EIGHTH SEMESTER

Sl. No.	Course Category	Subject Code	Subject Title	L	T	P	Contact Hours/week	Credit	Full Marks
1.	Program Elective-4 (any one)	PE CE 801/1	Earthquake Engineering	3	0	0	3	3	100
		PE CE 801/2	Structural Dynamics	3	0	0			
		PE CE 801/3	Pavement Design	3	0	0			
2.	Program Elective-5 (any one)	PE CE 802/1	Remote Sensing and GIS	2	0	0	2	2	100
		PE CE 802/2	Ground Improvement and Ground Engineering	2	0	0			
		PE CE 802/3	Engineering Geology	2	0	0			
3.	Open Elective-3	OE 803	See in Annexure-III	3	0	0	3	3	100
4.	Open Elective-4	OE 804	See in Annexure-IV	2	0	0	2	2	100
5.	Project - 3	PR CE 805	Project Work Final	0	0	12	12	6	200
6.	Seminar - 2	SE CE 806	Seminar on Contemporary Engineering Topics - II	0	0	2	2	1	100
7.	Online Course	SW CE 807	SWAYAM Courses	0	0	0	0	1	100
			Total :	10	0	14	24	**18**	**800**

Earthquake Engineering

Course Code	PE CE 801/1
Course Title	Earthquake Engineering
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Structural Engineering
Course Category	Professional elective courses (PEC)
Number of classes	38 hours

Course Outcomes: After completion of the course students will be able to-

CO No	CO Description	K-level
CO-1	Illustrate the basic technical terms of earthquake engineering.	K-2
CO-2	Explain seismological background on structures.	K-2
CO-3	Compare static loads and dynamic loads.	K-4
CO-4	Design Earthquake Resistant Structures.	K-5

Course contents:-

Module 1: Dynamic Loads on the Structures **10 Hours**

Definitions of basic problems in dynamics, static versus dynamic loads, different types of dynamic loads, un-damped vibration of SDOF system, natural frequency and Hours of vibration, damping in structure, response to periodic loads, response to general dynamic load, response of structure subject to gravitational motion, use of Fourier series for periodic forces. Direct determination of frequencies and mode shapes, orthogonality principle, approximate methods for determination of frequencies and mode shapes, modal error of forced vibration of MDOF system, modal analysis, applications to multistoried rigid frames subject to lateral dynamic loads.

Module 2: Seismological Background **10 Hours**

Seismicity of a region, earthquake faults and waves, structure of earth, plate tectonics, elastic-rebound theory of earthquake, Richter scale, measurement of ground motion, seismogram. Characterization of ground motion: earthquake response spectra, factors influencing response spectra, design response spectra for elastic systems, peak ground acceleration, response spectrum shapes, deformation, pseudo-velocity, pseudo-acceleration response spectra, peak structural response from the response spectrum, response spectrum characteristics.

Module 3: Deterministic Earthquake Responses **9 Hours**

Types of earthquake excitation, lumped SDOF elastic systems, translational excitation, lumped MDOF elastic systems, translational excitation time history analysis, multistoried buildings with symmetric plans, multistoried buildings with unsymmetric plans, torsional response of symmetric plan building, distributed-parameter elastic systems, translational excitation, combining maximum modal responses using mean square response of a single mode, SRSS and CQCC combination of modal responses.

Module 4: I. S. Code Method of Seismic Analysis **9 Hours**

I. S. code method of seismic analysis: seismic coefficient method and its limitation, response spectrum method, I. S. code provision for seismic analysis of buildings. Review of damages during past earthquakes and remedial measures, seismic design considerations, allowable ductility demand, ductility capacity, reinforcement detailing for members and joints.

References / Suggested learning Resources:-

1. Structural Dynamics-An introduction to Computer Methods, Roy R. Craig.
2. Dynamics of Structures, Anil K. Chopra, Prentice Hall, India.
3. Dynamics of Structures, Cloguh&Penzien, Tata McGraw Hill, New Delhi
4. Structural Dynamics, John M. Biggs, Tata McGraw Hill, New Delhi
5. Fundamentals of Earthquake Engineering, N. M. Newmarks& E. Rosenblueth, Prentice Hall.
6. Earthquake Design Practice for Building, D. Key, Thomas Telford, London, 1988.
7. Earthquake Engineering, R. L. Wiegel, 2nd Edition, Prentice Hall, London, 1989
8. Design of Multistoried Buildings for Earthquake Ground Motions, J. A. Blume, Portland CementAssociation, Chicago, 1961
9. Proceedings on World Conference on Earthquake Engineering, 1956-2000.
10. I. S. codes No. 1893, 4326, 13920. (Latest Editions).

