

Module 2: Over Head Transmission Lines (8 Lectures):
Calculation of inductance and capacitance of single phase, three phase, single circuit and double circuit transmission lines, Representation and performance of short, medium and long transmission lines, Ferranti effect, Surge impedance loading

Module 3: Corona and Interference (8 Lectures):
Phenomenon of corona, corona formation, calculation of potential gradient, corona loss, factors affecting corona, methods of reducing corona and interference, Electrostatic and electromagnetic interference with communication lines. Overhead line Insulators: Type of insulators and their applications, potential distribution over a string of insulators, methods of equalizing the potential, string efficiency

Module 4: Mechanical Design of transmission line (8 Lectures):

Catenary curve, calculation of sag & tension, effects of wind and ice loading, sag template, vibration dampers
Insulated cables: Type of cables and their construction, dielectric stress, grading of cables, insulation resistance, capacitance of single phase and three phase cables, dielectric loss, heating of cables

Module 5: Neutral grounding and electrical design of transmission line (8 Lectures):

Necessity of neutral grounding, various methods of neutral grounding, earthing transformer, grounding practices

Electrical Design of Transmission Line: Design consideration of EHV transmission lines, choice of voltage, number of circuits, conductor configuration, insulation design, selection of ground wires, EHV AC and HVDC Transmission: Introduction to EHV AC and HVDC transmission and their comparison, use of bundle conductors, kinds of DC links, and incorporation of HVDC into AC system

Text Books

1. W. D. Stevenson, "Element of Power System Analysis", McGraw Hill,
2. C. L. Wadhwa, "Electrical Power Systems" New age international Ltd. Third Edition
3. Asfaq Hussain, "'Power System", CBS Publishers and Distributors,
4. B. R. Gupta, "Power System Analysis and Design" Third Edition, S. Chand & Co.

Reference Books

1. M. V. Deshpandey, "Elements of Power System Design", Tata McGraw Hill,
2. Soni, Gupta & Bhatnagar, "A Course in Electrical Power", Dhanpat Rai & Sons,
3. S. L. Uppal, "Electric Power", Khanna Publishers

Course Contents and Lecture Schedule

Module No.	Topic(s)	No. of Lectures
1	Single line Diagram of Power system, Brief description of power system Elements: Synchronous machine, transformer, transmission line, bus bar, circuit breaker and isolator,	3
1	Supply System, Different kinds of supply system and their comparison, choice of transmission voltage	3
1	Transmission Lines: Configurations, types of conductors, resistance of line, skin effect, Kelvin's law, Proximity effect	2
2	Calculation of inductance and capacitance of single phase, three phase, single circuit and double circuit transmission lines,	4
2	Representation and performance of short, medium and long transmission lines, Ferranti effect, Surge impedance loading	4
3	Phenomenon of corona, corona formation, calculation of potential gradient, corona loss, factors affecting corona, methods of reducing corona and interference, Electrostatic and electromagnetic interference with communication lines	4
3	Overhead line Insulators: Type of insulators and their applications, potential distribution over a string of insulators, methods of equalizing the potential, string efficiency	4
4	Catenary curve, calculation of sag & tension, effects of wind and ice loading, sag template, vibration dampers	4
4	Insulated cables: Type of cables and their construction, dielectric stress, grading of cables, insulation resistance, capacitance of single phase and three phase cables, dielectric loss, heating of cables	4
5	Necessity of neutral grounding, various methods of neutral grounding, earthing transformer, grounding practices	3
5	Electrical Design of Transmission Line: Design consideration of EHV	3

	transmission lines, choice of voltage, number of circuits, conductor configuration, insulation design, selection of ground wires,	
5	EHV AC and HVDC Transmission: Introduction to EHV AC and HVDC transmission and their comparison, use of bundle conductors, kinds of DC links, and incorporation of HVDC into AC system	2

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EEE - 307	Microprocessors	3L: 1T: 2P	5 Credits	Course Type: PCC

Preamble:

This course will provide a good understanding and hold to the students in the area of microprocessor. The course includes: Fundamentals and basic Concepts of microprocessor, assembly language programming of microprocessor, interfacing of microprocessor with various peripherals.

