Faculty of Engineering & Technology
KAKATIYA UNIVERSITY, WARANGAL-506 009
Department of Electrical & Electronics Engineering

B. Tech. (EEE) VI SEMESTER

S. No.	Course Code	Course Title	Scheme of Instruction			Lecture hrs/week	Scheme of Examination		Credits
			L	T	P		CIE	SEE	
1	PC3201EE	Power Semiconductor Drives	3	1	0	4	30	70	4
2	PC3202EE	Switchgear and Protection	3	0	0	3	30	70	3
3	PC3203EE	Power System Operation and Control	3	1	0	4	30	70	4
4	PE-II	Professional Elective-II	3	0	0	3	30	70	3
5	PC3208EE	Signals and Linear Systems	3	0	0	3	30	70	3
6	PC3209EE	Microprocessor Systems	3	0	0	3	30	70	3
7	PC3210EE	Microprocessor Systems Laboratory	0	0	2	2	25	50	1
8	PC3211EE	Linear Control SystemsLaboratory	0	0	2	2	25	50	1
	Summer Internship(Six weeks during summer vacation)		--	--	--	--	--	--	--
	Total		**18**	**2**	**4**	**24**	**230**	**520**	**22**

(PE-II) Professional Elective – II

1. PE3204EE Electrical Distribution System
2. PE3205EE Electrical Energy Conservation and Auditing
3. PE3206EE Hybrid electric vehicles
4. PE3207EE MOOCS Course*

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B. Tech. (EEE) VI SEMESTER

PC3201EE

POWER SEMICONDUCTOR DRIVES

Teaching Scheme				Examination Scheme
L	T	P	C	Internal Marks: 30
3	1	0	4	External Marks: 70

UNIT – I

Introduction

Block diagram of Electrical drive-Dynamics of Electrical Drives-Four quadrant operation-Steady state stability-Load equalization

Control of DC Motors:

SinglePhasesemiandfullycontrolledconvertersconnected to d.c separately excited and d.c series motors – continuous current operation – output voltage and current waveforms –Speed-Torque Characteristics- Problems, three phase semi and fully controlled converters connected to d.c separately excited and d.c series motors – output voltage and current waveforms – Speed-Torque characteristics – Problems.

UNIT - II

Electric Braking – Plugging, Dynamic, andRegenerativeBrakingoperations-FourquadrantoperationofD.Cmotorsbysinglephaseandthree phase dual converters – Closed loop operation of DC motor (Block DiagramOnly)

Control of DC Motors By Choppers: Single quadrant, Two quadrant and four quadrant chopper fed dc separately excited and series motors – Continuous current operation – Output voltage and current wave forms – speed-torque characteristics – Problems on Chopper fed D.C Motors – Closed Loop operation (Block Diagram Only)

UNIT - III

Control of InductionMotor

Braking of induction motor: analysis of AC dynamic braking and DC dynamic braking

Variable voltage characteristics-Control of Induction Motor by AC Voltage Controllers – Waveforms – speed torquecharacteristics, Variablefrequencycharacteristics-Variablefrequencycontrol ofinductionmotorbyVoltagesourceand current source inverter and cyclo converters- PWM control – Comparison of VSI and CSI operations – Speed torque characteristics – numerical problems on induction motor drives – Closed loop operation of induction motor drives (Block DiagramOnly)

UNIT - IV

Rotor Side Control of Induction Motor

Static rotor resistance control – closed loop operation of slip ring induction motor with static rotor resistance control -Slip power recovery – Static Scherbius drive – Static Kramer Drive and its closed loop control – advantages, applications, problems.

UNIT - V

Control of Synchronous Motors

self-controlled and separately controlledsynchronous motors – Operation of self-controlled synchronous motorsbyVSI,CSIandcycloconverters.LoadcommutatedCSIfedSynchronousMotor– Operation– Waveforms – speed torque characteristics – Applications – Advantages and Numerical Problems – Closed Loop speed control scheme for load commutated inverter fed synchronous motor drives (Block Diagram Only)

TEXT BOOKS:

1. "G K Dubey", Fundamentals of Electric Drives, CRC Press,2002.
2. "VedamSubramanyam", Thyristor Control of Electric drives, Tata McGraw Hill Publications, 1987.

