ACADEMIC REGULATIONS
COURSE STRUCTURE
AND
DETAILED SYLLABUS

M. Tech.
HIGHWAY ENGINEERING

(Applicable for the batches admitted from 2015-16)

VALLURUPALLI NAGESWARA RAO VIGNANA JYOTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY

An Autonomous Institute, Accredited by NAAC with 'A' Grade
NBA Accreditation for CE, EEE, ME, ECE, CSE, EIE, IT B.Tech. Programmes
Approved by AICTE, New Delhi, Affiliated to JNTUH
Recognized as "College with Potential for Excellence" by UGC
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VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY
HYDERABAD
An Autonomous Institute

Academic Regulations - M.Tech. Programme
(Applicable for the batches admitted from the academic year 2015-2016)

1. Introduction

Academic programmes of the institute are governed by rules and regulations as approved by the Academic Council of the institute.

These academic rules and regulations are effective from the academic year 2015-16, for the students admitted into two year post graduate programme offered by the college leading to Master of Technology (M. Tech.) degree in different specializations offered by the departments of Civil Engineering, Electrical and Electronics Engineering, Mechanical Engineering, Electronics and Communication Engineering, Computer Science and Engineering, Information Technology and Electronics and Instrumentation Engineering.

The M.Tech. degree of Jawaharlal Nehru Technological University Hyderabad shall be conferred on students who are admitted to the programme after fulfilling all the requirements for the award of the degree.

1.1 Eligibility for Admissions

Admission to the above program shall be made subject to the eligibility and qualifications prescribed from time to time. Admissions shall be made on the basis of GATE Rank and merit rank obtained at an Entrance Test conducted by the TSSCHE or as decided by TSSCHE subject to reservations prescribed by the university/ State Government from time to time.

2. Programmes of study

The following two year M.Tech. degree programmes of study are offered by the departments at VNR VJIET.

Department	Specializations
ME	1. Advanced Manufacturing Systems 2. Automation 3. CAD/CAM
CE	1. Highway Engineering 2. Structural Engineering 3 Geotechnical Engineering
EEE	1. Power Electronics 2. Power Systems
CSE	1. Software Engineering 2. Computer Science and Engineering
ECE	1. VLSI System Design 2. Embedded Systems
EIE	Electronics and Instrumentation
IT	Computer Networks and Information Security

- **'ENGLISH'** language is used as the medium of instruction in all the above programmes.

3. Attendance requirements

Each academic year shall be divided into two semesters, each of 90 Instructions days, excluding examination, evaluation, declaration of results etc.

3.1 A student shall be eligible to appear for the semester end examinations in subject if he / she acquire a **minimum of 75% of attendance in that subject.**

3.2 Shortage of attendance up to 10% in any subject (i.e., attendance of 65% and above and below 75%) in a semester may be condoned by the Institute Academic Committee based on the rules prescribed by the Academic Council of the Institute from time to time.

3.3 A student shall get **minimum required attendance in at least three (03) theory subjects** in the present semester to get promoted to the next semester. In order to qualify for the award of the M.Tech. degree, the student shall complete all the academic requirements of the subjects, as per the course structure.

3.4 Shortage of **attendance below 65% shall in NO case be condoned**.

3.5 A stipulated fee shall be payable towards condonation of shortage of attendance.

3.6 In case the student secures less than the required attendance in any subject(s), he shall not be permitted to appear for the semester end examination in that subject(s). He shall re-register for the subject when offered next.

4. Evaluation

i. The performance of a student in each semester shall be evaluated subject–wise with a maximum of **100 marks for theory** and **100 marks for practical subjects**. In addition, **mini-project** and **comprehensive viva-voce** shall be evaluated for **100 marks** respectively.

ii. For theory subjects, the distribution shall be **40 marks for mid-term evaluation** and **60 marks for the semester end examination**.

❖ **Mid-Term Evaluation (40 M):**

Mid-term evaluation consists of **mid-term examination (30 M)** and **assignment/objective test/ case study/course project (10 M).**

➢ **Mid-term examination (30 M):**

- For theory subjects, two mid-term examinations shall be conducted in each semester as per the academic calendar. Each mid-term examination shall be evaluated for 30 marks.
- Pattern of Mid-term examination:
  3 X 10M = 30 M (three internal choice questions one from each UNIT shall be given, the student has to answer ONE question from each UNIT)
- There shall be TWO mid-term examinations for each subject and the average of two mid-term examinations shall be considered for calculating final mid-term examination marks in that subject.

- **Assignment/objective exam/ case study/course project (10 M):**

- Two assignment/objective exam/ case study/course project shall be given to the students covering the syllabus of first mid-term and second mid-term examinations respectively and evaluated for 10 marks each.
- The first assignment/objective exam/ case study/course project shall be submitted before first mid-term examination and the second one shall be submitted before second mid-term examination.
- The average of 2 assignments shall be taken as final assignment marks.

iii. For practical subjects, there shall be a **continuous evaluation during the semester for 40 marks and 60 marks for semester end examination**. Out of the 40 marks, **day-to-day work in the laboratory shall be evaluated for 10 marks**, and **15 marks for practical examination** and **15 marks for laboratory record.**

- **Semester End Examination (60 M):**

(a) Theory Courses

Question paper pattern for semester end examination (60 Marks)

- Paper shall consist of 05 questions of 10 marks each. (05X12M = 60 M)
- There shall be 01 question from each unit with internal choice.

(b) Practical Courses

Each laboratory course shall be evaluated for 60 marks. The semester end examination shall be conducted by two examiners, one Internal and other external concerned with the subject of the same / other department / Industry. The evaluation shall be as per the standard format.

4.1. **Evaluation of Mini-Project:** There shall be two presentations during the first year, one in each semester. For mini-project 1 and mini-project 2, a student under the supervision of a faculty member, shall collect the literature on a topic, critically review the literature, carry out the mini-project, submit it to the department in a report form and shall make an oral presentation before the departmental Project Review Committee (PRC). The Departmental PRC consists of Head of the Department, supervisor and one senior faculty member of the department. For each mini-project there shall be only internal evaluation of 100 marks. A student has to secure a minimum of 50% to be declared successful.

4.2. There shall be a comprehensive viva-voce in II year I semester. The comprehensive viva- Voce shall be conducted by a committee consisting of Head of the Department and two senior faculty members of the department. The comprehensive viva-voce is aimed to assess the students' understanding in various subjects studied during the M.Tech. programme of study. The comprehensive viva-voce shall be evaluated for 100 marks by the committee. There are no internal marks for the comprehensive viva-voce. A student must secure a minimum of 50% to be declared successful.

4.3. A student shall be deemed to have secured the minimum academic requirement in a subject if he secures a minimum of 40% of marks in the semester end examination and a minimum aggregate of 50% of the total marks in the semester end examination and mid-term evaluation taken together.

4.4. A student shall be given one chance to re-register, after completion of the course work, for each subject, provided the internal marks secured by a student are less than 50% and he has failed in the semester end examination. In such a case student may re-register for the subject(s) and secure required minimum attendance. Attendance in the re-registered subject(s) has to be calculated separately to become eligible to write the end examination in the re-registered subject(s). Re-registration for the subjects is allowed only if that particular re-registration subjects are the hindrance for the award of Degree. Re-registration is allowed in this case provided the student doesn't have any subject(s) yet to pass other than the re-registration subjects where the internal marks are less than 50% with prior permission.

4.5. Laboratory examination for M.Tech. courses must be conducted with two examiners, one of them being laboratory class teacher and second examiner shall be a teacher of same specialization either external or a teacher from the same department other than the teacher who conducted laboratory classes for that batch.

5. Evaluation of Project / Dissertation Work.

5.1 Registration of Project Work: A student shall be permitted to register for the project work after satisfying the attendance requirement of all the subjects (theory and practical subjects).

5.2 A Project Review Committee (PRC) shall be constituted with at least four members namely HOD, PG coordinator of the M.Tech. programme, project supervisor and one senior faculty member of same specialization.

5.3 After getting permission as per 5.1, a student has to submit, in consultation with the project supervisor, the title, objective and plan of action of his project work to the Departmental PRC for its approval. Only after obtaining the approval of PRC, the student can initiate the project work.

5.4 If a student wishes to change his supervisor or topic of the project he can do so with the approval of PRC. However, the committee shall examine whether the change of topic/supervisor leads to a major change of his initial plans of project proposal. If so, the date of registration for the project work shall be the date of change of supervisor or topic as the case may be.

5.5 Internal evaluation of the project shall be on the basis of the seminars (Project reviews) conducted during the second year by the PRC. A student shall submit draft report in a spiral bound copy form.

5.6 The work on the project shall be initiated in the beginning of the second year and the duration of project is for two semesters. A student is permitted to submit Project work only after successful completion of theory and practical course with the approval of PRC not earlier than 240 days from the date of registration of the project work. For the approval of PRC the student shall submit the draft copy of thesis to the Head of the Department (Through project supervisor and PG coordinator) and shall make an oral presentation before the PRC.

The student is eligible to submit project work if he has published at least one paper covering 70% of the project work and presented his project work in Show and Tell activity.

5.7 After approval of PRC, every student has to submit three copies of the project dissertation certified by the supervisor to the Department.

5.8 The dissertation shall be adjudicated by one examiner selected by the Chief Superintendent. For this, HOD shall submit a panel of 3/ 5 examiners, who are eminent in that field with the help of the concerned guide.

5.9 If the report of the examiner is not favourable, the student shall revise and resubmit the Dissertation, within the time frame as prescribed by PRC. If the report of the examiner is unfavourable again, the dissertation shall be summarily rejected.

5.10 If the report of the examiner is favorable, viva-voce examination shall be conducted by a board consisting of the project supervisor, Head of the Department and the external examiner who adjudicated the Thesis. The Board shall jointly report students work as:

A. Excellent
B. Good
C. Satisfactory
D. Unsatisfactory

Head of the Department shall coordinate and make arrangements for the conduct of viva-voce examination. The student has to secure any one of the grades as Excellent, Good or Satisfactory on his dissertation and viva-voce. If the report of the viva-voce is unsatisfactory, the student shall retake the viva-voce examination after three months, making modifications as suggested. If he fails to get a satisfactory report at the second viva-voce examination, he has to re-register for the project work as mentioned in clause 5.1. However, the student may select a new guide or new topic or both with the approval of the PRC and submit the project dissertation with a minimum of 240 days from the date of re-registration. Of course, this shall not prejudice the clause 6.1 below.

6. Award of Degree and Class

A student shall be declared eligible for the award of the M.Tech. degree, if he pursues a course of study and complete it successfully for **not less than two academic years** and **not more than four academic years**.

6.1 A student, who fails to fulfil all the academic requirements for the award of the degree within four academic years from the year of his admission, for any reason whatsoever, shall forfeit his seat in M.Tech. Course.

6.2 A student shall register and put up **minimum academic requirement in all 84 credits** and earn **84 credits.** Marks obtained in all 86 credits shall be considered for the calculation of Cumulative Grade Point Average (CGPA).

6.3 CGPA System:

Method of awarding absolute grades and grade points in two year M.Tech. degree programme is as follows:

- Absolute Grading Method is followed, based on the total marks obtained in mid-term evaluation and semester end examinations.

- Grades and Grade points are assigned as given below.

Marks Obtained	Grade	Description of Grade	Grade Points(GP) Value Per Credit
>=90	O	Outstanding	10.00
>=80 and <89.99	A	Excellent	9.00
>=70 and <79.99	B	Very Good	8.00
>=60 and <69.99	C	Good	7.00
>=50 and <59.99	D	Pass	6.00
<50	F	Fail	
Not Appeared the Exam(s)	N	Absent	

The student is eligible for the award of the M.Tech degree with the class as mentioned in the following table.