Prerequisites:

Computer Concept & C Programming ECS-102, Digital Electronics EET-203.

Course Outcomes:

On the successful completion of this course, students will be able to:

COs	Course Outcomes	Bloom's Level
CO1	Students will understand the Fundamentals of Microprocessor Architecture.	Knowledge (1)
CO2	Students will understand the 8-bit microprocessor.	Knowledge (1) Comprehension (2)
CO3	Students will understand the 16-bit microprocessor.	Knowledge (1) Comprehension (2) Analysis (4)
CO4	Students will demonstrate the ability to do assembly language programming.	Synthesis (5) Evaluation (6)
CO5	Do interfacing design of peripherals like 8237 DMA controller, 8255-Programmable peripheral interface, 8253/8254 Programmable timer/counter. 8259 programmable Interrupt Controller etc.	Application (3) Synthesis (5) Evaluation (6)

Mapping with Programme Outcomes:

CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO1O	PO11	PO12
CO1	3	2	1	1	-	1	-	-	-	-	-	2
CO2	3	2	2	1	-	1	-	-	-	-	-	2
CO3	3	2	2	2	-	1	-	-	-	-	-	2
CO4	3	3	3	3	2	1	1	-	1	-	1	2
CO5	3	3	3	3	2	1	1	-	1	-	1	2
Avg.	3.0	2.4	2.2	2.0	0.8	1.0	0.4	-	0.4	-	0.4	2.0

1: Slight (Low) 2: Moderate (Medium) 3: Substantial (High) if there is no correlation, put "-'

Course Level Assessment Questions

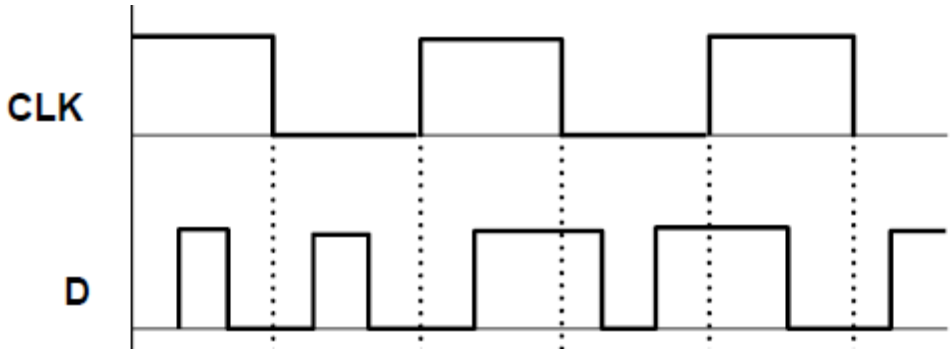
Course Outcome 1:

1. Explain Bussed Architecture of Microprocessor system.
2. What are the basic components of microcomputer, discuss the function if each components in brief.

3.Differentiate Static and Dynamic RAM

Course Outcome 2:

1. Draw the output of Positive and Negative Edge Triggered flip flop for the clock and input shown in figure below.



2. Explain immediate and implicit addressing mode.
3. Draw and discuss various machine cycles of 8085 processor.

Course Outcome 3:

1. Explain the advantage of memory segmentation.
2. Discuss BIU and EU of 8086.
3. What do you understand by branch control instruction explain any four branch control instruction.