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Structural Dynamics

Course Code	PE CE 801/2
Course Title	Structural Dynamics
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Structural Engineering
Course Category	Professional elective courses (PEC)
Number of classes	38 hours

Course Outcomes: After completion of the course students will be able to-

CO No	CO Description	K-level
CO-1	Describe basic problems and analysis in structural dynamics	K-2
CO-2	Analyze the assemblages of rigid bodies	K-4
CO-3	Comprehend the random vibrations	K-4
CO-4	Model multi-storey rigid frames subjected to lateral dynamic loads	K-4

Course Contents:-

Module 1: Introduction to Structural Dynamics (10 Hours)

Definition of basic problems in dynamics, static versus dynamic loads, different types of dynamic loads. SDOF systems- Un-damped vibration of SDOF system, natural frequency and period of vibration, damping in structures, viscous damping and coulomb damping, effect of damping on frequency of vibration and amplitude of vibration, logarithmic decrement, forced vibration, response to periodic loading, response to

periodic loading, response to pulsating forces, dynamic load factors, response of structure subjected to general dynamic load, Dulhamel‟s integral, numerical evaluation of dynamics response of SDOF systems, response of structure in frequency domain subjected to general periodic and non-periodic/impulsive forces of short duration, use of complex frequency response function, use of Fourier Series for periodic forces, introduction to vibration isolation, distributed mass system idealized as SDOF system, use of Rayleigh‟s method, response of SDOF system subjected to ground motion.

Module 2: Analysis of Generalized Single Degree of Freedom System (9 Hours)

Generalized properties: Assemblages of Rigid Bodies, Systems with distributed mass and elasticity, expressions for generalized system properties. Structure with distributed mass system- Use of partial differential equation, free vibration analysis of single span beams with various boundary conditions, determination of frequencies of vibration and mode shapes, forced vibration of single span beams subjected to the action of specified dynamic loads.

Module 3: Analysis of Lumped Mass Multi Degree of Freedom (MDOF) System (10 Hours)

Coupled and uncoupled systems, direct determination of frequencies of vibration and mode shapes, orthogonality principle, vibration of MDOF systems with initial conditions, approximate methods of determination of natural frequencies of vibration and mode shapes-vector iteration methods. Energy methods and use of Lagrange‟s method in writing equations of motions, decoupling of equations of motion, modal equation of motion, concept of modal mass and modal stiffness, forced vibration of MDOF system, modal analysis, application to multi storey rigid frames subjected to lateral dynamic loads.

Module 3: Random Vibrations and Response of Linear SDOF Systems (9 Hours)

-Random processes, stationary and ergodic processes, autocorrelation function, power spectral density function, relationship between power spectral and autocorrelation functions, power spectral density and autocorrelation functions for derivatives of processes, superposition of stationary processes, stationary Gaussian processes, stationary white noise, probability distribution for maxima and extreme values. Stochastic Response of Linear SDOF Systems- Transfer functions, relationship between input and output auto correlation functions, relationship between input and output power spectral density functions, response characteristics for narrowband systems.

References / Suggested learning Resources:-

1. Structural Dynamics-An Introduction to Computer Methods, John Wiley & Sons.
2. Dynamics of Structures, Anil K. Chopra, Prentice Hall, India.
3. Dynamics of Structures, Cloguh & Penzein, Tata McGraw Hill. New Delhi
4. Structural Dynamics, John M. Biggs, Tata McGraw Hill. New Delhi

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Pavement Design

Course Code	PE CE 801/3
Course Title	Pavement Design
Number of Credits	3 (L: 3, T: 0, P: 0)
Prerequisites	Transportation Engineering-I
Course Category	Professional elective courses (PEC)
Number of classes	38 hours