CGPA	Class
>= 8.0	First Class with Distinction
>= 7.0 and <8.0	First Class
>= 6.0 and < 7.0	Second Class

➢ **Calculation of Semester Grade Points Average (SGPA):**

- The performance of each student at the end of the each semester shall be indicated in terms of SGPA. The SGPA shall be calculated as below:

$$\text{SGPA} = \frac{\text{Total earned weighted grade points in a semester}}{\text{Total credits in a semester}}$$

$$\text{SGPA} = \frac{\sum_{i=1}^{p} C_i * G_i}{\sum_{i=1}^{p} C_i}$$

Where Ci = Number of credits allotted to a particular subject 'i'

Gi = Grade point corresponding to the letter grade awarded to the subject 'i'

i = 1,2,…..p represent the number of subjects in a particular semester

Note: SGPA is calculated and awarded for the students who pass all the courses in a semester.

- **Calculation of Cumulative Grade Point Average (CGPA):**

The CGPA of a student for the entire programme shall be calculated as given below:

- Assessment of the overall performance of a student shall be obtained by calculating Cumulative Grade Point Average (CGPA), which is weighted average of the grade points obtained in all subjects during the course of study.

$$\mathbf{CGPA} = \frac{\textbf{Total earned weighted grade points for the entire programme}}{\textbf{Total credits for the entire programme}}$$

$$\mathbf{CGPA} = \frac{\sum_{j=1}^{m} C_j * G_j}{\sum_{j=1}^{m} C_j}$$

Where Cj = Number of credits allotted to a particular subject 'j'

Gj = Grade Point corresponding to the letter grade awarded to that subject 'j'

j = 1,2,….m represent the number of subjects of the entire program.

- Grade lower than D in any subject shall not be considered for CGPA calculation. The CGPA shall be awarded only when the student acquires the required number of credits prescribed for the program.

- **Grade Card**

The grade card issued shall contain the following:

a) The credits for each subject offered in that semester

b) The letter grade and grade point awarded in each subject

c) The SGPA/CGPA

d) Total number of credits earned by the student up to the end of that semester.

7. Withholding of Results

If the student has not paid dues to the Institute, or if any case of indiscipline is pending against him, the result of the student may be withheld and he shall not be allowed into the next higher semester. The award or issue of the provisional certificate and the degree may also be withheld in such cases. This delay shall not prejudice clauses Nos.6.0 and 6.1.

8. Transitory Regulations

Students who have discontinued or have been detained for want of attendance or any other academic requirements, may be considered for readmission as and when they become eligible. They have to take up Equivalent subjects, as substitute subjects in place of repeated subjects as decided by the Chairman of the BoS of the respective departments. He/She shall be admitted under the regulation of the batch in which he/she is readmitted.

9. Minimum Instruction Days

The minimum instruction days for each semester shall be **90 instruction days.**

10. General

10.1 The academic regulations should be read as a whole for purpose of any interpretation.

10.2 In case of any doubt or ambiguity in the interpretation of the above rules, the decision of the Principal is final.

10.3 The Institute may change or amend the academic regulations and syllabi at any time and the changes and amendments made shall be applicable to all the students with effect from the date notified by the Institute.

10.4 Wherever the words he, him or his occur, they shall also include she, her and hers.

11. Supplementary Examination

Supplementary examinations shall be conducted along with regular semester end examinations. (During even semester regular examinations, supplementary examinations of odd Semester and during odd semester regular examinations, supplementary examinations of even semester shall be conducted).

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF CIVIL ENGINEERING

Program Educational Objectives (PEOs)

I. To provide the student with a solid foundation in Planning, Design, Construction, Operation and Maintenance of highway projects in the context of environmental, economic and social requirements.

II. To equip students with modern concepts and tools which would enable them to become globally competent professionals and fitting into a broad range of career opportunities in highway research and industry.

III. To prepare the students in lifelong learning for professional advancement, that would help them to execute complex transportation projects with professional ethics and social responsibilities.

Program Outcomes (POs)

The program demonstrates that:

a. **Engineering Knowledge:** The student is capable of applying the principles of basic science, engineering and optimization techniques to solve highway engineering problems.
b. **Problem Analysis:** The Graduates will possess critical thinking skills, problem solving abilities and familiarity with the computational procedures essential to the field.
c. **Design & Development of Solutions:** The student is able to plan, analyze, design, synthesize and execute complex highway infrastructure projects considering societal and environmental considerations.
d. **Conduct investigations of complex problems:** The student will use research based knowledge and methods to design, conduct experiments and to analyze and interpret experimental data to provide sustainable engineering solutions for highway related societal problems in local and global context.
e. **Modern Tool Usage:** The student will get hands on training in Modern Highway Engineering software's and modern equipment.

f. **The Engineer and Society:** The Students will apply reasoning informed by the appropriate knowledge to assess societal, health, safety, legal and cultural issues.

g. **Environment and Sustainability:** As the students possess substantial knowledge in multi disciplinary subjects, they will be able to plan various projects keeping in view its environmental effects on other related fields.

h. **Ethics:** The student will practice and apply professional skills with social responsibility

i. **Individual and Team work:** The Graduate can functions effectively in multi-disciplinary projects and demonstrate leadership qualities.

j. **Communication:** The Student will excel in expressing ideas, writing technical reports with good communication and managerial skills.

k. **Project Management and Finance:** The Graduates will demonstrate knowledge and understanding of the critical issues for professional practices such as the procurement of works, interaction with contractors during the construction phase of a project, the finance management and managerial capabilities.

l. **Life-Long learning:** The student engages in lifelong learning for professional advancement.

VNR VIGNANA JYOTHI INSTITUTE OF ENGINEERING & TECHNOLOGY

M.TECH. (HIGHWAY ENGINEERING)

(R15 Regulation)

I YEAR I SEMESTER **COURSE STRUCTURE**

Code	Group	Subject	L	T/P/D	Credits
HIG01	**Core**	Pavement Material Characterization	3	1	4
HIG02		Pavement Analysis & Design	3	1	4
HIG03		Highway Geometric Design	3	1	4
HIG11	**Elective - I & Elective – II Basket**	Highway Project Formulation & Economics	3	0	3 + 3
HIG12		Environmental Impact Assessment for highway projects	3	0	
HIG13		Road Safety & Traffic Management	3	0	
HIG14		Evaluation and Strengthening of Pavements	3	0	
STR11		Advanced Concrete Technology	3	0	
STR16		Principles of Bridge Engineering	3	0	
MTH31	**Open Elective -I**	Computer based numerical methods	3	0	3
ENG32		Professional & Technical Communication	3	0	
STR31		Energy Efficient Buildings	3	0	
HIG51	**Lab**	Pavement Engineering Lab	0	3	2
HIG61		Mini Project - I	0	0	4
Total			**18**	**6**	**27**

I YEAR II SEMESTER **COURSE STRUCTURE**

Code	Group	Subject	L	P	Credits
HIG04	**Core**	Pavement Management Systems	3	1	4
HIG05		Traffic Engineering	3	1	4
HIG06		Urban Transportation Planning	3	1	4
HIG21	**Elective - III & Elective – IV Basket**	Remote Sensing & GIS	3	0	3 + 3
HIG22		Rural Road Technology	3	0	
HIG23		Intelligent Transportation Systems	3	0	
HIG24		Highway Construction and Quality Control	3	0	
HIG25		Airport Planning & Design	3	0	
GTE06		Engineering of Ground			
STR41	**Open Elective – II**	Optimization Techniques in Engineering	3	0	3
HIG41		Construction Technology and Project Management	3	0	
GTE41		Ground foundation and structure interaction	3	0	
HIG52	**Lab**	Highway Material Characterization & Traffic Simulation Lab	0	3	2
HIG62		Mini Project - II	0	0	4
Total			**18**	**6**	**27**

II YEAR I SEMESTER **COURSE STRUCTURE**

Code	Group	Subject	L	P	Credits
HIG63		Comprehensive Viva-Voice	0	0	4
HIG71		Internship / Dissertation Phase - I	0	0	8
Total			**0**	**0**	**12**

II YEAR II SEMESTER **COURSE STRUCTURE**

Code	Group	Subject	L	P	Credits
HIG72		Dissertation Phase - II	0	0	18
Total			**0**	**0**	**18**

VNR Vignana Jyothi Institute of Engineering & Technology

I Year – I Sem. M.Tech. (Highway Engineering)	**L**	**T/P/D**	**C**
	3	**1**	**4**

(HIG 01) PAVEMENT MATERIAL CHARACTERIZATION

Course Objectives:
Student shall be able to

- **Understand** properties and tests performed on Sub grade soil, aggregates.
- **Learn** different Soil Stabilization Techniques.
- **Appreciate** different tests performed on Bitumen and techniques to improve its properties.
- **Gain knowledge** on quality of cements its IRC methods for concrete mix design and role of Admixtures**.**

Course Outcomes:
After the completion of the course student should be able to

- **Explain** properties and tests performed on sub grade soil, aggregate, bitumen and cement.
- **Understand** soil stabilization and how it is done.
- **Comprehend** how to improve bitumen properties by modification techniques
- **Aware** of advanced concrete used in road construction, role of admixtures and design of concrete mixes.

UNIT I:
Sub- grade Soil Characterization: Properties of sub-grade layers; different types of soils, Mechanical response of soil; Soil Classification; Index and other basic properties of soil; A critical look at the different laboratory and in-situ procedures for evaluating the mechanical properties of soils viz. SPT, DCPT, CPT, CBR, Plate Load test & resilient modulus; Suitability of different type of soil for the construction of highway embankments and pavement layers; Field compaction and control. Dynamic properties of soil: FWD test.

UNIT II:
Introduction to Soil Stabilization: Physical and Chemical modification: Stabilization with admixtures like cement, lime, calcium chloride, fly ash and bitumen. Grouting: Categories of grouting, Art of grouting, Grout materials, Grouting techniques and control. Introduction to Ground improvement techniques; Introduction to Geo textiles and synthetics applications.

UNIT III:
Aggregate Characterization: Origin, Classification, Types of aggregates; Sampling of aggregates; Mechanical and shape properties of aggregates, Aggregate texture and skid resistance, polishing of aggregates; Proportioning and Blending of aggregates: Super pave gradation, Fuller and Thompson's Equation, 0.45 power maximum density graph; Use of locally available materials in lieu of aggregates.

UNIT IV:

Bitumen and Bituminous Concrete Mix Characterization: Bitumen sources and manufacturing, Chemistry of bitumen, bitumen structure, Rheology of bitumen, Elastic modulus, Dynamic modulus, visco-elastic and fatigue properties, creep test, stiffness modulus of bitumen mixes using shell nomographs; Resilient, Diametral Resilient and Complex (Dynamic) Moduli of Bituminous Mixes, Permanent Deformation Parameters and other Properties. Modified bitumen: Crumb Rubber Modified bitumen, Natural rubber modified bitumen, polymer modified bitumen; Introduction to emulsified bitumen and its characterization; Long term and short term ageing and its effect on bitumen performance, Tests to simulate ageing of bitumen viz. RTFOT and PAV. Desirable properties of bituminous mixes, Design of bituminous mixes: Modified Marshall's specifications, Hubbard Field method of mix design, Hveem's method of mix design; Introduction to super pave mix design procedure

UNIT V:

Cement and Cement Concrete Mix Characterization: Types of cements and basic cement properties, Special cements; Quality tests on cement; Tests on cement concrete including compressive strength, flexural strength, modulus of elasticity and fatigue properties; Introduction to advanced concretes like self compacted concrete, Light weight concrete, Roller Compacted Concrete for pavement application; IS method of cement concrete mix design with case studies; Role of different admixtures in cement concrete performance; Joint filers for Jointed Plain Cement Concrete Pavements and their characterization; Nano technology applications in cement concrete.

Text Books:

1. Asphalt Institute. Mix Design Methods – For Asphalt Concrete and Other Hot-Mix Types Manual Series No. 2 (MS-2), Asphalt Institute, Kentucky, USA, 1997.
2. Highway Materials, Soils and Concretes by Atkins, N. Harold, Fourth Edition, 1980, Prentice-Hall.