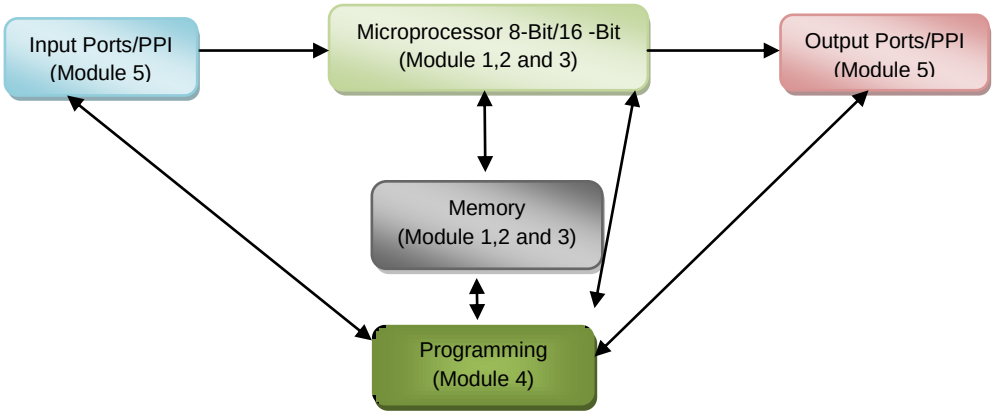
Course Outcome 4:

1. Implement macro RTL for MVI r, DATA.
2. Draw the flow chart and write a program to reverse the string of 'N' numbers.
3. Discuss use stack pointer and stack memory.

Course Outcome 5:

1. Discuss Mode-1 operation of 8253.
2. Draw and explain interfacing circuit of PPI with microprocessor.
3. Explain programmed and Interrupt driven I/O.

Concept Map



Module 1: Fundamentals of Microprocessors: (6Hours)

Microprocessor and Microprocessor Development Systems: Evolution of Microprocessor, Microprocessor architecture and its operations, memory, inputs-outputs (I/Os), data transfer schemes interfacing devices, architecture advancements of microprocessors, typical microprocessor development system.
Fundamentals of Microprocessor Architecture: 8-bitMicroprocessor architecture, Internal Block Diagram, CPU, ALU, address, data and control bus, Clock and RESET circuits, Stack and Stack Pointer, Program Counter, I/O ports, Memory Structures, Data and Program Memory.

Module 2 :8 Bit Microprocessor (7 Hours)

8085 microprocessor: pin configuration, internal architecture. Timing & Signals, ALU, machine cycles, Buses and CPU Timings, Bus size and signals, machine cycle timing diagram, instruction timing, processor timing. Instruction Set of 8085, Addressing Modes; Register addressing, direct addressing; register indirect addressing, immediate addressing, and implicit addressing. Instruction format, op-codes, mnemonics, no. of bytes, no. of machine cycles and T states, addressing modes. Instruction Classification; Data transfer, arithmetic operations, logical operations, branching operation, machine control, Writing assembly Language programs, Assembler directives.

Module3: 16-bit Microprocessors (8 Hours):

Architecture: Architecture of INTEL 8086 (Bus Interface Unit, Execution unit), register organization, memory addressing, memory segmentation, Operating Modes
Instruction Set of 8086, Addressing Modes, Instruction format, data transfer, arithmetic , logic string, branch control transfer, processor control, Interrupts, Hardware and software interrupts, responses and types.

Module 4: Instruction Set and Programming (9 Hours)

Addressing modes: Introduction, Instruction syntax, Data types, Subroutines Immediate addressing, Register addressing, Direct addressing, Indirect addressing, Relative addressing, Indexed addressing, 8085 and 8086 Instruction set, Instruction timings. Data transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions, Subroutine instructions, Bit manipulation instruction. Assembly language programs.

Module 5: Peripheral Interfacing: (10 Hours)

I/O programming: Programmed I/O, Interrupt Driven I/O, DMA I/O interface: serial and parallel communication, memory I/O mapped I/Os. Peripheral Devices: 8237 DMA controller, 8255-Programmable peripheral interface, 8253/8254 Programmable timer/counter. 8259 programmable Interrupt Controller.

Text Books:

1.R. S. Gaonkar, ", Microprocessor Architecture: Programming and Applications with the 8085", Penram International Publishing, 1996.

2.D. V. Hall, "Microprocessors & Interfacing", McGraw Hill Higher Education, 1991.

3.Brey, Barry B. / "INTEL microprocessors" / Prentice Hall (India) .

4.Liu and Gibson G.A. / "Microcomputer Systems: The 8086/8088 Family" / Prentice Hall (India).