REFERENCES:

1. "SKPillai",AFirstcourseonElectricalDrives,NewAgeInternational(P)Ltd.2nd Edition.1989
2. "P. C. Sen", Thyristor DC Drives, Wiley-Blackwell, 1981
3. "B. K. Bose", Modern Power Electronics, and AC Drives, Pearson2015.
4. "R. Krishnan", Electric motor drives - modeling, Analysis and control, Prentice Hall PTR,2001

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B. Tech. (EEE) VI SEMESTER

PC3202EE

SWITCHGEAR AND PROTECTION

Teaching Scheme				Examination Scheme
L	T	P	C	Internal Marks: 30
3	0	0	3	External Marks: 70

UNTI-I

PROTECTIVE RELAYS

Introduction, Need for power system protection, effects of faults, evolution of protective relays, zones of protection, primary and backup protection, essential qualities of protection, classification of protective relays and schemes, current transformers, potential transformers, basic relayterminology.

OPERATING PRINCIPLES AND RELAY CONSTRUCTION: Electromagnetic relays, thermal relays, static relays, microprocessor based protectiverelays.

UNTI-II

OVER-CURRENT PROTECTION

Time-current characteristics, current setting, over current protective schemes, directional relay, protection of parallel feeders, protection of ring mains, Phase fault and earth fault protection, Combined earth fault and phase fault protective scheme, Directional earth faultrelay.

DISTANCE PROTECTION: Impedance relay, reactance relay, MHO relay, input quantities for various types of distance relays, Effect of arc resistance, Effect of power swings, effect of line length and source impedance on the performance of distance relays, selection of distance relays, MHO relay with blinders, Reduction of measuring units, switched distance schemes, auto re-closing.

UNTI-III

PILOT RELAYING SCHEMES

Wire Pilot protection, Carrier current protection.

AC MACHINES AND BUS ZONE PROTECTION: Protection of Generators, Protection of transformers, Bus-zone protection, frame leakageprotection.

UNTI-IV

STATIC RELAYS

Amplitude and Phase comparators, Duality between AC and PC, Static amplitude comparator, integrating and instantaneous comparators, static phase comparators, coincidence type of phase comparator, staticover current relays, static directional relay, static differential relay, static distance relays, Multi input comparators, concept of Quadrilateral and Elliptical relay characteristics.

MICROPROCESSOR BASED RELAYS: Advantages, over current relays, directional relays, distance relays.

UNTI-V

CIRCUIT BREAKERS

Introduction, arcing in circuit breakers, arc interruption theories, re-striking and recovery voltage, resistance switching, current chopping, interruption of capacitive current, oil circuit breaker, air blast circuit breakers, SF6 circuit breaker, operating mechanism, selection of circuit breakers, high voltage d.c. breakers, ratings of circuit breakers, testing of circuitbreakers.

FUSES: Introduction, fuse characteristics, types of fuses, application of HRC fuses, discrimination.

TEXT BOOKS:

1. Badriram and D.N. Vishwakarma, Power System Protection and Switchgear, TMH2001.
2. U.A.Bakshi, M.V.Bakshi: Switchgear and Protection, Technical Publications,2009.

REFERENCES:

1. C.Russel Mason – “The art and science of protective relaying, Wiley Eastern,1995
2. L.P.Singh “Protective relaying from Electromechanical to Microprocessors”, New Age International

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B. Tech. (EEE) VI SEMESTER

PC3203EE
POWER SYSTEM OPERATION AND CONTROL

Teaching Scheme				Examination Scheme
L	T	P	C	Internal Marks :30
3	1	0	4	External Marks :70

UNIT – I

Economic Operation of Power Systems: Optimal operation of Generators inn thermal Power Stations-heat rate curve-cost curve-incremental fuel and production costs-input/output characteristics-optimum generation allocation with line losses neglected-Optimum generation allocation including the effect of transmission line losses-loss coefficients-general transmission line loss formula.