References:

1. Highway Materials by Kerbs Robert D. and Richard D. Walker, McGraw-Hill, 1971.
2. Ministry of Road Transport and Highways. *Specifications for Road and Bridge Works*, Fifth Revision, Indian Roads Congress, New Delhi, India
3. "*The Shell Bitumen Handbook*", by Read, J. And Whiteoak, D., Fifth edition, Shell Bitumen, Thomas, Telford Publishing, London 2003
4. Mallick, R.B. and T. El-Korchi *Pavement Engineering – Principles and Practice*, CRC Press, Taylor and Francis Group, Florida, USA, 2009

VNR Vignana Jyothi Institute of Engineering & Technology

I Year – I Sem. M.Tech (Highway Engineering)	**L**	**T/P/D**	**C**
	3	**1**	**4**

(HIG 02) PAVEMENT ANALYSES & DESIGN

Course Objectives:

Student shall be able to

- **Understand** the basic modeling concepts used to **analyze** flexible and rigid pavements.
- **Appreciate** pavement management concepts to better manage road pavement.
- Apply the various types of highway appurtenance to **enhance** the safety of motorists.
- **Learn** on rigid pavement design components

Course Outcomes:

After the completion of the course student should be able to

- Understand the **Design** factors flexible and rigid pavements
- **Explain** the assumptions in pavement layers and carryout design of flexible and rigid pavement.
- **Discriminate** different methods of flexible pavement design
- **Different** methods of rigid pavement design

UNIT I:

Introduction: Road Pavements and pavement layers - types, functions, choice Factors affecting design and performance of flexible and rigid pavements – Pavement design factors, loads – axle load distribution, ESWL, EWL,VDF due to varying loads, Sub grade support - CBR and plate bearing tests, Resilient Modulus, fatigue tests, permanent deformation Pavement material Characteristics, climatic, drainage and environmental factors, their effects and evaluation.

UNIT II:

Stresses and Deflection / Strain in Flexible Pavements: Application of elastic theory, stresses, deflections / strains in single, two and three layer system, Applications in pavement design, Problems.

UNIT III:

Flexible Pavement Design: Empirical, semi empirical and theoretical design approaches, principle, advantages and application. Outline of other common design methods such as AASHTO and Asphalt Institute methods, Problems.

UNIT IV:

Stresses in Rigid Pavements: Types of stresses and causes; Introduction to Westergaard's equation for calculation of stresses in rigid pavements due to wheel loads and temperature; Considerations in rigid pavement analysis, wheel load stresses, warping stresses, frictional stresses, combined stresses.

UNIT V:

Rigid Pavement Design: Design of cement concrete pavements for highways; PCA and ACI Methods: Design of joints, reinforcements, tie bars, dowel bars and slab thickness as per IRC guidelines. Design features of continuously reinforced concrete pavements, Problems.

Text Books:

1. Huang, Y.H. *Pavement Analysis and Design*, Second Edition, Dorling Kindersley (India) Pvt. Ltd., New Delhi, India, 2008.
2. Asphalt Institute. Thickness Design – Asphalt Pavements for Highways and Streets Manual Series No. 1 (MS-1), Asphalt Institute, Kentucky, USA, 1999.

References:

1. Principles of Pavement Design**"** by Yoder and Witczak, John Wiley and sons Inc(second edition) 1975
2. Modern Pavement Management" by W.Ronald Hudson, Ralph Haas and Zeniswki Mc Graw Hill and Co
3. IRC Design guides, IRC 37-2012, IRC 81-1997, IRC 58 – 2011, IRC 59 – 1976, IRC 101-1988, MORTH, 5th Edition, New Delhi, 2013
4. Design & Performance of Road Pavements" David Croney, Paul Croney, Mc Graw hill Book Co.

VNR Vignana Jyothi Institute of Engineering & Technology

I Year – I Sem. M.Tech. (Highway Engineering)	**L**	**T/P/D**	**C**
	3	**1**	**4**

(HIG 03) HIGHWAY GEOMETRIC DESIGN

Course Objectives:

Student shall be able to

- **Understand** the various factors affecting in pavement design
- **Knowledge** on design aspects and methods for rural and urban roads.
- **Introduce** students the principal of highway design, road safety and highway construction materials.
- Start applying these skills to **design** roads and select material for road construction.

Course Outcomes:

After the completion of the course student should be able to

- **Apply** knowledge in fixation of ideal alignment and design of highway
- **Describe** design element: sight distance, horizontal curvature, super elevation, grades, visibility on vertical curves, cross section elements
- Use fundamental physics and mathematical **knowledge** in deriving geometric design equations
- **Plan** surveys, preparation of survey forms and data collection from field for highway design

UNIT I:

Highway System: Functional Classification of Highway System, Highway Design Controls: Topography, Driver characteristics, Vehicle Characteristics, Traffic, Capacity and Level of Service, Design Speed. Objectives of Geometric Design. Cross Section Elements: IRC Design specifications, Pavement Surface characteristics: Skid Resistance, Road Roughness; Camber, Objectives, design standards. Specifications for hill roads.

UNIT II:

Geometric Design of Highway Element: Sight distances: Objectives, Types, factors affecting, Problems on Sight distance, Alignment: Types, Objective and Factors affecting alignment, Horizontal alignment: Objectives, design Criteria, super-elevation, extra widening and Design of transition curves. Vertical alignment: Objectives, design Criteria, Types of gradient, Grade Compensation, design of summit and valley curves, combination of vertical and horizontal alignment, design of expressways, IRC standards and guidelines for design and Problems.

UNIT III:

Intersection Design: Introduction of Intersection Design: Objectives, Types of Intersections, Design Principles for Intersections. Design of At-grade Intersections: Objectives, Channelization, Traffic Islands and Design standards for intersection. Design of Rotary Intersection: Objectives, Advantages and Disadvantages and determining the capacity. Grade separated Interchanges: Objectives, Types, warrants and Design standards.

UNIT IV:

Highway Design and Specifications: Design Considerations: Design considerations for rural, urban arterials, expressways, and other rural Roads. Urban roads -design speeds, volumes, levels of service. IRC Specification for Expressway and Rural Roads.

UNIT V:

Miscellaneous Facilities on Highway: Pedestrian facilities: Objectives of Pedestrian facilities, Types of Pedestrian facilities on Urban Roads and IRC Specification. Cycle Tracks: Objectives, Types of cycle track, Guidelines and IRC Design standards Bus bays: Objectives, Types, Guidelines and IRC Design standards. Parking facilities: Objectives, Types, Guidelines and IRC Design standards.

Text Books:

1. Principles and Practice of Highway Engineering by L.R.Kadiyali and N.B.Lal, Khanna, 7th edition, 2007
2. Traffic Engineering and Transportation Planning by L.R. Kadiyali and N.B.Lal, Khanna Publishers, 2009

References:

1. Highway Engineering by S.K. Khanna, C.E.G. Justo and Veeraraghavan A 10th Ed., Nem Chand & Bros, 2013.
2. Transportation Engineering-An introduction by C. JotinKhisty and B.KentLall, Prentice-Hall, India, 2008
3. IRC Codes for Signs, Markings and Mixed Traffic Control in Urban Areas.
4. Design codes IRC: SP: 41-1994, IRC SP: 31-1992, IRC 43-1994, Indian Roads Congress, New Delhi. Highway Capacity Manual 2010, Transportation Research Board

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I Year – I Sem. M.Tech. (Highway Engineering)	**L**	**T/P/D**	**C**
	3	**0**	**3**

(HIG 11) HIGHWAY PROJECT FORMULATION & ECONOMICS
(Elective – I / Elective -II)

Course Objectives:
Student shall be able to

- **Introduced** to economic evaluation concepts, preparation of detailed project report
- **Formulate** in understanding and computation of road user cost for evaluation of highway projects
- **Analyze b**asic methods of economic analysis carried for transportation engineering projects
- **Recognize** the importance of EIA for transportation engineering projects

Course Outcomes:
At the end of the course, students will be able to:

- **Classify** the requirements in project formulation, Non-monetary and monetary, development of cash flow diagrams, Preparation of Project and components in Highway Planning
- Fundamental **knowledge** calculation of road user costs methodologies for economic evaluation of accidents
- **Estimate** transportation project feasibility using economic methods.
- **Explain** factors Environmental impact assessment for highway projects.

UNIT I:
Project Formulation- Requirements in project formulation, Criteria fixation, Components of project, Non-monetary and monetary Criteria in formulation of project, Decision making Criteria input in Project formulation. Preparation of DPR - Guidelines , Transport Projects and development of cash flow diagrams, Cost and benefit components, Discounting criteria, Preparation of Project, Highway Planning, Traffic infrastructure, Project formulation, Road Network project development. Need for Economic Evaluation; Principles of economic evaluation; Welfare economics; Social costs, Vest change, Rate of return

UNIT II:
Road user costs - Value of Travel time Savings - Economic concept of evaluation of travel time savings; Issues connected with evaluation of travel time savings. Vehicle operating costs- Components of VOC, Road User Cost study in India; Accident costs; Methodologies for economic evaluation of an accident ; Factors involved, Basic methods of economic analysis

UNIT III:
Basic methods of economic analysis; Equivalent Uniform Annual Cost Method; Present worth of cost method; Equivalent uniform annual net return method; Net present value method; Benefit

cost ratio method; Rate of Return Method. Applications of these methods to highway projects.

UNIT IV:
Project appraisal by shadow pricing with case studies. Toll system analysis, Financial analysis ; Budgeting

UNIT V:
Environmental impact assessment: Basic Concepts, Objectives, Transportation Related Environmental Impacts – Vehicular Impacts – Safety and Capacity Impacts – Roadway Impacts – Construction Impacts, Environmental Impact Assessment – Environmental Impact Statement, Environment Audit, Typical case studies

Text Books:
1. Transportation Engineering Economics by Heggie. I. G.; Mc Graw Hill Publishers, 1972.
2. Economic Analysis for Highways by Winfrey. R; International Textbook; 1st edition, 1969

References:
1. Traffic Engineering and Transport Planning by L.R Kadiyali, Khanna Publishers, 2000
2. Road User Cost Study, CRRI
3. IRC: SP: 30-1993, Manual on Economic Evaluation of Highway Projects in India, IRC Publications, New Delhi.
4. IRC: SP: 19; 2001**,** Manual For Survey, Investigation & Preparation of Road Projects, IRC Publications, New Delhi.

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	3	**0**	**3**

(HIG 12) ENVIRONMENTAL IMPACT ASSESSMENT FOR TRANSPORTATION PROJECTS
(Elective – I / Elective -II)

Course Objectives:
Student shall be able to

- **Assess** environmental impacts of road traffic under various policy options Estimate air pollution concentrations as a function of emission, meteorology, topography and they built environment from road traffic
- **Promote** the integration of all forms of transport and land use planning, leading to a better, more efficient transport system
- Plan, develop and manage land transport system to support a quality environment while making optimal use of our transport and safeguarding the **well-being** of the travelling public
- **Deliver** an effective land transport network that is integrated, efficient, cost-effective and sustainable to meet the nation's needs

Course Outcomes:
After the completion of the course student should be able to

- **Understand** national and international contexts on transport and the environment. Basic understanding of the concepts of traffic and environment management for sustainability
- **Knowledge** of policies and reports which have a strong bearing on local and global air pollution and sustainability issues
- **Appreciate** the multiple complexities of successful planning, data collection and analysis and identification of improvements
- **Realize** to current issues relating to traffic flow, road safety and air quality

UNIT I:
Introduction: Environment and its interaction with human activities – Environmental imbalances. Attributes, Impacts, 'Indicators and Measurements - Concept of Environmental Impact Assessment (EIA); Environmental Impact Statement, Objectives of EIA, Advantages and Limitations of EIA

UNIT II:
Environmental Indicators: Indicators for climate - Indicators for terrestrial subsystems - Indicators for aquatic subsystems - Selection of indicators - Socio-economic indicators – Basic information - Indicators for economy - Social indicators - Indicators for health and nutrition - Cultural indicators - Selection of indicators.