Course Outcomes: After completion of the course students will be able to-

CO No	CO Description	K-level
CO-1	Demonstrate flexible and rigid pavements	K-2
CO-2	Design flexible pavement as per IRC	K-6
CO-3	Design rigid pavement as per IRC	K-6
CO-4	Design joints and overlays as per IRC	K-6

Course Contents:-

Module- 1: Introduction (9 hours)

Types and component parts of pavements, Factors affecting design and performance of pavements. Highway and airport pavements.Stresses and Deflections in Flexible Pavements: Stresses and deflections in homogeneous masses. Burmister's two layer theory, three layer and multi-layer theories; wheel load stresses, various factors in traffic wheel loads; ESWL of multiple wheels. Repeated loads and EWL factors; sustained loads. Pavement behaviour under transient traffic loads.

Module- 2: Flexible Pavement Design (10 hours)

Flexible Pavement Design Methods for Highways and Airports: Empirical, AICTE Model Curriculum for Undergraduate degree in Civil Engineering (Engineering & Technology) 145 | Page semi-empirical and theoretical approaches, development, principle, design steps, advantages; design of flexible pavements as per IRC.

Module- 3: **Rigid Pavement Design (10 hours)**

Stresses in Rigid Pavements: Types of stresses and causes, factors influencing the stresses; general considerations in rigid pavement analysis, EWL; wheel load stresses, warping stresses, frictional stresses, combined stresses.Rigid Pavement Design: Types of joints in cement concrete pavements and their functions, joint spacings; design of CC pavement for roads and runways as per IRC,

Module- 4: Design of Joints and Overlays (9 hours)

Design of joint details for longitudinal joints, contraction joints and expansion joints. IRC method of design by stress ratio method. Design of continuously reinforced concrete pavements; Maintenance, repair and rehabilitation of pavements including design of bituminous and concrete overlays as per IRC

References / Suggested learning Resources:-

1. Pavement Analysis and Design, Yang H. Hung, Prentice-Hall 18

2. Design and Performance of Road Pavements, David Croney, McGraw Hill,
3. Guide for Design of Pavement AASHTO
4. Principles of Pavement Design Yoder & Witczak Wiley Publication
5. IRC guidelines for the design of flexible and rigid pavements.

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Remote Sensing and GIS

Course Code	PE CE 802/1
Course Title	Remote Sensing and GIS
Number of Credits	2 (L: 2, T: 0, P: 0)
Prerequisites	Knowledge of surveying, map reading and basic mathematics.
Course Category	Program elective (PE)
Number of classes	26 hours

Course Outcomes: After completion of the course students will be able to-

CO No	CO Description	K-level
CO-1	Analyse the energy interactions in the atmosphere and earth surface features	K-4
CO-2	Interpret the images for preparation of thematic maps	K-5
CO-3	Analyze spatial and attribute data for solving spatial problems	K-4
CO-4	Create GIS and cartographic outputs for presentation	K-6
CO-5	Apply Remote sensing and GIS in different engineering contexts	K-3

Course contents:-

Module 1: **- Remote Sensing (8 hours)**

Sources of Energy, active and passive radiation, Electromagnetic spectrum, radiation laws, interaction of energy with atmosphere scattering, absorption, atmospheric windows, interaction of EMR with earth surface features- spectral signatures, stages in remote sensing.

Sensors and Platforms: Characteristics of space platforms and sensors, LANDSAT, SPOT, NOAA and IRS Series.

Module 2: **- Digital Image Processing and GPS (8 hours)**

Photogrammetry; Aerial and Terrestrial; Fundamentals of Satellite Image Interpretation: Types of data products, visual interpretation techniques, Digital image processing, basic concepts of digital image processing techniques.

GPS surveying - principles and methods, DGPS, error in observations and corrections, mapping with GPS.

Module 3: **- GIS (4 hours)**

Fundamental concepts of GIS – Modeling Real World Features- Raster data model, vector data model, Data Formats- Spatial and Non-Spatial data, Data collection and Input, Data conversion, Hardware & software Requirements.

Topology – Editing and Error Rectification, Types of topology, Topological Relationships.