UNIT- II

Modeling of Turbine: first order turbine model-block diagram representation of steam turbines and approximate linear models and modeling of synchronous generator
Modeling of Governor: Mathematical modeling of speed governing system-derivation of small signal transfer function.
Modeling of Excitation System: Fundamental characteristics of an excitation system-transfer function-block diagram representation of IEEE type-1 model.

UNIT – III

Load frequency control: Necessity of keeping frequency constant-definitions of control area-single area control-block diagram representation of an isolated power system-steady state analysis-dynamic response-uncontrolled case.
Proportional plus integral control of single area and its block diagram representation, steady state response-load frequency control and economic dispatch control.
Load frequency control of 2-area system-uncontrolled case and controlled case-tie line bias control

UNIT – IV

Overview of reactive power control-reactive power compensation in transmission systems-advantages and disadvantages of different types of compensation equipment for transmission systems-load compensation-specifications of load compensator-uncompensated and compensated transmission lines-shunt and series compensation.

UNIT – V

Computer Control of Power Systems: Need of computer control of power systems. Concept of energy control centre (or)load dispatch centre and the functions - system monitoring - data acquisition and control. System hardware configuration – SCADAandEMSfunctions.Networktopology–ImportanceofLoadForecastingandsimpletechniques offorecasting

TEXT BOOKS

1. C.L.Wadhwa,ElectricalPowerSystems,3rdEdn,NewAgeInternationalPublishingCo.,2001.
2. D. P. Kothari and I. J. Nagrath, Modern Power System Analysis, 4thEdn, Tata McGraw Hill Education Private Limited2011.

REFERENCES:

1. D. P. Kothari: Modern Power System Analysis-Tata Mc Graw Hill Pub. Co.2003.
2. Hadi Sadat: Power System Analysis –Tata Mc Graw Hill Pub. Co.2002.
3. Power System Analysis and Design by J.Duncan Glover and M.S.Sarma., THOMPSON, 3rd Edition
4. Electric Energy systems Theory – by O.I.Elgerd, Tata Mc Graw-hill Publishing Company Ltd., Second edition.
5. Power System Analysis by Grainger and Stevenson, Tata McGraw Hill
6. Power System Operation and Control – by G. Sreenivasan; S.Sivanagaraju Published by Pearson Education India,2009

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B. Tech. (EEE) VI SEMESTER

PE3204EE

ELECTRICAL DISTRIBUTION SYSTEM

Teaching Scheme				Examination Scheme
L	T	P	C	Internal Marks :30
3	0	0	3	External Marks :70

UNIT-I

Introduction, Load characteristics. Diversified demand. Non- coincidence demand. Coincidence factor, contribution factor Problems. Rate structure, customer billing, types of distribution transformers.

UNIT-II

Design of Sub-transmission lines and distribution sub-stations. Substation bus schemes, rating of distribution substation, service area with multiple feeders, percent voltage drop Calculations.

UNIT-III

Design considerations of primary systems, radial type, loop type primary feeder, primary feeder loading, uniformly distributed load application to a long line. Design considerations of secondary systems. Secondary banking. Secondary networks. Network transformers, unbalanced loads and voltages.

UNIT-IV

Voltage drop and power loss calculations of 3-phase systems. Voltage fluctuations, measures to reduce flickering. Methods of load flow of Distribution Systems - forward sweep and backward sweep methods.

UNIT-V

Application of capacitors to distribution systems. Effect of series and shunt capacitors, power factor correction, economic justification for capacitors. Best capacitor location-Algorithm. Distribution Automation: Definitions, Components of distribution SCADA.

Suggested Reading

1. Turan Gonen, Electric Power Distribution Engineering, Mc Graw Hill Book Co., International Student Edition. 1986.
2. A.S. Pabla, Electric Power Distribution, Tata McGraw Hill Publishing Company Ltd., 1997.

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B. Tech. (EEE) VI SEMESTER

PE3205EE

ELECTRICAL ENERGY CONSERVATION AND AUDITING

Teaching Scheme				Examination Scheme
L	T	P	C	Internal Marks :30
3	0	0	3	External Marks :70

UNIT-I

Energy Scenario: Commercial and Non-commercial energy, primary energy resources, commercial energy production, final energy consumption, energy needs of growing economy, long term energy scenario, energy pricing, energy sector reforms, energy and environment, energy security, energy conservation and its importance, restructuring of the energy supply sector, energy strategy for the future, air pollution, climate change. Energy Conservation Act-2001 and its features.