UNIT III:

Environmental issues: Water resource development - Land use - Soil erosion C1nd their short and long term effects - Disturbance and long term impacts - Changes in quantity and quality of flow ¬Sedimentation – Environmental impact assessment of water resource development structures – Case studies, Water Quality Impact Assessment - Attributes, Water Quality Impact Assessment of Water

UNIT IV:

Project Resources: Data Requirements of Water Quality Impact Assessment for Dams, Impacts of Damson Environment, Case Studies. Environmental Issues in Industrial Development: On-site and Off-site impacts during various stages of industrial development, Long term climatic changes, Green house effect, Industrial effluents and their impaction natural cycle, Environmental impact of Highways, Mining and Energy development

UNIT V:

Methodologies for Carrying Environmental Impact Assessment: Overview of Methodologies .Ad hoc, Checklist, Matrix, Network, Overlays, Benefit Cost Analysis, Choosing a Methodology, Review Criteria.

Text Books:

1. Environmental Impact Assessment by Canter, L.W., McGraw Hill Pub. Co., New York, 1997
2. Environmental Analysis of Transportation Systems by Louis Franklin Cohen and Gary Richard Mc Voy, John Wiley & Sons, 1982

References:

1. Environmental Impact Analysis by Jain, R.K., Urban, L.V., Stracy, G.S., an Nostrand Reinhold Co., New York, 1991
2. Environmental Fate and Transport Analysis with Compartment Modeling by Keith W. Little, CRC Press, Taylor & Francis Group, 2012.
3. NCHRP Report 541. Consideration of Environmental Factors in Transportation Systems Planning, TRB, 2005.
4. NCHRP Synthesis 272, Best Management Practices for Environmental Issues Related to Highway and Street Maintenance: A Synthesis of Highway Practice, National Research Council, TRB, 1999

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(HIG 13) ROAD SAFETY & TRAFFIC MANAGEMENT
(Elective – I / Elective -II)

Course Objectives:

Student shall be able to

- Apply the **principles** of a systems approach to the analysis of risk factors for road traffic injuries.
- **Apply** methods for reducing traffic impacts on commUNITies such as traffic calming strategies, accident reductions and parking management.
- **Discuss** the key risk factors for road traffic injuries.
- **Understand** the role of ITS in Dynamic Traffic Management

Course Outcomes:

After the completion of the course student should be able to

- **Explain** the factors for road traffic injuries.
- **Analyze** and provide solutions for traffic calming and parking management.
- **Evaluate** the risk factors for road traffic injuries.
- **Understand** the role of ITS in Dynamic Traffic Management.

UNIT I:

Road Accidents: Causes, Scientific investigations and data collection, Analysis of individual accidents to arrive at real causes, statistical methods of analysis of accident data, Basic concepts of Road accident statistics, safety performance function: the empirical Bayes method Identification of Hazards road location. Application of computer analysis of accident.

UNIT II:

Safety in Road Design: Operating the road network for safety, highway operation and counter measures, road safety audit, principles – procedures and practice, code of good practice and checklist, vehicle design factors, driver and Friction characteristics influencing road safety.

UNIT III:

Road Signs and Traffic Signals: Classifications, location of signs, measures of sign effectiveness, Types of visual perception, sign regulations, sign visibility sign variables, text versus symbols. Road Markings: Role of Road marking, classification, visibility. Traffic Signals need, signal face, Illumination and location of signals, factors affecting signal design, pedestrian safety, fixed and vehicle actuated signals, Design of signals, Area Traffic control. Delineators, Traffic Impact Attenuators, Road Side rest areas, safety Barriers, Traffic Aid Posts.

UNIT IV:

Traffic Management Techniques: Integrated Safety improvement and Traffic Calming Schemes, speed and load limit, Traffic light, safety cameras, Test on driver and vehicles, pedestrian safety issues, parking, Parking enforcement and its influences on accidents. Travel demand management; Method of Traffic management measures: Restrictions of Turning movements, One-way streets, Tidal Flow operation methods, Exclusive bus lanes and closing side – streets; latest tools and techniques used for road safety and traffic management. Road safety issues and various measures for road safety; Legislation, Enforcement, Education and Propaganda, Air quality, Noise and Energy Impacts; Cost Road Accidents.

UNIT V:

Incident Management: Introduction, characteristics of traffic incidents, types of incidents, Impacts, Incident management process, Incident traffic management; applications of ITS: Motorist information, Equipment used; Planning effective Incident management program, Best practice in Incident management programs. National importance of survival of Transportation systems during and after disasters especially cyclones, earth quakes, floods etc. and manmade disasters like sabotage, terrorism etc.

Text Books:

1. Observational Before-After Studies in Road Safety by Ezra Hauer, Pergamon Press, 1997 (reprinted 2002).
2. Institute of Transportation Engineers (ITE), the Traffic Safety Toolbox: A Primer on Traffic Safety, ITE, 1999.

References:

1. Traffic Collision Investigation by J. Stannard Baker, Northwestern University Center for
2. Public Safety, 2002
3. Traffic Control and Road Accident Prevention by Popkess C.A.Chapman and Hall, 1997
4. The Handbook of Road Safety Measures by Rune Elvik and Truls V, Elsevier, 2004.
5. Statistical and Econometric Methods for Transportation Data Analysis by Simon Washington, Matthew K, and Fred Mannering, Chapman & Hall/CRC Press, 2003.

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	3	**0**	**3**

(HIG 14) EVALUATION AND STRENGTHENING OF PAVEMENTS
(Elective – I / Elective -II)

Course Objectives:

Student shall be able to

- Learn the **importance** of evaluation and strengthening of pavements
- **Explains** the stress and strains for various types of pavements and its evaluation procedures
- **Reveal**s the structural and functional requirements of pavements along with its failures
- Understands overlay designs **concepts** performed through BBD and FWD

Course Outcomes:

After the completion of the course student should be able to

- **Assess** how functional and structural pavements occurs
- **Understands** different types of distress in pavements
- **Perform** BBD and FWD test for evaluation of pavements
- **Explains** the different types of pavement failures

UNIT I:

Introduction: Highway and airport pavements, Types and component parts of pavements, their differences - Factors affecting design and performance of pavements.

UNIT II:

Stresses and Deflections in Flexible & Rigid Pavements: Stresses and deflections in homogeneous masses. Wheel load stresses, various factors in traffic wheel loads; ESWL and EWL factors. Pavement behavior under transient traffic loads; Factors affecting design and performance of 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.

UNIT III:

Structural and Functional Requirements of Flexible and Rigid Pavements: Pavement distress; different types of failures & its causes – structural & functional safety – repair and retrofitting of road structures.

UNIT IV:

Evaluation of Surface Condition: Methods of measurement of skid resistance, unevenness, ruts and cracks. Pavement surface condition evaluation by physical measurements, by riding comfort and other methods; their applications.

UNIT V:

Evaluation of Pavement Structural Condition: Evaluation by non-destructive tests such as FWD, Benkelman Beam rebound deflection using BBD for flexible overlay design, Plate load test, wave propagation and other methods of load tests; evaluation by destructive test methods, and specimen testing.

Text Books:

1. Principles of Pavement Design' by Yoder, E.J., and Witczak, 2nd ed. John Wiley and Sons, 1975.
2. The design and performance of road pavements by Croney, D. and P. Croney, McGraw-Hill Book Company, London, UK, 1991

References:

1. Test Book of Highway Engineering' by Khanna and Justo, Nem chand brothers, Roorkee-2004.
2. Pavement Management System' by Haas and Hudson McGraw Hill Book Co., New York, 1994.
3. Pavement Design and Materials by Papagiannakis, A.T. and E.A. Masad, John Wiley and Sons, New Jersey, USA, 2008.
4. Pavement Engineering – Principles and Practice by Mallick, R.B. and T. El-Korchi CRC Press, Taylor and Francis Group, Florida, USA, 2009.

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	3	**0**	**3**

(STR11) ADVANCED CONCRETE TECHNOLOGY
(Elective – I / Elective -II)

Course Objectives:

Student shall be able to

- **Adopt the correct** type of cement to suit the particular requirements depending on exposure conditions.
- **Design** economic concrete mix proportion for the given exposure conditions and with the available materials, to the extent possible for the desired strength.
- **Address** various problems that arise during concreting operations.
- **Judge and resolve** any controversy that arises regarding material suitability confidently by substantiating through field and laboratory tests.

Course Outcomes:

After the completion of the course student should be able to

- **Determine** the properties of concrete ingredients i.e. cement, sand, coarse aggregate by conducting different tests and decide the suitability.
- **Recognize** the effects of the rheology and early age properties of concrete on its long-term behavior.
- Use **appropriate** chemical admixtures and mineral additives for achieving the desired properties.
- Use **advanced** laboratory techniques to assess the strength characteristics after disasters.

UNIT I:

Concrete Making Materials: Cement – Bogue's compounds –Hydration process - Types of cement –Aggregates-Gradation curves-Combined aggregates-Alkali silica reaction–Admixtures-mineral and chemical admixtures.

UNIT II:

Fresh and Hardened Concrete: Fresh concrete-workability tests on concrete–setting times of fresh concrete- segregation and bleeding.

Hardened Concrete: Abram's law – Gel- space ratio - maturity concept –stress strain behavior-creep and shrinkage-durability of concrete-Non-destructive testing of concrete. Introduction to XRD & SEM Analysis.

UNIT III:

High Strength Concrete: Microstructure-manufacturing and properties--ultra high strength concrete. High performance concrete- Requirements and properties of high performance concrete-design considerations.

UNIT IV:

Special Concretes: Light weight concrete-Self Compacting concrete-Polymer concrete -Fiber reinforced concrete –Reactive powder concrete-Bacterial concrete-Geo-polymer concrete – Requirements and guidelines- Advantages and Applications – Porous pavement – White Topping – Roller compacted concrete.

UNIT V:

Concrete Mix Design: Quality control –Quality assurance-Quality audit-Mix design by various methods-BIS method-DOE method-ACI method - Erntroy& Shacklock's method.

Text Books:

1. Concrete Technology by M.L. Gambhir, McGraw Hill Education (India) Pvt. Ltd,5th edition
2. Concrete Technology by M.S. Shetty,S. Chand& Co.

References:

1. Concrete technology by A.M. Neville& J J Brooks, Low price edition 2004, Pearson Education.
2. Concrete –Microstructure, properties and materials by P. Kumar Mehta & Paulo J.M. Monteiro- 3rd edition published by Tata Mc Graw Hill Education Pvt. Ltd.
3. Properties of concrete by A.M. Neville, Pearson publishers,
4. Design of Concrete Mixes by N. Krishna Raju, CBS Publications.

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(STR16) PRINCIPLES OF BRIDGE ENGINEERING
(Elective – I / Elective -II)

Course Objectives:

Student shall be able to

- **Develop** site selection and design concepts for bridge
- **Build up** a clear understanding of conceptual design.
- **Understand** the load flow mechanism and identify loads on bridges
- Carry out conceptual **design,** selecting suitable geometry and also understand maintenance aspects of a bridge

Course Outcomes:

After the completion of the course student should be able to

- **Apply knowledge** of mathematics, science and engineering to meet desired needs such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
- **Compile** and function with multidisciplinary teams
- **Identify**, formulate and solve engineering problems
- Use the **techniques**, skills and modern engineering tools necessary for engineering practice

UNIT I:

Investigations and Planning: Investigations for culverts and minor bridges, Investigations for major bridges - topography, catchment, hydrology, geotechnical aspects, construction resources - design flood discharge - methods, linear waterway. choice of foundation for piers and abutments - types - cost ratio - clearance - choice of foundation - open, pile, well, block foundations - relative suitability. Setting out for piers and abutments for minor and major bridges. classification of culverts and bridges - components of bridge structures - loading standards - railway and road loading standards.

UNIT II:

Foundations: Open foundations - excavation under G W T., baling out, cofferdams - floating caisson process - individual footings - raft footings - design considerations. pile foundations - types - load tests - strength - lateral resistance - construction of driven and cast-in-site piles - design considerations. Foundations II: Well foundation - types - caissons - design of wells - well sinking - open sinking and pneumatic sinking - materials for staining - concrete in staining - bottom plug, sand filling and well cap

UNIT III:

Piers, Abutments, Superstructure: Piers and abutments - function, aesthetics, materials; wing walls - construction aspects. Superstructure - types - choice of materials - design principles, considerations and criteria of pipe culverts, slab culvert, box culvert, causeways. RC Bridges - Design Principles: Design of T beam and slab bridge - design principles of RC balanced cantilever bridge and articulation. Design concepts of rigid frame bridges - thumb rule design of masonry arch bridges - design of bowstring girder bridge and components.