Module 4: **- Analysis in GIS, Applications of GIS and Remote Sensing (6 hours)**

Analysis using raster and vector data — retrieval, reclassification, overlaying, buffering - data output — printers and plotters. Open source software's. GIS and remote sensing applications — urban applications — water resources — urban analysis — watershed management — resources information system — hazard mitigation.

References / Suggested learning Resources:-

1. Floyd F. Sabins, Remote Sensing Principles and Interpretation, W.H. Freeman and Co. 2007.
2. Lillisand T.M and Kiefer R.W, Remote Sensing and Image Interpretation, John Wiley and Sons, 2008.
3. Paul R. Wolf: Elements of Photogrammetry, with Air Photo Interpretation and Remote Sensing, McGraw Hill International Book Company, 2000.
4. C.P. Lo, Albert K. W. Yeung, Concepts and Techniques of Geographic Information Systems, Prentice Hall India Pvt. Ltd, New Delhi, 2002.
5. Kang-Tsung Chang, Introduction to Geographic Information Systems, Tata McGraw Hill Publishing Company Ltd, New Delhi, 2008.
6. Peter A. Burrough and Rachael A. McDonnell, Principles of Geographical Information Systems, Oxford University Press, 2005.

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Ground Improvement and Ground Engineering

Course Code	PE CE 802/2
Course Title	Ground Improvement and Ground Engineering
Number of Credits	2 (L: 2, T: 0, P: 0)
Prerequisites	Geotechnical Engineering
Course Category	Program elective (PE)
Number of classes	26 hours

Course Outcomes: After completion of the course students will be able to-

CO No	CO Description	K-level
CO-1	Identify basic deficiencies of various soil deposits.	K-3
CO-2	Decide various ways and means of improving the soil.	K-4
CO-3	Categorize the implementing techniques of soil improvement.	K-4
CO-4	Explain the fundamentals of machine foundation	K-2, K-5

Course Contents:

Module 1: Ground Improvement Techniques (7 Hours)

Role of ground improvement and methods. Selection of suitable ground improvement techniques based on various types of soil condition viz. alluvial, laterite and black cotton soils. Ground Improvement Techniques- Sand drains, stone column, diaphragm wall, rock anchors. Heavy damping, compaction of piles. Preloading with sand drains/sand wicks.

Module 2: Machine Foundation, Dewatering and Geosynthetics (6 Hours)

Introduction- Soil dynamics theory of vibration, degrees of freedom, principles of machine foundation design. Dewatering, field pumping test, common dewatering methods. Effects of dewatering. Geosynthetics- Application, types, functions, Properties& designing with geosynthetics.

Module 3: Drainage Techniques, Dynamic Compaction and Consolidation (7 Hours)

Improvement of deep cohesionless soils and cohesive soils, geological properties of reinforced soils. Drainage techniques-Well points-Vaccum and electro osmotic methods. Dynamic compaction and consolidation-Vibroflotation-sand pile compaction-lime piles-installation techniques only-relative merits and their limitations.

Module 4: Reinforced Earth and Geotextiles (6 Hours)

Concept of reinforcement - Types of reinforcement material - Applications of reinforced earth – use of Geotextiles for filtration, drainage and separation in road and other works.Types of grouts - Grouting equipment and machinery - Injection methods - Grout monitoring – Stabilisation with cement, lime and chemicals - Stabilisation of expansive soils.

References / Suggested learning Resources:-

1. Koerner R.M., “Construction and Geotechnical Methods in Foundation Engineering”, McGraw-Hill,1994.
2. Purushothama Raj, P. “Ground Improvement Techniques”, Tata McGraw-Hill Publishing Company,NewDelhi,1995.
3. Moseley M.P., Ground Improvement Blockie Academic and Professional, Chapman and Hall,Glassgow,1993.
4. Jones J.E.P., Earth Reinforcement and Soil Structure, Butterworths, 1995. 2002.
5. Das, B.M., “Principles of Foundation Engineering”, Thomson Books / Cole, 2003.