UNIT-II

Basics of Energy and its various forms: Electricity tariff, load management and maximum demand control, power factor improvement, selection & location of capacitors, Thermal Basics-fuels, thermal energy contents of fuel, temperature & pressure, heat capacity, sensible and latent heat, evaporation, condensation, steam, moist air and humidity & heat transfer, units and conversion.

UNIT-III

Energy Efficiency in Electrical Systems: Electrical system: Electricity billing, electrical load management and maximum demand control, power factor improvement and its benefit, selection and location of capacitors, performance assessment of PF capacitors, distribution and transformer losses. Electric motors: Types, losses in induction motors, motor efficiency, factors affecting motor performance, rewinding and motor replacement issues, energy saving opportunities with energy efficient motors.

UNIT-IV

Energy Efficient Technologies in Electrical Systems: Maximum demand controllers, automatic power factor controllers, energy efficient motors, soft starters with energy saver, variable speed drives, energy efficient transformers, electronic ballast, occupancy sensors, energy efficient lighting controls, energy saving potential of each technology.

UNIT-V

Energy Management and Audit: Definition, energy audit, need, types of energy audit. Energy management (audit) approach understanding energy costs, bench marking, energy performance, matching energy use to requirement, maximizing system efficiencies, optimizing the input energy requirements, fuel & energy substitution, energy audit instruments. Material and Energy balance: Facility as an energy system, methods for preparing process flow, material and energy balance diagrams.

Suggested Readings:

1. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-1, General Aspects (available online).
2. Guide books for National Certification Examination for Energy Manager / Energy Auditors Book-3, Electrical Utilities (available online).
3. S. C. Tripathy, *Utilization of Electrical Energy and Conservation*, McGraw Hill, 1991.
4. Success stories of Energy Conservation by BEE, New Delhi (www.bee-india.org).

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B. Tech. (EEE) VI SEMESTER

PE3206EE

HYBRID ELECTRIC VEHICLES

Teaching Scheme				Examination Scheme
L	T	P	C	Internal Marks :30
3	0	0	3	External Marks :70

UNIT-I

Introduction : Basics of vehicles mechanisms, history of electric vehicles (EV) and hybrid electric vehicles (HEV), need and importance of EV and HEV, Power/Energy supplies requirements for EV/HEV applications, vehicle power source characterization, and transmission characteristics. Vehicle mechanics – Roadway fundamentals, vehicle kinetics, Dynamics of vehicle motion - Propulsion System Design.

UNIT II

Drive-Train Topologies: Review of electric traction, various electric drive-train topologies, basics of hybrid traction system, various hybrid drive-train topologies, power flow control in drive-train topologies, fuel efficiency analysis.

UNIT III

Electrical Machines and Power Converters for Hybrid and Electric Vehicles: Electric system components for EV/HEV, suitability of DC and AC machines for EV/HEV applications, AC and DC Motor drives. Permanent magnet and switch reluctance machines, configuration and control of drives. Power Converters- Converters for EV and HEV applications.

UNIT IV

Energy Sources for EV/HEV: Requirements of energy supplies and storage in EV/HEV, Review of batteries, fuel cells, flywheels and ultra-capacitors as energy sources for EV/HEV, characteristics and comparison of energy sources for EV/HEV, hybridization of different energy sources.

UNIT V

Electric Vehicles Charging Station: Type of Charging station, Selection and Sizing of charging station, Components of charging Stationand Single line diagram of charging station. Contactless inductive charging- Stationary Inductive charging, resonant and compensation circuit topologies.

Suggested Readings*:*

1. James Larminie, John Lowry, Electric Vehicle Technology Explained, Wiely, USA, 2012.
2. Chris Mi, M. Abdul Masrur&David Wenzhong Gao, Hybrid Electric Vehicles: Principles and Applications with Practical Perspective, , Wiely, 2011
3. Iqbal Hussain, Electric & Hybrid Vehicles – Design Fundamentals, 2nd Edition, CRC Press, 2011.
4. SimoraOnori, Hybrid Electric Vehicles Energy Management Strategies, Springer.