UNIT IV:

Elements of Pre-stressed (Post Tensioned and Pre-tensioned) Concrete Bridge Design: Size, pre-stress force, eccentricity, design of cables, end blocks. Features and Design Consideration Of Bridges: Suspension bridges, cable stayed bridges and their components; bearings - types - design of rocker and roller bearings.

UNIT V:

Construction And Maintenance: Bridge superstructure construction - supports and centering for RC bridges - erection of precast RC girders and steel girder bridges - maintenance of bridges, strengthening of masonry arch bridges.

Text Books:

1. Essentials of Bridge Engineering by Victor J. Oxford and IBH Publishing Co., New Delhi, 1999.
2. Design of Bridges by Krishna Raju N, Oxford and IBH Publishing Co., New Delhi, 1998.

References:

1. Design of bridge structures by T.R. Jagadeesh, PHI learning pvt. Ltd.2009.
2. Bridge Deck analysis simplified by Bakht B and Jaeger L G, McGraw Hill book company, Singapore, 1987
3. Bridge Engineering by Ponnuswamy S, Tata McGraw Hill Publishing Co., New Delhi, 1986.
4. Design of concrete Bridges by M.G.Aswani, V.N.Vazirani and M.M.Ratwani McGraw Hill Publishing, 2000.

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(MTH31) COMPUTER BASED NUMERICAL METHODS
(Open Elective - I)

Course Objectives:
Student shall be able to

- Apply the basic **knowledge** of mathematics in engineering.
- Provide a formidable base for **analysis** and programming using computer applications.
- **Develop** the ability in programming and solutions based on the various analysis tools.

Course Outcomes:
After the completion of the course student should be able to

- **Apply** it to basic (linear) ordinary and partial differential equations.
- **Identify** mathematical model for solution of common engineering problems.
- **Formulate** simple problems into programming models.

UNIT I:
Solution of Algebraic and Transcendental Equations: Introduction, errors and approximations, binary and decimal systems, computing roots using direct methods (bisection, regulafalsi) and Iterative Methods (fixed point iterative and Newton-Raphson Methods) and applications
Lab: Implementation of algorithms on computers using any computer language and comparison (Bisection and N-R Method)

UNIT II:
Solution of Simultaneous Linear Equations: Introduction, Methods of solution direct (Matrix inversion and Gauss elimination methods) and iterative methods (Gauss Jacobi and Gauss seidel methods) disadvantages of ill-conditioned systems and pivoting, Eigen value, computing largest Eigen value by power method and applications
Lab: Implementation of algorithms on computers and comparison

UNIT III:
Interpolation, Numerical Differentiation and Integration: Introduction, Interpolation for equally spaced data and unequally spaced data by Newton's methods, Lagrange's method and cubic splices. Numerical differentiation formulae using finite differences and interpolation. Newton-Cotes integration formulae (Trapezoidal and Simpsons rules) and Gauss quadrature formulae and applications.
Lab: Implementation of algorithms on computer (Newton's formula, Trapezoidal and Simpsons rule)

UNIT IV:

Numerical Solutions of Differential Equations (ODE & PDE): Introduction, solution of ODE of IVP type by Euler's methods, Runge - Kutta methods (single step) and multistep methods**.** Numerical solution of PDE using finite difference schemes approach, (Parabolic, Elliptic type) and applications

Lab: Implementation of R-K method (for ODE) Bender Schmidt and Crank- Nicolson methods (for PDE)

UNIT V:

Linear Programming Problems (LPP): Introduction, formation of LPP, methods of solution. Graphical method, simplex methods, dual simplex method, artificial variables, Big-on method, Transportation problems (by VAM) and applications.

Lab: Implementation of Simplex algorithm

Text Books:

1. Numerical Methods by Dr.B.S.Grewal
2. Numerical Analysis by R.L.Burden&J.D.Faires

References:

1. Numerical Methods for Engineers by Chopras S.C and Canale R.P
2. Numerical Methods for scientists and Engineers by Iyenger& Jai

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(ENG32) PROFESSIONAL AND TECHNICAL COMMUNICATION
(Open Elective - I)

Introduction:
This course aims to offer students a practical approach to professional and technical communication; and to focus specifically on verbal and written communication. Additionally, the course is designed to build confidence and; group communication and public speaking competence. Each unit in the syllabus is devised so as to include a writing component as well as an oral component.

Course Objectives:
- To enable the students to write without errors in spelling, mechanics, grammar and punctuation; resume, business letters, proposals and reports to accomplish academic as well as professional goals.
- To train students to write clearly, cohesively, emphatically and concisely.
- To groom students to speak accurately and fluently and prepare them for real world activities
- To train students in soft skills through group discussion to improve their EQ.

Course Outcomes:
Students will be able to:
- analyze communication situations and audiences to make choices about the most effective and efficient way to communicate and deliver messages
- write resume, business letters, project proposals and reports
- speak fluently and address a large group of audience and participate in discussions.
- navigate through complex environments through interpersonal and collaborative skills.

UNIT I:
- Oral Communication :Self-introduction
- Applications and Covering letters
- Resume Writing
- Job Interviews

UNIT II:
- Oral Communication: Impromptu Speech
- Reading Business and Technical Texts
- Writing E-mails
- Writing Business Letters and Business Memos

UNIT III:

- Oral Communication: Group Discussions
- Summarizing and Synthesising
- Writing Abstracts

UNIT IV:

- Oral Communication : Debate
- Writing Business Proposals
- Writing Technical Proposals

UNIT V:

- Oral Communication: Making Presentations
- Interpreting Graphic Information
- Writing Business Reports
- Writing Technical Reports

Text Book and Materials:

1. Ashraf Rizvi, M (2005). Effective Technical Communication, Tata Mc Graw Hill Publishing Company Limited, New Delhi.
2. M. Raman and S. Sharma, Technical Communication: Principles and Practices, OUP, 2004. (Indian Edition)

References:

1. William S. Pfeiffer, (2012) Technical Communication: A Practical Approach (7th ed.) Longman
2. Burnett, Rebecca. Technical Communication. 5th Ed., Heinle, 2001.
3. Gerson Sharon J. and Steven Gerson : Technical Writing Process and Product. 3rd edition, New Jersey: Prentice Hall 1999
4. Markel, Mike**.** Technical Communication: Situations and Strategies (8th EDITION (2006-2007)
5. R. C. Sharma and K. Mohan, Business Correspondence and Report Writing, Third Edition, TMH, 2002. (Indian Edition)
6. Anderson, Paul V. (2003). Reports. In Paul V. Anderson's Technical Communication: A Reader-Centered Approach (5th ed..) (pp. 457-473). Boston: Heinle.

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	3	**0**	**3**

(STR31) ENERGY EFFICIENT BUILDINGS
(Open Elective - I)

Course Objectives:

Student shall be enabled to

- **Study** the design of energy efficient buildings which balances all aspects of energy, lighting, space conditioning and ventilation.
- **Learn** passive solar design strategies.
- **Understand** the use of materials with low embodied energy.
- **Design** the standards for ventilation and different climatic zones

Course Outcomes:

After the completion of the course student should be able to

- **Design** energy efficient buildings which balance all aspects of energy, lighting, space conditioning and ventilation.
- **Design** energy efficient buildings with passive solar design strategies.
- **Use** materials with low embodied energy.
- **Apply** concepts in Energy auditing

UNIT I:

Introduction: Energy required for building construction - Heat Transfer – Measuring Conduction –Thermal Storage – Measurement of Radiation – The Green house Effect – Psychrometry Chart – Measuring latent and sensible heat. Thermal Comfort – Site Planning and Development – Temperature – Humidity – Wind – Optimum Site Locations – Sun Protection – Types of Shading Devices – Conservation – Heating and Cooling loads.

UNIT II:

Passive Solar Heating and Cooling: General Principles of passive Solar Heating – Key Design Elements - Direct gain Trombe Walls, Water Walls, Convective Air loops – Concepts – Case Studies – General Principles of Passive Cooling – Ventilation – Predicting ventilation in buildings – window ventilation calculations - Radiation – Evaporation and dehumidification – Mass Effect – Load Control – Air Filtration and odor removal – Heat Recovery in large buildings

UNIT III:

Day Lighting and Electrical Lighting: Materials, components and details - Insulation – Optical materials – Radiant Barriers Glazing materials - Day lighting – Sources and concepts – Building Design Strategies –Case Studies – Electric Lighting –Light Distribution – Electric Lighting control for day lighted buildings – Illumination requirement – Components of Daylight factor – Recommended Daylight factors – Day lighting analysis – Supplementary Artificial Lighting Design

UNIT IV:

Heat Control and Ventilation: Requirements – Heat transmission through building sections – Thermal performance of Building sections – Orientation of buildings – Building characteristics for various climates – Thermal Design of buildings Influence of Design Parameters – Mechanical controls –Examples. Ventilation – Requirements – Minimum standards for ventilation – Ventilation Design – Energy Conservation in Ventilating systems – Design for Natural Ventilation.

UNIT V:

Design for Climatic Zones: Energy efficiency – an overview of design concepts and architectural interventions –Energy efficient buildings for various zones – cold and cloudy – cold and sunny –composite – hot and dry – moderate – warm and humid – case studies of residences, office buildings and other buildings in each zones – Energy Audit – Certification

Text Books:

1. Energy – efficient Buildings in India by Majumdar, M. (Ed), Tata Energy Research Institute, Ministry of Non Conventional Energy Sources, 2002.
2. Handbook on energy audits and management Tata Energy Research by Tyagi, A. K.(Ed),

References:

1. Environmental Control System by Moore, F., McGraw Hill Inc., 2002
2. Sun, Wind and Light – Architectural Design Strategies by Brown, G.Z. and DeKay, M., John Wiley and Sons Inc, 2001
3. Energy Conservation in Commercial and Residential Buildings by Chilogioji, M.H., and Oura, E.N., Marcel Dekker Inc., New York and Basel, 1995.
4. Energy Conservation Standards – For Building Design, Construction and Operation by Dubin, F.S. and Long, C.G., McGraw Hill Book Company ,1990.

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(HIG51) PAVEMENT ENGINEERING LAB

CYCLE I:

Tests on Aggregates: Aggregates Sampling, Gradation- Shape tests- Elastic recovery - Aggregate Impact Test- Los Angeles Abrasion Test – Crushing strength of Aggregates- Specific Gravity Test and Water Absorption Test - bulking of sand.

CYCLE II:

Bitumen & Bituminous Mixes: Penetration Test -Ductility Test- Elastic recovery Softening point test - Viscosity test- Kinematic Viscosity and Absolute Viscosity Tests - Marshall Stability Mix Design-Analysis, Binder content determination.

CYCLE III:

Soil: Basic Tests-Gradation-dry and wet-Hydrometer Analysis- CBR Test, Soil stabilization.

CYCLE IV:

Mix Design: Wet Mix Macadam – CBR method.

Text Books:

1. Highway materials and pavement testing by Khanna, S.K., Justo, C.E.G., and A. Veeraragavan, 5th edition, Nem chand and brothers, Roorkee, India, 2009.

References:

1. Huang, Y.H. *Pavement Analysis and Design*, Pearson Prentice Hall, New Jersey, USA, 2004.
2. Relevant IS, IRC, ASTM Codes.

Note: All tests are performed as per IS, ASTM, AASHTO, TRL, IRC, BS procedures / specifications and guidelines

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(HIG61) MINI PROJECT – I

A mini project work shall be carried out on any topic in Highway engineering and a seminar should be given on the same along with a brief report.

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(HIG04) PAVEMENT MANAGEMENT SYSTEMS

Course Objectives:
Student shall be able to

- **Understand** Network level and project level PMS.
- **Evaluate** Pavements on Functional and Structural basis.
- **Learn** Alternative design strategies of pavements and Economic evaluation.
- **Appreciate** the role of Expert System in PMS.