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Engineering Geology

Course Code	PE CE 802/3
Course Title	Engineering Geology
Number of Credits	4 (L: 2, T: 0, P: 0)
Prerequisites	NIL
Course Category	Program Elective
Number of classes	26 hours

Course Outcome:

CO Number	CO Description	K-level
CO-1	To understand the weathering process, and superficial deposits and its geotechnical importance	K-2
CO-2	To classify the geological formations	K-2
CO-3	To analyze the geological hazards and preventing measures, and ground water with strength behaviour of rock	K-4
CO-4	To apply geological principles for mitigation of natural hazards and select sites for dams and reservoir followed by sub surface investigation.	K-3

Course Content:

Module 1: Physical Geology (06 hours)

Introduction-Branches of geology useful to civil engineering, scope of geological studies in various civil engineering projects. Mineralogy-Mineral, Origin and composition. Physical properties of minerals, basic of optical mineralogy, Rock forming minerals, megascopic identification of common primary & secondary minerals.

Physical Geology- Weathering. Erosion and Denudation. Factors affecting weathering and product of weathering. Superficial deposits and its geotechnical importance: Water fall and Gorges, River meandering, Alluvium, Glacial deposits, Laterite (engineering aspects), Desert Landform, Loess, Residual deposits of Clay with flints, mudflows, Coastal deposits.

Module 2: Petrology (07 hours)

Petrology-Rock forming processes. Specific gravity of rocks. Igneous petrology- Volcanic Phenomenon and different materials ejected by volcanoes. Types of volcanic eruption. Characteristics of different types of magma. Division of rock on the basis of depth of for mation and their characteristics. Chemical and Mineralogical Composition. Texture and its types. Various forms of rocks. Classification of Igneous rocks on the basis of Chemical composition. Detailed study of Acidic Igneous rocks like Granite, Rhyolite or Tuff, Felsite, Pegmatite, Hornfels. Engineering aspect to granite. Basic Igneous rocks Like Gabbro, Dolerite and Basalt. Engineering aspect to Basalt. Sedimentary petrology- mode of formation, Mineralogical Composition. Texture and its types, Structures, Gradation of Clastic rocks. Classification of sedimentary rocks and their characteristics. Detailed study of Conglomerate, Breccia, Sandstone, Mudstone

and Shale, Limestone Metamorphic petrology- Agents and types of metamorphism, metamorphic grades, Mineralogical composition, structures & textures in metamorphic rocks. Important Distinguishing features of rocks as Rock cleavage, Foliation. Detailed study of Gneiss, Schist, Slate with engineering consideration.

Module 3: Geological Hazards and Ground Water with Strength Behavior of Rock (07 hours)

Geological Hazards- Rock Instability and Slope movement: Concept of sliding blocks. Different controlling factors. Instability in vertical rock structures and measures to prevent collapse. Types of landslides. Prevention by surface drainage, slope reinforcement by Rock bolting and Rock anchoring, retaining wall, Slope treatment.

Ground water: Factors controlling water bearing capacity of rock. Pervious & impervious rocks and ground water. Lowering of water table and Subsidence.

Earthquake: Magnitude and intensity of earthquake. Seismic sea waves. Seismic Zone in India.

Module 4: Geology of Dam and Reservoir, Mechanics of Rock (06 in hours)

Geology of dam and reservoir site- Required geological consideration for selecting dam and reservoir site. Failure of Reservoir. Favorable & unfavorable conditions in different types of rocks in presence of various structural features, precautions to be taken to counteract unsuitable conditions, significance of discontinuities on the dam site and treatment giving to such structures.

Rock Mechanics- Sub surface investigations in rocks and engineering characteristics or rocks masses; Structural geology of rocks. Classification of rocks, Field & laboratory tests on rocks, Stress deformation of rocks, Failure theories and strength of rocks, Bearing capacity of rocks.