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B. Tech. (EEE) VI SEMESTER

PC3208EE
SIGNALS AND LINEAR SYSTEMS

Teaching Scheme				Examination Scheme
L	T	P	C	Internal Marks :30
3	0	0	3	External Marks :70

UNIT-I

Introduction to Signals & Systems: Classification of signals, Operations on signals, types of systems, Exponential and Trigonometric Fourier series, Dirichlet's condition.

UNIT-II

Fourier Transform: Representation of aperiodic signal, Introduction of Fourier transform, Convergence, properties of Fourier Transform, Fourier transform of periodic signals, Singularity function, Parseval's theorem, Energy spectral density, Development of Discrete Time Fourier transform, Convergence issues associated with the DTFT.

UNIT-III

Sampling: Sampling of continuous time signals, sampling theorem, Aliasing effect, reconstruction of a signal and its samples.
Convolution & Correlation of signals: Convolution integral, Properties of convolution, Graphical method of convolution, Convolution of Discrete time signals, overlap-add and overlap-save method of discrete convolution, Definition of correlation, Auto correlation, Properties of Autocorrelation, Cross correlation of signals.

UNIT-IV

Laplace Transform: Review of Laplace transforms, region of convergence and properties, poles and zeros, relation between Laplace and Fourier transforms, properties of Laplace transform, inverse Laplace transform, Solutions to differential equation and systembehavior.

UNIT-V

Z Transform: Definition of Z-Transform, Properties of Z-Transform, Region of convergence of Z-Transform, Inverse Z Transform using Inspection, Partial fraction expansion, Power series Expansion, Contour integration methods, Parseval's relation analysis of discrete time systems using Z-Transform. Realization of discrete time system using Direct form, Cascade parallel forms.

Suggested Readings:

1. Alan V. Oppenheim, Alan. S. Willsky, S Hamid Nawab, Signals and Systems, 2nd edition, Prentice Hall of India,2007.
2. Lathi B.P., Signals Systems Communications", 1st edition, B.S. Publications,2006.
3. Simon Haykin and Van veen, "Signal and system", Willy, secondedition.

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B. Tech. (EEE) VI SEMESTER

PC3209EE
MICROPROCESSOR SYSTEMS

UNIT – I
Intel 8086 architecture, Segmented memory, Minimum and Maximum modes of operation, timing diagram, addressing modes, Instruction set, Assembler directives, macros, procedures, assembly language programming using data transfer, arithmetic, logical, branching and string manipulation instructions

UNIT – II
8086 Interrupt structure, IO and Memory Interfacing concepts using 8086, IC Chip Peripherals8255 PPI, 8254 Programmable timer, 8257 DMA controller, 8251 USART .

UNIT – III
8051 Microcontroller – Internal architecture and pin configuration, 8051 addressing modes, instruction set, Bit addressable features. I/O Port structures, assembly language programming using data transfer, arithmetic, logical and branch instructions.

UNIT – IV
8051 Timers/Counters, Serial data communication and its programming, 8051 interrupts, Interrupt vector table, Interrupt programming.

UNIT - V
Real world interfacing of 8051 with external memory, expansion of I/O ports, LCD, ADC, DAC, stepper motor interfacing.

Suggested Readings:

1. Douglas V.Hall, *"Microprocessors and Interfacing Programming and Hardware"*, 2nd Edition, Tata McGraw- Hill publishing company Limited, New Delhi, 1994.
2. Ray A.K &Bhurchandi K.M, "Advanced Microprocessor and Peripherals", 2/e TMH, 2012.
3. Walter A.Triebel and Avatar singh, *"The 8088 and 8086 Microprocessors Programming, Interfacing,Software, Hardware and Applications"*, Prentice-Hall of India Private Limited, New Delhi, 1996.
4. Muhammad Ali Mazidi, Janice GillispieMazidi and RolinD.McKinlay, *"The 8051 Microcontroller and Embedded Systems using Assembly and C"*, 2nd Edition, Pearson education, 2009.
5. Manish K. Patel, "The 8051 Microcontroller Based Embedded Systems", McGraw Hill, 2014.