Course Outcomes:
At the end of the course students will be able to

- **Identify** and select the various Design strategies of pavement using PMS Concept.
- **Evaluate** the pavement condition using Functional and Structural Evaluation techniques.
- **Appraise** and Estimate the life cycle cost of Pavement.
- **Relate** ANN and Fuzzy concepts for PMS.

UNIT I:
Introduction: Definition -Components of Pavement Management Systems, Essential features Pavement Management Levels and functions: Ideal PMS- Network and Project levels of PMS- Influence Levels- PMS Functions- Function of Pavement evaluation

UNIT II:
Pavement Performance: Serviceability Concepts- roughness- Roughness Components- Equipment-IRI -modeling techniques, structural condition deterioration models, mechanistic and empirical models, HDM and other models, comparison of different deterioration models. Functional Evaluation: Functional and Structural deterioration models, unevenness prediction models and other models, comparison. Case studies. Equipments

UNIT III:
Evaluation of Pavement Structural Capacity: Basics- NDT and Analysis—Condition Surveys- Distress-Destructive Structural Analysis- Application in Network and Project Levels

UNIT IV:
Design Alternatives and Selection: design objectives and constraints, basic structural response models, physical design inputs, alternate pavement design strategies and economic evaluation, life cycle costing, analysis of alternate pavement strategies based on distress and performance, case studies. Equipments

UNIT V:

Expert Systems and Pavement Management: Role of computers in pavement management, applications of expert systems for managing pavements, expert system for pavement evaluation and rehabilitation, knowledge-based expert systems.

Text Books:

1. 'Pavement Management System' by Ralph Haas and Ronald W. Hudson, McGraw Hill Book Co. 1978
2. Modern Pavement Management by Haas, R.W.R.Hidson and J.P.Zaniewski. Krieger Publishing Company. Malabar, Florida, 1994.

References:

1. Infrastructure Management: Integrating Design, Construction, Maintenance, Rehabilitation, and Renovation by Hudson, W. R., R. Haas and W. Uddin Mc Graw Hill, Newyork, 1997.
2. Proceedings of North American Conference on Managing Pavement
3. Proceedings of International Conference on Structural Design of Asphalt Pavements NCHRP, TRR and TRB Special Reports.
4. Pavement Analysis and Design by Huang, Yang H. Prentice-Hall, Inc Englewood Cliffs, New Jersey 1993

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	3	**1**	**4**

(HIG05) TRAFFIC ENGINEERING

Course Objectives:

Student shall be able to

- **Introduce** students on the basic concepts of traffic engineering.
- **Analyze** capacity and level of service of highways.
- **Identify** the importance and types of parking and traffic safety in day-to-day life.
- **Design** signals at the intersection.

Course Outcomes:

After the completion of the course student should be able to

- Explain basic **characteristics** of traffic engineering like speed, flow and density.
- **Analyze** and calculate the capacity and level of service of any given highway.
- **Formulate** the parking demand and design a parking facility.
- **Design** the signals at the intersection.

UNIT I:

Basic Traffic Characteristics: Speed, volume and concentration. Relationship between Flow, Speed and Concentration Volume Studies - Objectives, Methods; Speed studies - Objectives: Definition of Spot Speed, time mean speed and space mean speed; Methods of conducting speed studies.

UNIT II:

Speed Studies: Methods of conducting speed studies; Presentation of speed study data; Head ways and Gaps; Critical Gap; Gap acceptance studies. **Highway Capacity and Level of Service:** Basic definitions related to capacity; Level of service concept; Factors affecting capacity and level of service; Computation of capacity and level of service for two lane highways Multilane highways and freeways.

UNIT III:

Parking Studies and Analysis: Types of parking facilities - on street parking and off street Parking facilities; Parking studies and analysis. **Traffic Safety:** Accident studies and analysis; Causes of accidents - The Road, The vehicle, The road user and the Environment; Engineering, Enforcement and Education measures for the prevention of accidents, Road safety audit.

UNIT IV:

Traffic Control and Regulation: Traffic Signals - Design of Isolated Traffic Signal by Webster method, Warrants for signalization, Signal Co-ordination methods, Simultaneous, Alternate, Simple progression and Flexible progression Systems.

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UNIT V:

Traffic and Environment: Detrimental effects of Traffic on Environment; Air pollution; Noise Pollution; Measures to curtail environmental degradation due to traffic.

Text Books:

1. Traffic Engineering and Transportation Planning by L.R. Kadiyali, Khanna Publishers, 2011.
2. Traffic Engineering by Roger P. Roess, Elena S. Prassas and William R. McShane, Prentice Hall, 4th edition, 2010.

References:

1. Traffic & Highway Engineering by Nicholas J Garber, Lester A Hoel, Third edition, Bill, 2011
2. Design codes IRC: SP: 41-1994, IRC SP: 31-1992, IRC 43-1994, Indian Roads Congress, New Delhi.
3. Highway Capacity Manual 2010, Transportation Research Board
4. Coleman A. O 'flaherty, Transport Planning and Traffic Engineering, Butterworth Heinemann, 2009.

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	3	**1**	**4**

(HIG06) URBAN TRANSPORTATION PLANNING

Course Objectives:
Student shall be able to

- **Introduce** students on basic concepts and methods of urban transportation planning in the India.
- **Design,** conduct and administer surveys to provide the data required for transportation planning.
- **Understand** and apply travel demand modeling, mode choice modeling and traffic Assignment Modeling
- **Identify** importance of transportation planning in cities.

Course Outcomes:
After the completion of the course student should be able to

- **Plan** and conduct surveys to provide the data required for transportation planning.
- **Recognize** zonal demand generation and attraction regression models.
- **Develop** and calibrate trip generation rates for specific types of land use developments.
- **Predict** the final decisions among planning alternatives that best integrate multiple objectives such as technical feasibility and cost minimization.

UNIT I:
Urban Transportation Planning: Goals and objectives - Hierarchical levels of Transportation planning - Forecast - Implementation - Constraints.UTP survey – Inventory of land use-Introduction of classical four stage modeling. Zonal Classifications.

UNIT II:
Trip Generation and Trip Distribution Trip classification - productions and attractions - Multiple regression models - Category analysis - Trip production models - Trip distribution models – Linear programming approach.

UNIT III:
Mode Split and Traffic Assignments: Behavioral models - Probabilistic models - Utility functions – logit models - Two stage model. Traffic assignment - Assignment methods - Route-choice behaviour - Network analysis.

UNIT IV:
Land-Use and its Interaction: Lowry derivative models - Quick response techniques - Non-Transport solutions for transport problems. Characteristics of urban structure. Town planning concepts.

UNIT V:

Applications of UTP: Preparation of alternative plans - Evaluation techniques - Plan implementation – Monitoring - Case studies.

Text Books:

1. Principles of Urban Transportation System Planning by Hutchinson, B.G., McGraw Hill, 1974.
2. An Introduction to Transportation Planning (The Living Environment) by Bruton, M. J., UCL Press, London, UK, 2000

References:

1. Transportation Engineering by C.J. Khisty and B. Kent Lall, Prentice Hall of India Pvt. Ltd., 2002.
2. Transportation Engineering and Planning by C.S. Papacostas and P.D. Prevedouros, Prentice Hall of India Pvt. Ltd., 2001.
3. UTP Lecture Notes by by Chari, S.R. Regional Engg. College, Warangal 1978.
4. Metropolitan Transportation Planning by Dicky J.W.,Script Book Co., Washington, D.C., 1975.

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	3	**0**	**3**

(HIG21) REMOTE SENSING & GIS
(Elective – III / Elective - IV)

Course Objectives:
Student shall be able to

- **Describe** and **define** various concepts of Remote Sensing and GIS.
- Enable them to **analyze** remote sensing and GIS data.
- **Appraise** the importance accuracy of remote sensing and GIS data
- **Apply** Remote Sensing and GIS knowledge in solving various highway engineering related problems.

Course Outcomes:
After the completion of the course student should be able to

- **Describe** different concepts and terms used in Remote Sensing and GIS
- **Compare** and process different data sets
- **Evaluate** the accuracy and **decide** whether a data set can be used or not.
- **Demonstrate** various applications in RS and GIS.

UNIT I:
Remote Sensing: Introduction- Principle of remote sensing, components of remote sensing, Remote sensing platforms, Radiometric quantities, Electromagnetic radiation and its properties, Electromagnetic energy laws, Interaction of EMR with earth features, Interaction of EMR with atmospheric features, atmospheric effects on remote sensing data, spectral reflectance curves, Spectral properties of soil, water, vegetation. Advantages and Disadvantages of Remote Sensing Data

UNIT II:
Satellites and Sensors: Sensors - Remote sensing sensors types, along track scanners, across track scanners. Sensor Characteristics – Swath, IFOV, Nadir view, Spatial Resolution, Spectral Resolution, Temporal, Resolution, Radiometric resolution, Atmospheric ,Radiometric, Geometric corrections **Satellites –** Satellite orbits, Geostationary and polar satellites, various satellites and their main applications, IRS satellites.

UNIT III:
Remote Sensing Data Interpretation, Processing and Enhancement: Elements of visual interpretation, Image enhancement techniques - necessity and importance, contrast enhancement techniques, low pass (smoothing) filters and high pass (sharpening) filters, linear and non-linear filtering techniques, edge detection, supervised classification, unsupervised classification, and Classification accuracy. Introduction to GPS and DGPS.

UNIT IV:

Geographical Information System: Introduction, Definition and Terminology, Components of GIS, GIS Data Input - Keyboard entry, Manual digitizing, Scanning methods, Errors in digitizing, Data output formatting and output devices, GIS Data Models – Raster, Vector, TIN, Spatial Data Analysis – Interpolation, Buffering techniques, Overlay operations

UNIT V:

Applications of GIS in Transportation Engineering: Applications of GIS in transportation engineering, GIS based road network planning, Shortest path detection using GIS, Automatic Navigation system using GPS and GIS , Identification of accident hot spots using GIS, GIS based traffic congestion analysis, Network analysis using GIS.

Text Books:

1. Remote Sensing and Image Interpretation by Thomas M. Lillesand and Ralph W.Kiefer, Wiley Publishers, 2006.
2. Introduction to Geographic Information systems by Kang-tsung Chang, McGrawHill Education (Indian Edition), 2008.

References:

1. Remote Sensing and GIS by Basudeb Bhatta , Oxford University Press, 2003.
2. Basics of Remote sensing and GIS by Dr. S. Kumar, Laxmi Publications, 2002
3. Remote Sensing and Geographical Information systems by M.Anji Reddy, B.S.Publications, 2004.
4. Remote Sensing and Geographical Information systems by Kali Charan Sahu, Atlantic Publishers and Distributors, 2009.

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	3	**0**	**3**

(HIG22) RURAL ROAD TECHNOLOGY
(Elective – III / Elective - IV)

Course Objectives:

Student shall be able to

- Must have the **knowledge** about various design factors considered for rural road.
- Familiar with the rural road design and construction aspects.
- To know the importance /role of rural roads as poverty reducer and infrastructure multiplier and how the rural roads act as a facilitators to promote agricultural growth, improve basic health provide economic access to economic opportunities and employment **opportunities**.
- **Important** concepts like classification, socio-economic impact, planning, design, construction and maintenance of the rural roads.

Course Outcomes:

After the completion of the course student should be able to

- Obtain a basic Knowledge to **describe** the need and importance of rural road network and how it influences the current growth of infrastructure in India.
- Learn route **selection** and surveys for road location, planning and alignment, type of material used in pavement construction for rural roads.
- Learn basic principles of geometric design which is **useful** to rural roads pavement design and complete procedure for pavement construction.
- Learn during the **construction** of a rural road what kind of quality control test shall be taken up and after construction what measures shall be taken for maintenance.