5.D. A. Patterson and J. H. Hennessy, "Computer Organization and Design: The Hardware/Software interface", Morgan Kaufman Publishers, 2013.

Reference Books:

1.Ray, A.K. & Bhurchandi, K.M./ "Advanced Microprocessors and Peripherals: Architecture, Programming and Interfacing"/ Tata McGraw Hill.

2.Singh, B.P. / "Advanced Microprocessors and Microcontrollers" / New Age International

3.Ayala, Kenneth J. / "The 8086 Microprocessor Programming & Interfacing the PC"/Pen ram International Publishing (India) Limited.

Web Reference:

1.Video/Web contents on NPTEL

List of Experiments:

1. To study 8085 based microprocessor system
2. To study 8086 based microprocessor system
3. To perform mathematical operations like addition, subtraction, multiplication and division on 8-bit processor 8085
4. To perform mathematical operations like addition, subtraction, multiplication and division on 16-bit processor 8086
5. To develop and run a program for finding out the largest/smallest number from a given set of numbers.
6. To develop and run a program for finding out the smallest number from a given set of numbers.
7. To develop and run a program for arranging in ascending order of a set of numbers
8. To develop and run a program for arranging in descending order of a set of numbers
9. To perform conversion of temperature from 0F to 0C and vice-versa
10. To perform mathematical operations like addition, subtraction, multiplication and division on 8-bit processor 8085
11. To perform mathematical operations like addition, subtraction, multiplication and division on 16-bit processor 8086

12. To obtain interfacing with PPI 8255 in I/O mode and BSR mode.
13. To obtain interfacing with 8253 and generation of square wave.
14. Understanding of Debug command on Advanced Microprocessors.
15. Microcontroller based mini project.

Module No.	Topic(s)	No. of Lectures
1	Microprocessor and Microprocessor Development Systems: Evolution of Microprocessor, Microprocessor architecture and its operations, memory, inputs-outputs (I/Os), data transfer schemes interfacing devices, architecture advancements of microprocessors, typical microprocessor development system	2
	Fundamentals of Microprocessor Architecture: 8-bitMicroprocessor architecture, Internal Block Diagram, CPU, ALU, address, data and control bus	2
	Clock and RESET circuits, Stack and Stack Pointer, Program Counter, I/O ports, Memory Structures, Data and Program Memory	2
2	8085 microprocessor: pin configuration, internal architecture. Timing & Signals, ALU, machine cycles, Buses and CPU Timings	2
	Bus size and signals, machine cycle timing diagram, instruction timing, processor timing	1
	Instruction Set of 8085, Addressing Modes; Register addressing, direct addressing; register indirect addressing, immediate addressing, and implicit addressing	2
	Instruction format, op-codes, mnemonics, no. of bytes, no. of machine cycles and T states, addressing modes. Instruction Classification; Data transfer, arithmetic operations, logical operations, branching operation, machine control, Writing assembly Language programs, Assembler directives	2
3	Architecture: Architecture of INTEL 8086 (Bus Interface Unit, Execution unit), register organization	3
	Memory addressing, memory segmentation, Operating Modes, Instruction Set of 8086, Addressing Modes, Instruction format	3
	Data transfer, arithmetic , logic string, branch control transfer, processor control, Interrupts, Hardware and software interrupts, responses and types	2
4	Addressing modes: Introduction, Instruction syntax, Data types, Subroutines Immediate addressing, Register addressing, Direct addressing, Indirect addressing, Relative addressing, Indexed addressing, Bit inherent addressing, bit direct addressing	3
	8085 and 8086 Instruction set, Instruction timings. Data transfer instructions, Arithmetic instructions, Logical instructions, Branch instructions	3
	Subroutine instructions, Bit manipulation instruction. Assembly language programs	3
5	I/O programming: Programmed I/O, Interrupt Driven I/O, DMA I/O interface: serial and parallel communication	2
	Memory I/O mapped I/Os. Peripheral Devices: 8237 DMA controller	2
	8255-Programmable peripheral interface, 8253/8254 Programmable timer/counter	3
	8259 programmable Interrupt Controller	3

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