References / Suggested Learning Resources:

1. Engineering and General Geology, Parbin Singh, 8th Edition (2010), S K Kataria & Sons.
2. Text Book of Engineering Geology, N. Chenna Kesavulu, 2nd Edition (2009), Macmillan Publishers India.
3. Geology for Geotechnical Engineers, J.C.Harvey, Cambridge University Press (1982).
4. Principles of Engineering Geology, K.V.G.K. Gokhale, BS Publications, Hyderabad, 2005
5. Engineering Geology: Principles and Practice, David George Price, Springer, 2009

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Project Work Final

Course Code	PR CE 805
Course Title	Project Work Final
Number of Credits	6 (L: 0, T: 0, P: 12)
Prerequisites	Nil
Course Category	Project (PR)
Number of classes	130 hours

Course Outcome:- After completion of the course, students will be able to:

CO Number	CO Description	K-level
CO-1	Demonstrate a sound technical knowledge of their selected project topic	K-2
CO-2	Develop the skill of working in a Team	K-3
CO-3	Design engineering solutions to complex problems utilizing a systematic approach	K-6
CO-4	Design the solution of an engineering project involving latest tools and techniques	K-6
CO-5	Develop the skill of effective communication with engineers and the community at large in written an oral forms	K-3
CO-6	Demonstrate the knowledge, skills and attitudes of a professional engineer	K-2

Course Content:-

The project topic should be selected / chosen to ensure the satisfaction of the urgent need to establish a direct link between education, national development and productivity and thus reduce the gap between the world of work and the world of study. The course should have the following-

1) Develop sound knowledge about the domain of the project work.
2) Perform detailed study about various components of a project.
3) Learn to be an important member of a team for successful execution of a project work.
4) Study about methodologies and professional way of documentation and communication related to project work.
5) Develop idea about problem formulation, finding the solution of a complex engineering problem.
6) Develop project report as per the suggested format to communicate the findings of the project work.
7) Acquire the skill of effective oral communication to the fellow engineers and people in the society at large.
8) Develop knowledge of how to organize, scope, plan, do and act within a project thesis.
9) Familiarity with specific tools (i.e. hardware equipment and software) relevant to the project selected.
10) Demonstrate the implementation of a project work.

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Seminar on Contemporary Engineering Topics – II

Course Code	SE CE 806
Course Title	Seminar on Contemporary Engineering Topics – II
Number of Credits	1 (L: 0, T: 0, P: 2)
Prerequisites	Nil
Course Category	Seminar (SE)
Number of classes	24 hours

Course Outcome:- After completion of the course, students will be able to:

CO Number	CO Description	K-level
CO-1	Identify contemporary topics in respective branch of engineering	K-3
CO-2	Survey literature to understand insight of the selected topic	K-4
CO-3	Develop report writing and presentation making skill	K-3
CO-4	Present the topic so prepared among audience using suitable aid	K-3

Course Content:-

Each student shall

1) Identify a topic of current relevance in his/her branch of engineering,
2) Get approval of the faculty concerned/HOD,
3) Collect sufficient literature on the selected topic, study it thoroughly (literature survey),
4) Prepare their own report and presentation slides and
5) Present in the class among fellow students and faculty members.

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SWAYAM Courses

Course Code	SW CE 807
Course Title	SWAYAM Courses
Number of Credits	1 (L: 0, T: 0, P: 0)
Prerequisites	Nil
Course Category	Online Course (SW)
Number of classes	-

Courses Outcome:- After completion of the courses, students will be able to:

CO Number	CO Description	K-level
CO-1	Make use of digital learning platform to enhance knowledge and skill beyond the prescribed curriculum structure	K-3
CO-2	Take part in proctored examination system to prepare oneself for similar future challenges	K-4
CO-3	Utilize the opportunity to learn from best faculty in the country for professional development	K-3
CO-4	Develop the skill of lifelong self-learning and become future ready	K-3

Courses Content:-

SWAYAM (Study Webs of Active-learning for Young Aspiring Minds); India Chapter of Massive Open Online Courses. SWAYAM is an indigenous developed IT platform, initiated by Government of India, which is instrumental for self-actualization providing opportunities for a life-long learning. Learner can

choose from hundreds of courses, virtually every course that is taught at the university/college/school level and these shall be offered by best of the teachers in India and elsewhere. Student having registered a course, having submitting the Assignments as per requirements of the course, shall at the end of each course, be assessed through a proctored examination. A student having successfully completed the course shall get a Certificate.

Each student has to undergo and qualify at least two relevant SWAYAM or equivalent courses (to be certified by concerned HOD) with certification during the entire course of B. Tech. program. The Head of the departments will approve the relevancy of a SWAYAM or equivalent course for respective branch of engineering.

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