UNIT I:

Introduction: Importance of Rural roads, Classification of rural roads, Terrain classification, Socio-economic impact of rural roads. Planning and Alignment: Data base for master plan, Concept of network planning, Rural Roads plan, Road alignment, Governing factors for route selection, Factors controlling alignment, Special considerations while aligning hill roads, Surveys, Detailed project report, Environmental issues

UNIT II:

Geometric Design: Introduction, Design speed, Basic principles of geometric design, Elements, Horizontal and vertical alignment, Alignment compatibility, Lateral and vertical clearances. Road Materials: General, Soil and material surveys, Soil as road construction material, Stabilized soils, Aggregates for pavement courses, New materials and stabilizers, Materials for bituminous construction, Materials for semi-rigid and rigid pavement, Materials for special pavements Climatic suitability of concrete materials

UNIT III:

Pavement Design: Introduction, Design parameters, Pavement components, Design of flexible pavement, Design of semi-rigid pavement, Design of rigid pavement, Design of special pavements, Drainage and Shoulders Specifications and Construction: General, Selection of construction materials and methodology, Earthwork, Sub-base, Base course, Bituminous constructions, Semi-rigid pavement construction, Concrete pavements, Construction of special pavements, Equipment required for different operations.

UNIT IV:

Green Road Concept and Use of Waste Materials: Introduction, Significance of green roads, Fly ash for road construction, Iron & steel and copper slags, Lime-rice husk ash concrete, Recycled concrete aggregate, Other waste materials. Quality Control in Construction: General, Pre-requisite, Specifications and codes of practice, Quality control tests during construction.

UNIT V:

Maintenance: General, Distresses/defects in pavements, Definitions of maintenance activities, Inventory of road and inspection, Types of maintenance, Classification of maintenance activities, Maintenance norms of maintenance cost.

Text Books:

1. IRC: SP 20-2002 ‘’Rural Roads Manual’ Indian road congress, New Delhi, 2002
2. IRC: SP 72-2007 ‘Guidelines for the Design of Flexible Pavements for Low Volume Rural Roads’

References:

1. IRC: SP 62-2004 ‘Guidelines for the Design and Construction of Cement Concrete Pavements for Rural Roads’
2. IRC ‘Specifications for Rural Roads’, MoRD, 2004
3. CRRI ‘Various Reports on Use of Waste Materials’ 2006.
4. Handbook of Transportation Engineering by Myer Kutz, Editor, McGraw-Hill Publishers, 2004

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	3	**0**	**3**

(HIG23) INTELLIGENT TRANSPORTATION SYSTEMS
(Elective – III / Elective - IV)

Course Objectives:
Student shall be able to

- To **understand** ITS architecture and standards.
- To **apply** appropriate ITS technology depending upon site specific conditions.
- **Design** and **implement** ITS components.
- To **understand concept** and **application** of Automated Highway Systems

Course Outcomes:
After the completion of the course student should be able to

- **Differentiate** different ITS user Services.
- **Apply** ITS fir road user safety.
- **Interpret** importance of AHS in ITS.
- **Extend** future research and special project.

UNIT I:
Introduction and ITS Travel Management: System Architecture, Standards, Database – Tracking Database – Commercial Vehicle Operations – Intelligent Vehicle Initiative - Metropolitan ITS – Rural ITS – ITS for Rail network.

UNIT II:
ITS Travel Management: Autonomous Route Guidance System – Infrastructure based systems – Telecommunications – Vehicle – Road side communication – Vehicle Positioning System – Electronic Toll Collection – Electronic Car Parking

UNIT III:
ITS Designs: Modeling and Simulation Techniques - Peer – to – Peer Program – ITS for Road Network – System Design – Mobile Navigation Assistant – Traffic Information Center – Public Safety Program.

UNIT IV:
Automated Highway Systems: Evolution of AHS and Current Vehicle Trends - Vehicles in Platoons – Aerodynamic Benefits - Integration of Automated Highway Systems – System Configurations - Step by Step to an Automated Highway System.

UNIT V:
Spacing and Capacity for Different AHS Concepts – Communication Technologies for AHS - The Effects of AHS on the Environment – Regional Mobility - Impact Assessment of Highway Automation.

Text Books:

1. ITS Hand Book 2000: Recommendations for World Road Association (PIARC) by Kan Paul Chen, John Miles.
2. "Intelligent Transport Systems – Cases and Policies" by Roger R. Stough, Publisher: Edward Elgar, 2001.

References:

1. Intermodal Freight Transport by David Lowe, Elsevier Butterworth-Heinemann Publishers, 2005
2. "Positioning Systems in Intelligent Transportation Systems" by Chris Drane and Chris Rizos, Artech House Publishers, London, 2000
3. "Perspectives on Intelligent Transport Systems" by Joseph M. Sussman, Springer Publishers, 2000
4. Intelligent transport System, Intelligent Transportation primer, Washington, US, 2001.

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	3	**0**	**3**

(HIG24) HIGHWAY CONSTRUCTION AND QUALITY CONTROL
(Elective – III / Elective - IV)

Course Objectives:

Student will able to

- **Learn** and define the various component of pavement structure.
- **Understand**, Design and construct various drainage systems.
- **Gain knowledge** on various equipments used for construction of road.
- **Differentiate** about various construction of base course such as WMM, WBM Etc.

Course Outcomes:

After completion of this course student will able to

- **Recognize** and select the Equipments for the construction of Road.
- **Design** and economize the various constructions of different layers. Such as Base and Sub base course.
- **Identify** and select the maintenance works of various components of road works.
- **Principle** of construction planning and importance of CPM PERT

UNIT I:

Components of road and pavement structure including sub-grade, drainage system, functions, requirements and sequence of construction operations Plants and equipment for production of materials - crushers, mixers, bituminous mixing plants, cement concrete mixers – various types, advantages and choice.

UNIT II:

Drainage – Assessment of drainage requirements for the road and design of various components, drainage materials, Construction of surface and subsurface drainage system and design of filter materials for roads. Drainage for urban roads.

UNIT III

Road construction equipment – different types of excavators, graders, soil compactors / rollers, pavers and other equipment for construction of different pavement layers – their uses and choice Problem on equipment usage charges; Pre-construction surveys and marking on ground - Specifications and steps for the construction of road formation in embankment and cut, construction steps for granular sub-base, quality control tests.

UNIT IV:

Different types of granular base course – WMM, CRM, WBM; specifications, construction method and quality control tests. Different types of bituminous layers for binder and surface courses; their specifications (as per IRC and MORTH); construction method and quality control tests. Different types of sub-base and base course for cement concrete (CC) pavement and

construction method. Construction of cement concrete (PQC) pavements joints quality control during construction. Construction details of interlocking concrete block pavements

UNIT V:

Principle of construction planning, application of CPM and PERT(Problems not included) Road maintenance works – day to day and periodic maintenance works of various components of road works and road furniture. Preparation of existing pavement – patching, profile correction, Special measures to deal with reflection cracks in pavement layers, slipperiness of surface, etc. Special problems in construction & maintenance of hill roads, land slide, causes, investigation, and preventive and remedial measures, protection of embankment and cut slopes.

Text Books:

1. Construction Planning Equipment and Method by Peurifoy, R.L., and Clifford,JS McGraw Hill Book Co.
2. Inc. Hot Mix Asphalt Materials, mixture design and construction by Freddy L Roberts, Prithvi S Kandhal et al, (2nd Edition), National Asphalt Pavement Association Research and Education Foundation, Maryland, USA.

References:

1. Construction Equipment and its Management by Sharma S.C., Khanna Publishers
2. Hot Mix Asphalt Paving Hand book by National Asphalt Pavement Association 5100 Forbes Boulevard, Lanhm, Mary Land, USA
3. MoRTH Manual for Construction and Supervision of Bituminous Works- 2013, Indian Roads Congress
4. MoRTH Manual for Maintenance of Roads- 1989, Indian Roads Congress
5. IRC: 42-1994, IRC:15-2002, IRC SP :11-1988, , 55-2001, 57-2001,58-2001, IRC 19-1977, 27-1967, 29-1988, 34-1970, 36-1970,48-1972,61-1976, 63-1976, 68-1976, 81-1997,82-1982, 84-1983,93-1985, 94-1986, 95-1987, 98-1997, 105-1988.

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	3	**0**	**3**

(HIG25) AIRPORT PLANNING & DESIGN
(Elective – III / Elective - IV)

Course Objectives:
Student shall be able to

- **Understand** the effect of atmospheric variables on aircraft performance
- **Design** Airport airfield components
- **Plan** and **design** capacity of airport Terminals based on Land Traffic
- **Understand** about the aircraft traffic control aids

Course Outcomes:
After the completion of the course student should be able to

- **Explains** direction of runways and its **o**rientation
- **Designs** geometry of Airport Infrastructure
- **Prepare** Structural design of Runways, Taxiways and Apron-gate area
- **Arrange** Master plan for Airport and Terminal area locations.

UNIT I:
Introduction: Growth of air transport, airport organization and associations, Classifications of airports airfield components, airport traffic zones and approach areas. Aircraft Characteristics Related to Airport Design: Components, size turning radius, speed, airport characteristics

UNIT II:
Capacity and Delay: Factors affecting capacity, Determination of runway capacity related to delay, gate capacity, Taxiway capacity. Airport planning, surveys and Design: Airport Site Selection, Runway length and width, sight distances, longitudinal and transverse grades, runway intersections, taxiways, clearances, aprons, numbering, holding apron, noise control, Problems.

UNIT III:
Planning and Design of the Terminal Area: Operational concepts, space relationships and area requirements, vehicular traffic and parking at airports.

UNIT IV:
Airport Grading and Drainage: Grading of airport area, hydrology, design of drainage systems, construction methods, layout of surface drainage and subsurface drainage system, Problems.

UNIT V:
Air Traffic Control and Aids: Runways and taxiways markings, day and night landing aids, airport lighting, ILS and other associated aids.

Text Books:

1. Airport Engineering: Planning, Design and Development of 21st Century Airports by Ashford, N. J., Mumayiz, S. A., and Wright, P. H. , Fourth Edition, John Wiley & Sons, New Jersey, USA, 2011.
2. Planning and Design of Airports by Horonjeff, R., McKelvey, F. X., Sproule, W. J., and Young, S. B., Fifth Edition, McGraw-Hill, New York, USA, 2010.

References:

1. Airport Design and Operation by Kazda, A., and Caves, R. E., Second Edition, Elsevier, Oxford, U.K., 2007.
2. Airport planning and Design by Khanna, S. K., Arora, M. G., and Jain, S. S. Sixth Edition, Nem Chand and Bros, Roorkee, India, 2012.
3. Air Transportation Planning and Design by Kumar, V., and Chandra, S. Galgotia Publications Pvt. Ltd., New Delhi, India, 1999.
4. Airport Systems: Planning, Design, and Management by Neufville, R. D., and Odoni, A. McGraw-Hill, New York, USA, 2003.

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	3	**0**	**3**

(GTE06) ENGINEERING OF GROUND
(Elective – III / Elective - IV)

Course Objectives:

Student shall be able to

- **Know** the need and objectives of ground improvement techniques.
- **Comprehend** the principles of various ground improvement methods
- **Compare** different methods of ground improvement and understand their suitability.
- **Apply** the relevant method to remedy a difficult soil condition.

Course Outcomes:

After the completion of the course student should be able to

- **Apply** the principles of ground improvement to a given site condition
- Work out the choice of right technique to **improve** different difficult grounds
- Ensure safe, stable and economical **construction** for any structure.
- Learn the issues affecting **design** and construction of various methods for soil improvement

UNIT I:

Introduction to Ground Modification: Need and objectives of Ground Improvement, Classification of Ground Modification Techniques – suitability and feasibility, Emerging Trends in ground improvement.

UNIT II:

Mechanical and Hydraulic Modification: Methods of compaction, Shallow compaction, Deep compaction techniques - Vibro-floatation, Blasting, Dynamic consolidation, pre-compression and compaction piles, Field compaction control.; Hydraulic Modification: Methods of dewatering – open sumps and ditches, Well-point system, Electro-osmosis, Vacuum dewatering wells; pre-loading without and with sand drains, strip drains and rope drains.

UNIT III:

Physical and Chemical Modification: Stabilization with admixtures like cement, lime, calcium chloride, fly ash and bitumen. Grouting: Categories of grouting, Art of grouting, Grout materials, Grouting techniques and control.

UNIT IV:

Soil Confinement Systems: Concept of confinement, Gabion walls, Crib walls, Sand bags, Evergreen systems and fabric Formwork. Miscellaneous Techniques: Design, Construction and applications of stone columns, lime columns.