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B. Tech. (EEE) V SEMESTER

PC3210EE
MICROPROCESSOR SYSTEMS LAB

Teaching Scheme				Examination Scheme
L	T	P	C	Internal Marks :25
0	0	2	1	External Marks :50

List of Experiments:

1. Addition, subtraction using 8085
2. Multiplication and division using 8085
3. Simple programs on 8086 kits
4. Searching and sorting using 8086 assembly language
5. String operations like concatenation and swapping using 8086
6. DAC interface to 8086
7. ADC interface to 8086
8. Stepper motor interface to 8086
9. Study of Keil software for 8051
10. Basic programs using 8051 instructions
11. Flashing LED program using 8051
12. Timer program to generate square wave on ports of 8051

Note: At least ten experiments should be conducted in the Semester.

Suggested Readings:

1. Ramesh S.Gaonkar, *"Microprocessor Architecture programming and Applications with the 8085"*, 5th Edition, Penram International publishing (India) private Limited, 1999.
2. Douglas V.Hall, *"Microprocessors and Interfacing programming and Hardware"*,2nd Edition, Tata McGraw- Hill publishing company Limited, New Delhi, 1994.
3. Muhammad Ali Mazidi, Janice GillispieMazidi and RolinD.McKinlay, *"The 8051 Microcontroller and Embedded Systems using Assembly and C*", 2nd Edition, Pearson education, 2009.

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B. Tech. (EEE) VI SEMESTER

PC3211EE
LINEAR CONTROL SYSTEMS LAB

Teaching Scheme				Examination Scheme
L	T	P	C	Internal Marks :25
0	0	2	1	External Marks :50

LIST OF EXPERIMENTS

1. Characteristics of D.C. and AC. Servomotor and their transfer function.
2. Characteristics of synchros.
3. Frequency response of second order system.
4. Operating characteristics of Stepper motor.
5. Step response of second order system.
6. D.C. Position control system.
7. A.C. Position control system.
8. Performance of P, PI and PID Controller on system response.
9. Design of lag and lead compensation.
10. ON - OFF temperature control systems.
11. Simulation of control system concepts using MATLAB.
12. PLC (Programmable Logic Controller) applications. (a) Bottle filling (b) Speed control of Stepper motor (c) Liquid level control.
13. Data acquisition system and applications.
14. Industrial process control trainer.

Note: Atleast ten experiments should be conducted in the Semester.

Suggested Reading:

1. Nagrath I.J. &Gopal.M - Control System Engineering, Wiley Eastern, 2003.
2. B.C.Kuo - Automatic Control Systems, Wiley India edition, 7th Edition, 2002.
3. K.Ogata - Modern Control System, Prentice Hall of India, 4th edition, 2002.
4. N.C.Jagan - Control Systems, B.S Publications, 2nd edition,2008.

SUMMER INTERNSHIP

Summer Internship is introduced as part of the curricula for encouraging students to work on problems of interest to industries. A batch of two or three students will be attached to a person from an Electrics/Electronics Industry / R & D Organization / National Laboratory for a period of 6 weeks. This will be during the summer vacation following the completion of the VI semester course. One faculty member will act as an internal guide for each batch to monitor the progress and interacts with the Industry guide.

After the completion of the project, students will submit a brief technical report on the project executed and present the work through a seminar talk to be organized by the department. Also the students have to produce the certificate given by the concern industry before the committee constituted by the department.

One faculty member will co-ordinate the overall activity of Summer Internship.

ANNEXURE

L	:	Lectures
T	:	Tutorials
P	:	Practical's
CIE	:	Continuous Internal Evaluation
SEE	:	Semester End Examination
PC	:	Professional Course
PE	:	Professional Elective
OE	:	Open Elective
HS	:	Humanities& Social Sciences

*Student is required to complete the MOOCS course in electrical and electronics engineering offered by the following agencies. The student is required to take prior approval from the Department, before registering for any course. Unless the student submits a pass certificate, he/she shall not be eligible for the award of degree.

SWAYAM: www.swayam.gov.in , NPTEL: www.onlinecourse.nptel.ac.in