UNIT V:

Modification by Inclusions and Confinement : In-Situ ground reinforcement, ground anchors, rock bolting and soil nailing. Thermal modification, Ground freezing. Filtration, Drainage and seepage control with Geo-synthetics.

Text Books:

1. Engineering principles of ground modification by Manfred R. Hanusmann, McGraw-Hill pub. Co., New York, 2000.
2. Construction and Geotechnical methods in Foundation Engineering by Robert M. Koerner, McGraw-Hill Pub. Co., New York, 2002.

References:

1. Engineering with Geosynthetics by C.V.J. Varma, A.R.G. Rao, G.V. Rao. Divan Enterprises, New Delhi, 1995.
2. Foundation Engineering Hand Book by Winterkorn and Fang, Van Nostrand Reinhold Co., New York, 2006.
3. Soil Improvement by Preloading by Aris C. Stamatopoulos & Panaghiotis C. Kotzios – John Wiley & Sons Inc. Canada, 2003.
4. Ground Improvement Techniques by P. Purushothama Rao Laxmi Publications (P) Limited, 2010.

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	3	**0**	**3**

(STR41) OPTIMIZATION TECHNIQUES IN ENGINEERING
(Open Elective - II)

Course Objectives:

Student shall be able to

- **Define** statement of optimization problem
- **Solve** optimization problems using linear programming
- **Solve** optimization problems using Dynamic programming
- **Optimize** structural elements like beams, trusses and frames and achieve efficient designs based on various applications and objective functions for professional practice.

Course Outcomes:

After the completion of the course student should be able to

- **Understand** Engineering optimization.
- **Classify** and **formulate** the optimization problems.
- **Acquire** the concepts of linear programming & Dynamic programming.
- **Perform** network analysis

UNIT I:

Introduction to Optimization: Introduction - Historical developments – Engineering applications of optimization - statement of an optimization problem - classification of optimization problems - Optimization Techniques. Optimization by calculus: introduction - Unconstrained functions of a single variable - problems involving simple constraints _ Unconstrained functions of several variables - treatment of equality constraints _ Extension lo multiple equality constraints - Optimization with inequality constraints - The generalized Newton-Raphson method.

UNIT II:

Linear Programming: Introduction - Applications of linear programming - standard form of a linear programming problem - Geometry of linear programming problems - Definitions and theorems - Solution of a system of Linear simultaneous equations - pivotal reduction of a general system of equations - Motivation of the simple Method - simplex Algorithm _ Two phases of the simple method.

UNIT III:

Non-Linear Programming: Introduction - Unimoial Function - unrestricted search - Exhaustive search - Dichotomous search - Interval Halving method _ Fibonacci method - Golden section method- comparison of elimination methods _ Unconstrained optimization techniques- Direct search methods - Random search methods _ grid search method - Univariate method - Powell's method - simplex method – Indirect search methods - Gradient of a function - steepest descent method - conjugate gradient - Newton's method.

UNIT IV:

Dynamic Programming: Introduction - Multistage decision processes - concept of sub-optimization and the principle of optimality - computational procedure in dynamic programming - example illustrating the Calculus method of solution - example illustrating the tabular of solution - conversion of a final value problem into an initial value problem - continuous dynamic programming - Additional applications.

UNIT V:

Network Analysis: introduction - Elementary graph theory - Network variables and problem types - Minimum-cost route - Network capacity problems - Modification of the directional sense of the network.

Text Books:

1. Traffic Flow Fundamental by Adolf D. May, Prentice-Hall, New Jersey, 1990.
2. Linear Programming - Methods and Applications by Gan, S.I., McGraw Hill, 2001.

References:

1. Transport Planning and Control by Griffiths J.D., Mathematics in Proceedings of the 3rd IMA International Conference on Mathematics in Transport Planning and Control; Pergamon Publishers, 1998.
2. Introductory Operations Research by H.S. Kasene and K.D. Kumar, Springer (India), Pvt .LTd. 2004.
3. Traffic Engineering by Roger P. Roess, Elena S. Prassas, William R. McShane, Pearson, 2011.
4. Engineering optimization: Theory and practice by SS Rao, New Age International (P) Limited, 3rd edition, 1998.

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I Year – II Sem. M.Tech. (Highway Engineering)	**L**	**T/P/D**	**C**
	3	**0**	**3**

(HIG41) CONSTRUCTION TECHNOLOGY AND PROJECT MANAGEMENT (Open Elective - II)

Course Objectives:

Student shall be able to

- **Understand** role of project management
- **Learn** on preparation of project Schedules, Life cycle cost.
- S**tudy** about critical construction management
- **Understand** about BOT, BOOT & PP projects

Course Outcomes:

After the completion of the course student should be able to

- **Develop** Organization Structure of Construction Company
- **Estimate** Project Cost and Develop Cost Models
- **Prepare** Contract documents
- Arbitration and settlement of **disputes**, arbitration and conciliation Act

UNIT I:

Introduction to Project Management: Construction as industry and its challenges, Role of Project management, systems approach, systems theory and Concepts, Organisation, Management Functions, Overview of Management Objectives, Tools and Techniques, Life cycle of construction projects, time estimates and construction schedules, CPM and PERT, Linear programming, queuing concept, simulation, bidding models, game theory

UNIT II:

Project Cost Estimation: Approximate cost, detailed cost estimates, administrative approval and expenditure sanctions, rate analysis by client and contractor, bidding processes and strategies, Pre-qualification of bidders, construction equipment, equipment economics, various items of construction : Earthwork, Excavation. Earth- moving, Drilling, Blasting, dewatering, foundation, Finishing items, construction safety including of fire and electrical works

UNIT III:

Contract Management: Why law is critical to construction management, contract, its definition, Indian contract Act, documents forming a contract, Tendering and contractual procedures, stages of awarding contract, general conditions of Indian (domestic) contracts, General conditions of International contracts (FIDIC), contract administration; Duties and responsibilities of parties; important site documents, importance of standards and codes in contract documents.

UNIT IV:

Quality Management and Safety in Construction Industry: Quality control by statistical methods, sampling plan, control charts, ISO 14000, Safety Measures, Safety Programmes, Safety Awareness and Implementation of Safety Plan - Compensation

UNIT V:

Interpretation of Contract: Interpretation of contract in case of inconsistency, post contract problems, contract interpretation, concealed conditions, termination of contract, claims and disputes, dispute resolution techniques, negotiations, arbitration and settlement of disputes, arbitration and conciliation Act, alternate dispute resolutions, delay, liquidated damages, actual damages.

Text Books:

1. A Guide to Quantity Surveyors, Engineers Architects and Builders(Vol I: Taking off quantities, Abstracting & Billing; Vol II: Analysis of Prices) by Kharb, K.S.
2. Building and Engineering Contracts by Patil, B.S., Pune

References:

1. Law relating to Building and Engineering Contracts in India by Gajerai, G.T., Butterworths.
2. Construction Cost Engineering Handbook by Anghel Patterson - Marcel DekkenInc
3. Fundamentals of Construction Management and Organisations by K.Waker A Teraih and Jose M.Grevarn;
4. A Guide to the Project Management Body of Knowledge (PMBOK), Draft Copy, 1994. A Publication of the Project management Institute, USA.

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I Year – II Sem. M.Tech (Highway Engineering)	**L**	**T/P/D**	**C**
	3	**0**	**3**

(GTE41) GROUND-FOUNDATION-STRUCTURES INTERACTION
(Open Elective - II)

Course Objectives:

Student shall be able to

- **Develop** an understanding to function on multidisciplinary areas.
- **Introduce** the concepts and terminology of structure soil interaction.
- **Create** ability to identify, formulates, and solve foundation engineering problems.
- **Understanding** the impact of engineering solutions in economic and environmental context.

Course Outcomes:

After the completion of the course student should be able to

- **Identify**, **formulate** and **solve** geotechnical engineering problems.
- **Design** a foundation system for economic and safe aspects for the society.
- **Improvise** techniques, skills, and modern engineering tools necessary for necessary understanding in geotechnical engineering practice.
- **Apply** the theoretical knowledge to solve real life problems in the field.

UNIT I:

Soil-Foundation Interaction: Introduction to soil-foundation interaction problems, Soil behaviour, Foundation behaviour, Interface behaviour, Scope of soil foundation interaction analysis, soil response models, Winkler, Elastic continuum, Two parameter elastic models, Elastic-plastic behaviour, Time dependent behaviour.

UNIT II:

Beam on Elastic Foundation- Soil Models: Infinite beam, Two-parameters models, Isotropic elastic halfspace model, Analysis of beams of finite length, combined footings.

UNIT III:

Analysis of Finite Plates: Axis symmetric loading of circular plate, two-parameter elastic medium, elastic solid medium, Application of strain enerygy method. Rectangular plates-elastic medium, elastic solid medium. Numerical analysis of finite plates – Finite difference method, Finite element techniques, Discrete element method.

UNIT IV:

Analysis of Axially and Laterally Loaded Piles and Pile Groups: Elastic analysis of single pile, Theoretical solutions for settlement and load distributions, Analysis of pile group, Interaction analysis, Load distribution in groups with rigid cap, Load deflection prediction for laterally loaded piles, Sub grade reaction and elastic analysis, Interaction analysis, Pile-raft system.

UNIT V:

Ground-Foundation-Structure Interaction: Effect of structure on ground foundation interaction, Static and dynamic loads.

Text Books:

1. Elastic Analysis of Soil-Foundation Interaction by Selvadurai, A. P. S., Elsevier, 1979
2. Pile Foundation Analysis and Design by Poulos, H. G., and Davis, E. H.,Wiley, 1980

References:

1. Foundation Analysis by Scott, R. F., Prentice-Hall, 1981
2. Foundation Design & Analyses by Bowles, J. E., Mc Graw Hill Education, Fifth Edition
3. Advanced Foundation Engineering by Das, B. M., Cengage learning, Seventh Edition, 2011

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I Year – II Sem. M.Tech. (Highway Engineering)	**L**	**T/P/D**	**C**
	0	**3**	**2**

(HIG52) HIGHWAY MATERIAL CHARACTERIZATION & TRAFFIC SIMULATION LAB

CYCLE I:

Tests on Functional & Structural Characteristics Pavement:

a) Road Roughness survey using MERLIN
b) Pavement evaluation using DCP & BBD Techniques
c) Aggregate Polishing Value and Skid Resistance

CYCLE II:

Bitumen & Bituminous Mix Performance:

a) Test on Rotational Viscometer using Brookfield Viscosity
b) Test on Long Term Ageing
c) Test on Short Term Ageing using RTFO
d) Loss on Heating
e) Resilient Modulus of Bituminous Mixes
f) Rutting Characteristics of Bituminous Mixes

CYCLE III:

Traffic Simulation: Simulation for traffic architecture elements & Traffic Planning using VISSIM, VISUM.

Text Books:

1. Highway materials and pavement testing by Khanna, S.K., Justo, C.E.G., and A. Veeraragavan, 5th edition, Nem chand and brothers, Roorkee, India, 2009.

References:

1. Huang, Y.H. *Pavement Analysis and Design*, Pearson Prentice Hall, New Jersey, USA, 2004.
2. Relevant IS, IRC, ASTM Codes.

Note: All laboratory tests are as per IS, ASTM, AASHTO, TRL, IRC, BS procedures / specifications and guidelines

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I Year- II Sem. M.Tech. (Highway Engineering)	L	T/P/D	C
	0	0	4

(HIG62) MINI PROJECT– II

A mini project work shall be carried out on any topic of Highway engineering and a seminar should be given on the same along with a brief report.

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II Year – I Sem. M.Tech. (Highway Engineering)	L	T/P/D	C
	0	0	4

(HIG63) COMPREHENSIVE VIVA-VOCE

II Year – I Sem. M.Tech. (Highway Engineering)	L	T/P/D	C
	0	0	8

(HIG71) INTERNSHIP / DISSERTATION – PHASE- I

II Year – II Sem. M.Tech. (Highway Engineering)	L	T/P/D	C
	0	0	18

(HIG72) DISSERTATION – PHASE- II